SOCIOTECHNICAL
ENVIRONMENTS

EDITED BY
STEFANO CRABU
PAOLO GIARDULLO
FRANCESCO MIELE
MAURO TURRINI

STS italia

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EDITORS' INTRODUCTION

Performing sociotechnical environments: intersections of bodies, knowledge, artefacts and politics

This volume, the second edition of the STS Italia Proceedings, includes a selection of the works presented at the 6th STS Italia Conference held in Trento (Italy) from the 24th to the 26th of November 2016. The focal theme of the conference, organised by the Italian Society for the Study of Science and Technology in collaboration with the Department of Sociology and Social Research of the University of Trento, was Sociotechnical Environments. As with the previous edition, the conference – organised around twenty thematic tracks and one open track – represented a priceless interdisciplinary discussion arena that facilitated the meeting of different scientific and disciplinary perspectives interested in developing theoretical and empirical reflections on the new challenges for STS, such as the agential materiality or, from another perspective, the intimacy between human subjects and heterogeneous technological objects related to acting in situ or embedded environments (Griswold et al., 2013).

It seems crucial to recognise that the word 'environment' is ubiquitous, as it flows through a wide range of debates in social sciences. The most obvious is its common sense, the meaning that immediately recalls the essential modernistic duality between 'natural' and 'artificial'. Nonetheless, as with other ideas or innovations, the notion of 'environment' is a discursive artefact, as it is pliable enough to be interpreted and domesticated based on the specific and contingent 'needs' of various academic communities. Hence, the notion of 'environment' is currently translated and betrayed in a multiplicity of meanings and interpretative frameworks according to the discipline using it as research object, analytical device or even as a pure conceptual metaphor.

In assuming this complexity, the title of this introduction reverberates the emphasis of the present volume on the scientific debate that in recent

decades has paid increasing attention to the theme of the sociomaterial dimension of 'acting' and 'knowing'. The concept of environment, thus, represents a multi–vocal discursive device, evocative of settings of action densely populated by human and non–human actors (Bruni, 2013; Orlikowski, 2007). Its analytical interest concerns the understanding of the heterogeneous modalities through which the physical features of objects and environments recursively act upon social actors to co–define bodies, knowledge, politics and sense–making practices. Nowadays, it is a widely accepted assumption that technoscience increasingly shapes the environments of our everyday and professional activities. Nevertheless, we should not understand these environments as the mere results of top–down technocratic solutions and rational choices. Rather, they emerge from a collective, dynamic and open–ended process of intersection that directly involves social arrangements and technoscientific processes, human actors and material artefacts, natural resources, political and social movements and cultural frameworks. In this way, reflecting on the sociotechnical co–production of our everyday settings of interactions bestows centrality to the relationship between technoscientific practices and the natural environment, with environmental practices, politics and materialities as pivotal dimensions in the current research agenda in multiple fields and intellectual domains. This multiplicity emerges in the different parts of this volume that refer to the notion of environment as a polysemous entity that crosses different disciplinary fields and analytical interests. The authors did not endorse a monolithic disciplinary identity, but rather tried to establish a dialogue at the intersection of different STS sensitiveness. In spite of a focal common interest in questioning how sociotechnical environments are performed and manufactured in practices, the papers collected in this book are extremely heterogeneous as to their analytical objects.

Overall, the contributions demonstrate a wide set of topics and approaches, which span from infrastructures to political activism and from design practices to gender–technology relationships. At the same time, they share a common analytical frame, an intellectual posture that instead of refuting or adhering to recurring dichotomies such as that between Body and Mind, Nature and Culture, Work and Game, Efficiency and Sustainability, Social and Technical looks at how such dichotomies are shaped. In this way, the volume gives an account of the unavoidable multidimensionality of the sociotechnical dimension of the environments, given that they can be inhabited and co–produced by different people, different epistemic communities (Akrich, 2010; Haas, 1992) and different

technologies. In this respect, addressing the constitutive *agencement* of the 'social' and the 'technical' in everyday environments (Callon, 2008) is more than a 'situationist' or naïve attraction for the material interpellations that can shape and drive human action. On the contrary, it reflects a radical analytical posture, which is agnostic about the nature of actors (humans or not) and is oriented to understand how practices, knowledge, language and symbols are interlaced with technologies, knowledge and spatial arrangements in performing the situated environments of interactions. From this perspective, the contributions presented in this volume explore sociotechnical environments as the emerging results of a set of activities in which expert knowledge (both scientific and experiential) and technologies converge, and thus question the role of situated settings in mediating the technoscientific manufacturing of our social world, and how they relate to broader sociotechnical landscapes (Geel, 2002).

The four sections of this volume reflect the heterogeneity of the conference in terms of the topics, theoretical frameworks and methodological techniques adopted by the different authors. The published contributions are a selection of the full papers submitted to the conference. These were already a selection of the more than 150 abstracts (available as documentation on the conference's website) presented to the various tracks of the conference. The selection of abstracts for the conference was in the charge of the track convenors, while the reviewing and subsequent selection of the full papers for publication in the present proceedings was managed by the editorial team, which has collectively reviewed each paper with the aim to valorise and give a voice to the different perspectives and approaches adopted by the authors. As a result, this publication contains 50 reviewed papers that represent a multi–perspective output by interdisciplinary scholars belonging to different fields and sectors, together animated by a common analytical interest in understanding the multimodal and creative intersection of the material and immaterial objects, human subjects and politics involved in performing the meanings and materiality of different socio–technical environments.

Section 1 (*Environments in the Making. Politics, Interventions and Creativity*) provides multiple perspectives on relationships with the environment: political actions, conflicts, exploitation of natural resources and the quest for harmony. These critical perspectives and promising theoretical insights regarding heterogeneous assemblages of elements

explore the ambiguities and emerging frictions relating to the environment in terms of characterising contemporary environmental issues. Knowledge production processes regarding environments, and how they assemble with technologies, are perspectives applied to studies of different scenarios (e.g. environmental activism, rural development, energy transition, smart grids) in a variety of geographic contexts, ranging from urban areas to Arctic regions, and from Europe to Latin America and Asia.

Section 2 (*Gender, Bodies and Health in Sociotechnical Environments*) highlights how sociotechnical environments are featured in specific technologies, symbolic representations and languages strictly intertwined with the processual redefinition of bodily experiences, as well as 'doing' and 'un–doing' gender practices. Overall, the papers in this section represent case studies grounded in a critical reflection on the gender–technology relationship; some also outline organisational strategies oriented to boost a gender–sensitive culture in sociotechical environments.

Section 3 (*Enacting Objects, Infrastructures and Innovation*) focuses on the interaction between the environment and objects on two main levels. The first is methodological. In this regard, several articles engage with a range of conceptual tools of the 'old' Actor Network Theory, such as 'script', 'delegation' or 'translation', in order to show that the sociality and agency of the objects provide a (still) innovative perspective on work procedures, learning programs or design processes. Second, objects devise new interactions with the environment by representing it, recreating it or including it in, as demonstrated in the case studies presented, socio–technical infrastructures, the digital reconfiguration of care or the design of new materials.

Section 4 (*Designing Environments*) focuses on the socio–technical processes that occur in the design and re–design of artefacts, technologies and infrastructures. On the one hand, in this section technical objects, along with their material features, are represented as non–human agents that populate diverse social realms, thus influencing and orientating people and their courses of actions. On the other hand, various contributions underline how human actors, including when they are conceived in the guise of mere 'end–users', can enact discursive, material and affective practices aimed at domesticating new artefacts. Overall, this section, from both the theoretical and empirical points of view, emphasises how the social and the material are deeply interlocked and how, in particular, in the design field human and non–human actors define each other in a process of mutual constitution.

This volume is the result of collective work organised through several geographically dispersed stages, and we would like to thank several people that have directly and indirectly contributed to the outcome. First, we want to thank STS Italia Board members Federico Neresini, Paolo Magaudda and Marina Maestrutti, together with the members of the local organising team – Attila Bruni, Massimiano Bucchi, Claudio Coletta, Michela Cozza, Antonella De Angeli, Silvia Fornasini, Teresa Macchia, Sergio Minniti, Mariacristina Sciannamblo, Giacomo Poderi and Maurizio Teli – for their contribution to the overall design of the 6th STS Italia Conference – Sociotechnical Environments programme. Many thanks to the several convenors and organisers of the tracks at the conference; they have been able to structure the main theme into a plurality of topics and questions, and have been responsible for the selection of abstracts and for feedback on the presentations during the conference: Maria Carmela Agodi, Simone Arnaldi, Sonia Brondi, Sara Colombo, Vincenzo D'Andrea, Gabriel Dorthe, Christine Fassert, Jeanne Guien, Liam Heaphy, Michalon Jérôme, Raineau Laurence, Marina Maestrutti, Paolo Magaudda, Alvise Mattozzi, Sergio Minniti, Baptiste Monsaingeon, Annalisa Murgia, Annalisa Pelizza, Giuseppe Pellegrini, Giuseppina Pellegrino, Luigi Pellizzoni, Barbara Pentimalli, Sung–Yueh Perng, Manuela Perrotta, Ilenia Picardi, Enrico Maria Piras, Barbara Poggio, Cristina Popescu, Roberta Raffaetà, Hasegawa Reiko, Barbara Saracino, Nicolae Stefan, Assunta Viteritti, Giuseppe A. Veltri and Paolo Volonté. We are also grateful to Sergio Minniti for his work in publishing production.

Finally, we have to stress that this volume is released by STS Italia, under the label STS Italia Publishing, which enabled this publication thanks to its financial support. As with the previous edition, this volume is released as an Open Access Digital Publication with the aim of fostering the scientific activities of the Society and its public relevance, and of increasing the visibility of these works by means of supporting alternative ways of scientific publishing.

Stefano Crabu (University of Padova)
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References

Akrich, M. (2010) From Communities of Practice to Epistemic Communities: Health Mobilizations on the Internet. *Sociological Research Online*, 15. [Online] Available from: http://www.socresonline.org.uk/15/2/10.htm [Accessed: September 25th, 2017].

Bruni, A., Pinch, T. and Schubert, C. (2013) Technologically Dense Environments: What For? What Next?. *Tecnoscienza: Italian Journal of Science & Technology Studies*, 4 (2), 51–72.

Callon, M. (2008) Economic Markets and the Rise of Interactive Agencements: From Prosthetic Agencies to Habilitated Agencies. In Pinch, T. and Swedberg, R. (eds.), *Living in a Material World: Economic Sociology Meets Science and Technology Studies*. Cambridge: MIT Press

Geels, F.W. (2002) Technological Transitions as Evolutionary Reconfiguration Processes: A Multi–level Perspective and a Case–study. *Research Policy*, 31 (8), 1257–1274.

Griswold, W., Mangione, G. and McDonnell, T.E. (2013) Objects, Words, and Bodies in Space: Bringing Materiality into Cultural Analysis. *Qualitative Sociology*, 36 (4), 343–364.

Haas, P.M. (1992) Introduction: Epistemic Communities and International Policy Coordination. *International Organization*, 46 (1), 1–35.

Orlikowski, W.J. (2007) Sociomaterial Practices: Exploring Technology at Work. *Organization Studies*, 28 (9), 1435–1448.

SECTION I

Environments in the Making. Politics, Interventions and Creativity

Exploring the Interface of Environmental Activism and Digital Surveillance

Diletta Luna CALIBEO[*a] and Richard HINDMARSH [a]

[a] Griffith University

The topic of this paper is the emergent issue of surveillance of environmental activists through new and social media, as interests that potentially threaten the 'security of the state'. The latter is a frame that emerged post–9/11 to revise surveillance of criminal activities to also include the activities of social movements, including environmental activists. Following a background on environmental activism and surveillance, we find new and social media in contexts that enable both environmental activism and digital surveillance. In regard to the latter, we explore the concept of 'ecoterrorism', which frames certain understandings of environmental activism as acts of terrorism. We then briefly refer to recent cases of digital surveillance of environmental campaigners in Canada, Pennsylvania, and Australia. Finally, we investigate the extent to which digital surveillance may influence the protest activities of environmental activists, and how environmental activists (and everyday citizens) respond to surveillance. Summing up, we reflect first on the potential of digital surveillance to curb environmental activism with its aim to protect the environment and move towards strong sustainability and green economies; and second, on the potential of environmental activism to resist or manage surveillance.

Keywords: New and social media; online surveillance; environmental activism; ecoterrorism

Introduction

The 'security of the state' is a seemingly growing but rather opaque frame of States that emerged post–9/11 to justify and/or inform the

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[*] Corresponding author: **Diletta Luna Calibeo**| e–mail: **dilettaluna.calibeo@griffithuni.edu.eu**

monitoring of a range of terrorist activities. Along with their expansion to new categories of claimed terrorism, is, for example, the category of social movements including environmental activism. Online surveillance also emerged in complementing and expanding traditional forms of surveillance.

International focus on online surveillance is particularly centred on the notion of 'terrorism' (Dauvergne and Lebaron, 2014; Fuchs et al., 2012). However, little scholarly attention has so far been paid to the online surveillance of environmental activists; but this may be because it is still a highly emergent field. It is an important area to investigate as not only does online surveillance raise civil liberties issues, but for environmental activism it potentially acts as a constraint to better addressing global environmental problems (see also Hindmarsh and Calibeo, this volume).

Accordingly, the aim of this paper is to identify and better understand the substance, key issues, and implications of online surveillance for environmental activism. It is informed by two themes: (i) *the interface of environmental activism and new and social media*, and (ii) *the interface of surveillance and ecoterrorism*, with subthemes of surveillance of environmental activists, and of participatory surveillance. These themes, in utilising the thematic analytical approach of Owen (1994), were discerned from a wide range of sources with relevance to the fields of environmental politics; science, technology and society studies (STS); and new media studies. In addition, grey literature such as 'networks' of blogs, as new forms of new and social media databases and archives, and other websites, were drawn on.

The interface of environmental activism and new and social media

Typically, environmental activists are found in the environmental movement, which is described as a 'loose, noninstitutionalised network of informal interactions' that includes individuals and organisations at 'varying degrees of formality … engaged in collective action motivated by shared identity of concern about environmental issues' (Rootes, 2007, p. 610). Activism is typically referred to as 'sustained collective action with a political purpose' (Dauvergne and Lebaron, 2014, p. 7). Environmental activism can thus be described as 2purposeful and effortful engagement in behaviours aimed at preserving or improving the quality of the environment, and increasing public awareness of environmental issues' (Fielding, McDonald and Winnifred, 2008, p. 319).

This engagement may occur through a range of behaviours, including 'protesting, rallying, petitioning, educating the public, lobbying government and corporations, participating in direct actions such as blockades or participating in voluntary conservation or revegetation work' (Fielding, McDonald and Winnifred, 2008, p. 319; also O'Brien, 2013, p. 2). These behaviours are now often informed by the use of new and social media; however, it is difficult to clearly discern digital and non–digital aspects of environmental activism as they often complement each other. For instance, Gerbaudo (2012) observed that social media has been recently and successfully used by activists as a means to organise and coordinate mobilisation in social uprisings, including the 2011 Occupy Wall Street movement. However, Gerbaudo (2012) also highlighted that new and social media complement face–to–face interaction, which is crucial for social movements to gain larger support.

In the STS literature, digital technologies are conceptualised as complex and globalizing sociotechnological systems (Berkhout, Smith and Stirling, 2004; Fuchs, 2010; Meijer et al., 2006). Such systems are understood as the 'interplay of humans, organizations, and technical systems', highlighting the interconnections between technological innovation and society (Dalpiaz, Giorgini and Mylopoulos, 2011, p. 1). Sociotechnological systems thus constitute the interface between technological and social infrastructures–social arrangements, practices, relationships, values, and behaviours); in other words, they are an important part of human organisation (Star, 1999; also Miller, Sarewitz and Light, 2008).

At this interface, citizens routinely connect with dispersed people otherwise not encountered in 'increasingly homogeneous immediate communities' (Wojcieszak, Baek and Delli Carpini, 2009, p. 1093). Citizens apply public dialogue on new and social media through publishing opinions, reviewing, challenging, and pressuring organisations and institutions. These actions enable broader civic participation in environmental decision making (e.g. Zavestovski, Shulman and Schlosberg, 2005), as new conduits of environmental activism (Leeder, 2007; Lester and Hutchins, 2009).

In the environmental activism arena, new and social media are most often used in relation to protests, chronic technological disasters (Kera, Rod and Peterova, 2013; Muralidharan, Dillistone and Shin, 2011; van Laer and van Aeist, 2010), old growth forest campaigns (Lester and Hutchins, 2009), and anti–consumerist campaigns (Micheletti and Stolle 2008). This use of new and social media readily aligns to democratically–informed participatory movements on environment and technoscience that have

steadily emerged over the last three decades (Beck, 1998; Hindmarsh and Matthews, 2008).

A notable social media environmental mobilisation occurred in response to BP's 2010 Gulf of Mexico oil disaster (Anderson, 2014; Hindmarsh and Calibeo, this volume). Among other things, this action prominently aired the company's long historical record of 'bypassing safety measures and environmental laws' (Muralidharan, Dillistone and Shin, 2011, p. 226). However, while environmental and anti–BP groups grew and were highly active on new and social media through Facebook, Twitter, and blogs (Anderson 2014; Bennett, Segerberg and Walker, 2014; Muralidharan, Dillistone and Shin, 2011), questions remain on the extent that the online protest activities impacted 'on policy and fundamentally changed attitudes towards oil drilling' (Anderson, 2014, p. 126).

In addition, potential of new and social media for change is challenged by privacy violations, concentration of media ownership, and digital surveillance. The focus of this paper is then on digital surveillance, which has particularly gained critical attention in potentially affecting social movements, Internet users, and society as a whole (Andrejevic, 2014; Fuchs et al., 2012; Morozov, 2011). So, what extent does surveillance challenge digital environmental activism in the context of online surveillance and so–called ecoterrorism?

The interface of surveillance and ecoterrorism

Surveillance is generally understood as the process of watching a suspect person or place (Lyon, 2007). We also refer to surveillance in relation to 'fighting' crime or terrorism in regard to the frame of the 'security of the State', and to actions described as acts of 'ecoterrorism' (Lyon, 2007; van Rest et al., 2014). Environmental activists appear to be a suspect social movement 'category' at the forefront of state surveillance since the environmental movement surfaced in the 1970s (Christoff, 1996; Loadenthal, 2013; Potter, 2011).

Ecoterrorism initially was adopted to describe the so–called 'radical environmental movement' and 'hard core' direct actions (Leader and Probst, 2004, p. 44; also Ackerman, 2003). Such actions, often located at the periphery of environmental movements, were common in the early phase of environmentalism from the late 1970s to the early 1990s. However, they lessened as environmentalism became increasingly mainstreamed (Dunlap and Mertig, 2013; Hutton and Connors, 1999).

Notable direct actions aimed to protect whales and other wildlife on the high seas by Greenpeace and Sea Shepherd; to protect old growth forests from logging by (US) Earth First (Button, John and Brearley, 2002; Leader and Probst, 2004); and to shut down nuclear power stations and biological warfare research and animal testing facilities (Potter, 2011; Walby and Monaghan, 2011). Earth First and the Animal Liberation Front were 'believed responsible for some 600 criminal acts between 1996 and 2002 and some [US]$43 million in damages' (Leader and Probst, 2004, p. 37).In response , by the mid–1990s, 'the FBI in the US and Scotland Yard in the UK were 'monitoring the actions of certain eco–terrorist groups' (Eagan, 1996, p. 14; also Walby and Monaghan, 2011).

Infiltration was a traditional surveillance practice to place undercover officers among environmental groups. For example, at the 1992 Twyford Down protest in the UK 'police and security services infiltrated direct action groups delaying road developments leading to the seizure of the last major occupied tunnel' (Welsh, 2007, p. 366). Surveillance agencies also share intelligence information with private interests, a practice that has raised issues of government accountability (Button, John and Brearley, 2002).

By the 1990s, ecoterrorism had become increasingly institutionalised as a state category for surveillance (Taylor, 1998; Wadman, 1999). In 1998, US Congressman Frank Riggs held a 'Hearing on Ecoterrorism'. According to Taylor (1998, p. 26), it featured a list of witnesses 'stacked with some of the most vocal adversaries of radical environmental and animal liberation movements'. Further hearings on ecoterrorism were planned for the US Senate by Senator Orin Hatch (Taylor, 1998, p. 26)

Post–9/11, the 'Global War on Terrorism' was launched by the Bush administration. Subsequently, the US started to aggressively prosecute 'misdemeanour acts of criminality', including vandalism, theft, trespassing and arson, and to reimage them 'as federally prosecutable acts of terrorism' (Loadenthal, 2013, p. 94; also Button, John and Brearley, 2002; Joosse, 2012). Intensive surveillance operations were further legitimised in the US with the 2001 Patriot Act, which allowed court orders to investigate the activities of social movements if the FBI considered them relevant (Joosse, 2012; Vanderheiden, 2005).

By the late 2000s, the ecoterrorism frame seemed to have become widely accepted by state and private interests, which furthered the idea that so–called 'radical environmentalists' were 'terrorists', who by their actions invited more surveillance (Smith, 2009, p. 564). According to Potter (2011, p. 672), surveillance measures included 'sweeping legislation, grand–jury witch hunts, blacklists, and FBI harassment'. Overall, Potter (2011, p. 673) claimed

that the rhetoric of 'terrorism' was used 'to push a political agenda, instil fear, and chill dissent' (see also Ellefsen and Larsen, 2012; Salter, 2011; Walby and Monaghan, 2011).

In turn, with the rise of new and social media, surveillance began online; for example, through 'data mining', a practice aimed at the 'collection, extraction and analysis of large sets of data by software designed for the purpose', including data from social networks like Twitter and Facebook (Harvey 2014, p. 26; see also Han, Kamber and Pei, 2011). Data mining also included collecting information on metadata (literally data about data), to create connections and associations among collected data.

Governmental surveillance through data mining – or metadata regimes – started in the US in the early 2000s. In 2004, the Washington Times (2004, p. 1) reported that US government agencies were 'collecting and sifting through massive amounts of personal information, including credit reports, credit–card purchases and other financial data, posing new privacy concerns'. France, Germany, and Australia followed thereafter in legislating metadata retention schemes (Bingemann, 2015).

Digital surveillance strategies, along with the traditional targeted surveillance practices such as infiltration of undercover officers among protest groups, have been used recently to identify and monitor the activities of environmental activists in the protest arena related to oil drilling.

Surveillance of environmental activists and participatory surveillance

In 2010, environmental protests began in Pennsylvania to oppose the Marcellus shale gas project. Citizens raised environmental concerns about dumping polluted wastewater from shale gas mining into rivers, often used as catchments for human water consumption (Howarth, Ingraffea and Engelder, 2011; Matz and Renfrew, 2015). Due to a local OHS intelligence bulletin being mistakenly emailed to a Pennsylvanian citizen opposing the project, protestors became aware that police were monitoring them. As later revealed, the US Office of Homeland Security (OHS) hired a private contractor to obtain information on planned anti–drilling actions (Wilber, 2012); with the identities of activists also passed onto business interests (Harwood, 2010).

Similarly, in 2011, environmental activists opposing the Keystone XL pipeline being laid across North America and Canada were placed under surveillance. TransCanada, the Keystone owner, claimed to local authorities

that activists and local landowners opposing the pipeline were threatening economic state security (Arnsdorf, 2015; Leahy, 2013). Accordingly, in 2011, the police placed Canadian citizens opposing the project under surveillance, as 'threats to national security' (Leahy, 2013, p. 1; also Chisholm and Uechi, 2014). Notably, in late 2013, the Canadian government issued a procurement document for 24/7 monitoring and analysis of social media content, which included 'blogs, micro–blogs, social networking sites including Facebook and Twitter, forums and message boards, traditional news websites and comment sections, and media sharing websites' (Rennie, 2013, p. 1).

Online surveillance also began in Australia. Front Line Action on Coal–an environmental group opposing coal mining–established a blockade in 2012 in Liard State Forest in New South Wales. A 2012 investigation by Australian media revealed that both the State government and the mining industry were monitoring environmental activists through 'state and territory law enforcement agencies', also through 'open source' material: websites and social media (Allard, 2014, p. 2). The mining companies operating in the area (Idemitsu and Whitehaven Coal) also admitted to having hired private security firms to infiltrate undercover officers among environmental activists (Dorling, 2012; Farrell, 2014).

In turn, the investigation also disclosed governmental involvement in surveillance actions. For example, Martin Ferguson (of the Labor Party and the Resources and Energy Minister of Australia in 2009) had requested more surveillance measures to assist energy companies and the police to manage 'the increasing risk of disruptions' during mining operations (Dorling, 2012, p. 1; also Allard, 2014).

These cases illustrate that governments and the corporate sector are engaging, and often collaborating, in surveillance operations of environmental activists, where traditional offline surveillance strategies and online surveillance ones, such as data mining and monitoring of 'open source' material, worked hand–in–hand.

That said, to what extent do such strategies influence the way individuals and activists use new and social media for campaigning? Some scholars argue that these strategies, and more broadly the anti–terror legitimation of online surveillance, has 'heightened sensitivities to surveillance, intensified activist anxieties and produced a climate of fear as well as public insecurity' (Welsh, 2007, p. 365; also Jeffries, 2011).

At the same time, Bingemann (2015, p. 28) has claimed that online surveillance strategies through metadata, for example, are 'ineffective in combatting terrorism', as it remains unclear whether the collection and

perusal of metadata can effectively identify terrorists (also European Commission, 2015). Referring to the 2015 Paris terrorist attacks, Australian Green Party Senator Scott Ludlam argued that there was 'scant evidence' demonstrating success in identifying terrorists through the collection of metadata, because 'It's indiscriminate and by definition harvests vast amounts of useless information on people who aren't persons of interest' (cited in Bingemann, 2015, p. 28). Ludlam also argued, like many others, that traditional targeted surveillance, complemented by social media monitoring, is the most effective surveillance.

In sum, the three cases above illustrate that new and social media can provide additional or alternative conduits for governments and corporations to exert surveillance on environmental activists, but it still seems that targeted surveillance complemented by social media monitoring is more effective.

Concomitantly, new and social media also provide activists with alternative conduits for communication and protest that sometimes inadvertently also challenge surveillance efforts (Doyle and Fraser, 2010). For example, in late October 2016, environmental activists were protesting the 'Dakota Access Pipeline', a 1200–mile pipeline to transport crude oil from North Dakota to Illinois. On Facebook, a post in the environmental camp suddenly went viral in claiming that the Morton County sheriff's department was using Facebook as an intelligence tool to identify and track activists who checked–in to the protest camp on Facebook, in relation to the Standing Rock site (Rogers, 2016).

 In response, Facebook users worldwide were asked by the campaign to 'check in at Standing Rock to overwhelm and confuse' police agencies, and to share the message on their profiles (Levin and Woolf, 2016; Skalicky and Davey, 2016). More than one million people responded in showing a willingness to challenge police surveillance and show solidarity to the protesters' cause (Levin and Woolf, 2016; Rogers, 2016; Shoichet, 2016). Such actions, as suggested by Doyle and Fraser (2010, p. 226), reflect that online surveillance can be 'surprisingly ineffective when confronted with the horizontal, self–organized power of online social networks', or 'many–to–many' communication (see also Hindmarsh and Calibeo, this volume).

Interestingly, in another reaction to being watched, Krueger (2005) observed that some users tended to increase their activities in challenging surveillance; for example, by participating more actively in online debates, as well as in social action. For instance, in the Pennsylvanian case discussed above, the FBI bulletin on surveillance of anti–drilling citizens was widely

disseminated online, informed news media and, empowered anti–drilling organisations to settle surveillance litigation with the state in 2015 (Cusick, 2015). In addition, there is the rise of new encryption technologies that many social media platforms are now providing.

Thus, even though new and social media provide surveillance agencies with a new tool to exert surveillance, it appears that, due to a number of reasons–such as horizontal communication, encryption technologies, the flexible structures of new and social media and the environmental movement–that digital surveillance is by itself ineffective, and that it is more effective when coupled to traditional surveillance.

Conclusions

To reiterate, the aim of this paper was to identify and better understand the interfaces of new and social media, environmental activism, and digital surveillance. Accordingly, we found the following.

First, the interface of environmental activism and new and social media, where social media are used as relatively new vehicles for communication by environmental activists, also enables alternative or complementary conduits for digital surveillance of activists; as shown in the cases of Pennsylvania, Canada, and Australia.

In such conduits, surveillance in its digital form, as in the traditional form, is contextualised by notions of state security, where the frame of 'ecoterrorism' appears to be making an extension from criminal areas to everyday activities of protest, and to 'whole–of–population' online surveillance. Such extension then positions all new and social media users as potential 'digital suspects', which raises questions about human rights in relation to increasingly mainstreamed forms of digital communication. Thus, associated issues of technology, civil liberties, and human rights are becoming more prominent in the critique of new and social media.

Overall, the effectiveness of digital surveillance as standalone surveillance is questioned. Difficulties for digital surveillance in democratic societies will very likely grow in the future with increasing public awareness and reacting user pressure on new and social media and/or telephone companies, and governments, in regard to privacy and surveillance issues. This is due, for instance, in regard to emergent mass encryption technologies sold in relation to privacy issues, and adopted by activists to avoid online surveillance; as demonstrated in the Standing Rock Facebook check–in case, and by the horizontal communication structure of new and social media.

In sum, several evidences strongly question whether digital surveillance by itself can pose an effective constraint to environmental activism. But, this situation appears to change when it used as a surveillance technique to inform traditional or targeted surveillance. Nevertheless, questions about, and the implications of, online surveillance of environmental activism, and, of course, of other social movements and citizens in general, remain. They invite broad public scrutiny and input about the substance, design, purpose, transparency, accountability, and legitimacy, of digital surveillance.

Reference list

Ackerman, G. (2003) Beyond Arson: A Threat Assessment of the Earth Liberation Front. *Terrorism and Political Violence*, 15 (4), 143–170.

Allard, T. (2014) Coal Spies: The Secret World of Black Ops. *The Age*, June 7th. [Online] Available from: http://goo.gl/1dlS2q [Accessed: October 28th, 2016].

Anderson, A. (2014) *Media, Environment And The Network Society*. Basingstoke: Palgrave Macmillan.

Andrejevic, M. (2014) WikiLeaks, Surveillance, and Transparency. *International Journal of Communication*, 8 (1), 2619–2630.

Arnsdorf, I. (2015) Big Oil's Fight for Keystone XL Includes Tracking Critics, Activists. *The Seattle Times*, February 24th. [Online] Available from: http://goo.gl/r8GwgB. [Accessed: October 16th, 2016].

Beck, U. (1998) Politics of Risk Society. In Franklin, J. (ed.), *The Politics of Risk Society*. Polity Press: Cambridge.

Bennett, L., Segerberg, A. and Walker, S. (2014) Organization in the crowd: Peer production in large–scale networked protests. *Information, Communication and Society*, 17 (2), 232–260.

Berkhout, F., Smith, A. and Stirling, A. (2004) Socio–technological Regimes and Transition Contexts. In Elzen, B. (ed.), *System Innovation and the Transition to Sustainability: Theory, Evidence and Policy.* Edward Elgar: Cheltenham.

Bingemann, M. (2015) Call to Ditch 'Overkill' Data Retention Laws after Paris. *The Weekend Australian*, November 21st. [Online] Available from: http://goo.gl/xbstMq [Accessed: October 30th, 2016].

Button, M., John, T. and Brearley, N. (2002) New Challenges in Public Order Policing: The Professionalisation of Environmental Protest and the Emergence of the Militant Environmental Activist. *International Journal of the Sociology of Law*, 30 (1), 17–32.

Chisholm, M. and Uechi, J. (2013) CSIS Spying on Citizens at Alarming Rate, FOIs Reveal. *Vancouver Observer*, February 26th. [Online] Available from: http://tinyurl.com/p2xgrez [Accessed: August 27th, 2016].

Christoff, P. (1996) Ecological Citizens and Ecologically Guided Democracy. In Doherty, B. and DeGeus, M. (eds.), *Democracy and Green Political Thought: Sustainability, Rights, and suspects*. New York: Routledge.

Cusick, M. (2015) Anti–drilling Group Settles Surveillance Litigation with State. *State Impact*, January 22nd. [Online] Available from: http://n.pr/2dCLXPo [Accessed: March 8th, 2017].

Dalpiaz, F., Giorgini, P. and Mylopoulos, J. (2013) Adaptive Socio–technical Systems: A Requirements–based Approach. *Requirements Engineering*, 18 (1), 1–24.

Dauvergne, P. and Lebaron, G. (2014) *Protest Inc.: The Corporatization of Activism*. Cambridge: Polity Press.

Dobson, A., and Sáiz, A. (2005) Environmental Politics: Introduction. *Environmental Politics*, 14 (2), 157–162.

Dorling, P. (2012) Spies Eye Green Protesters. *The Age*, January 7th. [Online] Available from: http://goo.gl/Wv6aoe [Accessed: March 8th, 2017].

Doyle, T., and McEachern, G. (2008) *Environment and Politics*. New York: Routledge.

Doyle, W., and Fraser, M. (2010) Facebook, Surveillance, and Power. In Wittkower, D. (ed.), *Facebook and Philosophy: What's on Your Mind?* Chicago: Open Court.

Dunlap, R. and Mertig, A. (eds.) (2013) *American Environmentalism: The US Environmental Movement, 1970–1990*. New York: Routledge.

Eagan, S. (1996) From Spikes to Bombs: The Rise of Ecoterrorism. *Studies in Conflict and Terrorism*, 19 (1), 1–18.

Ellefsen, S. and Larsen, G. (2012) *Eco Global Crimes: Contemporary Problems and Future Challenges*. Farnham: Ashgate.

European Commission (2015*) Study on Paving the Way for Future Policy Initiatives in the Field of Fight Against Organised Crime: The Effectiveness of Specific Criminal Law Measures Targeting Organised Crime*. Luxembourg: Publication Office of the European Union.

Farrell, P. (2014) Maules Creek Surveillance of Activists May Have Breached Licensing Laws. *The Guardian*, June 12th. [Online] Available from: https://goo.gl/LAr2kv [Accessed: March 8th, 2017].

Fielding, K., McDonald, R. and Winnifred, R. (2008) Theory of Planned Behaviour, Identity and Intentions to Engage in Environmental Activism. *Journal of Environmental Psychology*, 28 (4), 318–326.

Fuchs, C. (2010) StudiVZ: Social Networking in the Surveillance Society. *Ethics and Information Technology*, 12 (2), 171–185.

Fuchs, C., Boersma, K., Albrechtslund, A. and Sandoval, M. (2012) *Internet and Surveillance: The Challenges of Web 2.0 and Social Media*. New York: Routledge.

Gerbaudo, P. (2012). *Tweets and The Streets: Social Media and Contemporary Activism*. London: Pluto Press.

Han, J., Kamber, M. and Pei, J. (2012) *Data Mining: Concepts and Techniques*. Waltham: Elsevier.

Harvey, K. (2014) *Encyclopaedia of Social Media and Politics*. Thousand Oaks: Sage.

Harwood, M. (2010) Trickle Down Surveillance. *Reason.com*, October 5th. [Online] Available from: http://tinyurl.com/3axn4fq [Accessed: March 8th, 2017].

Hindmarsh, R., and Calibeo, D. (2017) The Potential of New and Social Media for Environmental Activism, in this volume.

Hindmarsh, R. and Matthews, C. (2008) Deliberative Speak at the Turbine Face: Community Engagement, Wind Farms, and Renewable Energy Transitions, Australia. *Journal of Environmental Policy and Planning*, 10 (3), 217–232.

Howarth, R., Ingraffea, A., and Engelder, T. (2011) Natural Gas: Should Fracking Stop? *Nature*, 477, 271–275.

Hutton, D. and Connors, L. (1999) *A History of the Australian Environmental Movement*. New York: Cambridge University Press.

Jeffries, F. (2011) Saying Something: The Location of Social Movements in the Surveillance Society. *Social Movement Studies*, 10 (2), 175–190.

Joosse, P. (2012) Elves, Environmentalism, and 'Eco–terror': Leaderless Resistance and Media Coverage of the Earth Liberation Front. *Crime Media and Culture*, 8 (1), 75–93.

Kera, D., Rod, J. and Peterova, R. (2013) Post–apocalyptic Citizenship and Humanitarian Hardware. In Hindmarsh, R. (ed.), *Nuclear Disaster at Fukushima Daiichi: Social, Political and Environmental Issues*. New York: Routledge.

Krueger, B. (2005) Government Surveillance and Political Participation on the Internet. *Social Science Computer Review*, 23 (4), 439–452.

Leader, S. and Probst, P. (2004) The Earth Liberation Front and Environmental Terrorism. *Terrorism and Political Violence*, 15 (4), 37–58.

Leahy, S. (2013) Canada's Environmental Activists Seen as 'Threat to National Security'. *The Guardian*, February 15th. [Online] Available from: http://tinyurl.com/muemau8 [Accessed: March 8th, 2017].

Leeder, K. (2007) Technology and Communication in the Environmental Movement. *Electronic Green Journal*, 1 (25), 1076–7975.

Lester, L. and Hutchins, B. (2009) Power Games: Environmental Protest, News Media and the Internet. *Media, Culture and Society*, 31 (4), 579–595.

Levin, S. and Woolf, N. (2016) Standing Rock: One Million People 'Check in' on Facebook to Support Dakota Pipeline Protesters, *The Guardian*, November 1st. [Online] Available at: http://bit.ly/2et6h3m [Accessed: October 31st, 2016].

Loadenthal, M. (2013) Deconstructing 'Ecoterrorism': Rhetoric, Framing and Statecraft as Seen through the Insight Approach. *Critical Studies on Terrorism*, 6 (1), 92–117.

Lyon, D. (2007) *Surveillance Studies: An Overview*. Cambridge: Polity Press.

Matz, J. and Renfrew, D. (2015) Selling 'Fracking': Energy in Depth and the Marcellus Shale. *Environmental Communication*, 9 (3), 288–306.

Meijer, I., Hekkert, M., Faber, J. and Smiths, R. (2006) Perceived Uncertainties Regarding Socio–technological Transformations: Towards a Framework. *International Journal of Foresight and Innovation Policy*, 2 (2), 214–240.

Micheletti, M. and Stolle, D. (2008) Fashioning Social Justice through Political Consumerism, Capitalism, and the Internet. *Cultural Studies*, 22 (5), 749–769.

Miller C., Sarewitz, D. and Light, A. (2008) Science, Technology, and Sustainability: Building a Research Agenda. *The National Science Foundation*. [Online] Available from http://goo.gl/JDEoh4 [Accessed: November 1st, 2016].

Morozov, E. (2011) *The Net Delusion*. New York: PublicAffairs.

Muralidharan, S., Dillistone, K. and Shin, J–H. (2011) The Gulf Coast Oil Spill: Extending the Theory of Image Restoration Discourse to the Realm of Social Media and beyond Petroleum. *Public Relations Review*, 37 (3), 226–232.

O'Brien, T. (2013) Fragmentation or Evolution? Understanding Change within the New Zealand Environmental Movement. *Journal of Civil Society*, 9 (3), 287–299.

Owen, W. (1984) Interpretive Themes in Relational Communication, *Quarterly Journal of Speech*, 70, 274–287.

Potter, W. (2011) *Green Is the New Red*. San Francisco: City Lights Books.

Rennie, S. (2013) Social Media Monitoring: Feds to Keep Close Eye on Facebook Posts. *Huffington Post*, November 29th. [Online] Available from: http://goo.gl/RvWbXz [Accessed: November 3rd, 2016].

Rogers, K. (2016) Why Your Facebook Friends are Checking in to Standing Rock. *The New York Times*, October 31th. [Online] Available at: http://nyti.ms/2ehp57W. [Accessed: October 31st, 2016].

Rootes, C. (2007) *Environmental Movements*. In Snow D., Soule S. and Kriesi H. (eds.), *The Blackwell Companion to Social Movements*. Malden: Blackwell.

Salter, C. (2011) Activism as Terrorism: The Green Scare, Radical Environmentalism and Governmentality. *Anarchist Developments in Cultural Studies*, 1, 211–238.

Skalicky, S. and Davey, M. (2016) Tension between Police and Standing Rock Protesters Reaches Boiling Point. *The New York Times*, October 28th. [Online] Available at: http://nyti.ms/2eV95YC [Accessed: October 31st, 2016].

Shoichet, C. (2016) Why your Facebook friends are checking in at Standing Rock. *CNN*, October 31st. [Online] Available at: http://cnn.it/2egfKxg [Accessed: October 31st, 2016].

Smith, T. (2009) The Social Media Revolution. *International Journal of Market Research*, 51 (4), 559–561.

Star, S. (1999) The Ethnography of Infrastructure. *American Behavioral Scientist*, 43 (3), 377–391.

Taylor, B. (1998) Religion, Violence and Radical Environmentalism: From Earth First! to the Unabomber to the Earth Liberation Front. *Terrorism and Political Violence*, 10 (4), 1–42.

Vanderheiden, S. (2005) Eco–terrorism or Justified Resistance? Radical Environmentalism and the 'War on Terror'. *Politics and Society*, 33 (3), 425–447.

van Laer, J. and van Aelst, P. (2010) Internet and Social Movement Action Pepertoires: Opportunities and Limitations. *Information Communication and Society*, 13 (8), 1146–1171.

van Rest, J., Grootjen, F., Grootjen M., Wijn, R., Aarts, O., Roelofs, M.L., Burghouts, G.J., Bouma, H., Alic, L. and Kraaij, W. (2014) Requirements for Multimedia Metadata Schemes in Surveillance Applications for Security. *Multimedia Tools Application*, 70 (1), 573–598.

Wadman, M. (1999) US Senate Gets Tough on Animal Activists. *Nature*, 399 (6735), 397–397.

Walby, K. and Monaghan, J. (2011) Private Eyes and Public Order: Policing and Surveillance in the Suppression of Animal Rights Activists in Canada. *Social Movement Studies*, 10 (1), 21–37.

Washington Times (2004) U.S. Agencies Collect, Examine Personal Data on Americans. *Washington TImes*, May 28th. [Online] Available from: http://tinyurl.com/m89duyj [Accessed: March 8th, 2017].

Welsh, I. (2007) In Defence of Civilisation: Terrorism and Environmental Politics in the 21st Century. *Environmental Politics*, 16 (2), 356–375.

Wilber, T. (2012) *Under the Surface: Fracking, Fortunes, and the Fate of the Marcellus Shale*. New York: Cornell University Press.

Wojcieszak, E., Baek, Y. and Delli Carpini, M. (2009) What is Really Going on? *Information, Communication and Society*, 12 (7), 1080–1102.

Zavestoski, S., Shulman, S. and Schlosberg, D. (2006) Democracy and the Environment on the Internet: Electronic Citizen Participation in Regulatory Rulemaking. *Science, Technology & Human Values*, 31 (4), 383–408.

Geo–social Movements by the Inhabitants of Fukushima: 'Solidarity in Fear' Vis–à–Vis the Risks after the Nuclear Accident

Rina KOJIMA[*a]

[a] Université Paris–Est

Since the Fukushima nuclear accident of March 2011, the Japanese authorities have designed and redesigned the evacuation zones on the basis of a radiation dose of 20 mSv/year, which is 20 times higher than the permitted public radiation dose under existing international norms. In Valérie November's analysis of the relation between risk and space, people affected by the accident make different mobility decisions based not only on their perception of risk, but also on the absence or scarcity of the mobility choices available to them. Today, some of these people have brought court actions against Tepco and the government establishing a 'solidarity in fear' vis–à–vis the 'real' and 'unreal' risks, in the formulation employed by Ulrich Beck. Through a number of interviews conducted since 2013, this paper first analyses the trajectory of the people affected by the accident, and then sheds light on their subsequent legal action: how do they navigate through the socio–technical controversy around the health risks of low–dose radiation?; who moves where (or not), and for what reason and purpose?

Keywords: Fukushima; radiation; risk; evacuation zone

Research methodology

This text is based on the analysis of the data collected through two French research projects in which I participated, notably in conducting the interviews: 1) DILEM project[i] and 2) SHINRAI project[ii]. Apart from these projects, the interviews I myself conducted are also included in the analysis. Within these frameworks, I conducted some ninety interviews between

[*] Corresponding author: **Rina Kojima** | e–mail: **rina.kojima@enpc.fr**

2013 and 2015, including a number of retrospective interviews in which I questioned the same people for a second and third time. The interviewees were selected among those living inside or outside the evacuation zones on the basis of their different mobility decisions: to leave, stay or return to the areas affected by the accident. They were organized by certain NGOs, through contacts I had made in previous research between 2012 and 2014, and also by my participation in social events where I was able to meet people who were prepared to be interviewed in situ.

These interviews were based on a qualitative approach using individual forms. In order to maintain a narrative mode in which the interviewees were able to talk freely about their choices and views, I used the prepared questionnaire in cases where interviewees found it hard to provide their own spontaneous input. In general, each interview lasted between 2 and 3 hours, though with some lasting more than 4, either in a single day or spread over 2 days. On the other hand, some interviews lasted an hour or less, due to interviewee unavailability, with the result that questionnaires were not fully completed. Furthermore, while the majority of the interviews were conducted in a private space – in people's homes, in a room reserved by the NGOs or a coffee shop where the interviewees' families and friends were not present, some were conducted in the presence of acquaintances. In these latter cases, I felt that there was a tendency for interviewees to practice self–censorship. Finally, all interviews were recorded, except in cases where the interviewees refused.

Trajectory: geographical movement through the risks

As is well known, as a result of the explosion in March 2011 at the Fukushima Daiichi nuclear power plant, owned by Tokyo Electric Power Company (Tepco), radioactive contamination spread across wide areas of East Japan (fig. 1).

The Japanese government issued mandatory evacuation orders for several areas based on distance from the nuclear power plant and background radiation dose (fig. 2): we can describe the residents of these evacuation zones as 'forced–evacuees'. In addition, some people outside these zones made a decision to leave by themselves because of their anxiety about the radiation risk; we will refer to them as 'self–evacuees'. Finally, many people remained in these zones despite their fear of radiation, because they were unable to leave; we will describe them as 'remainers'.
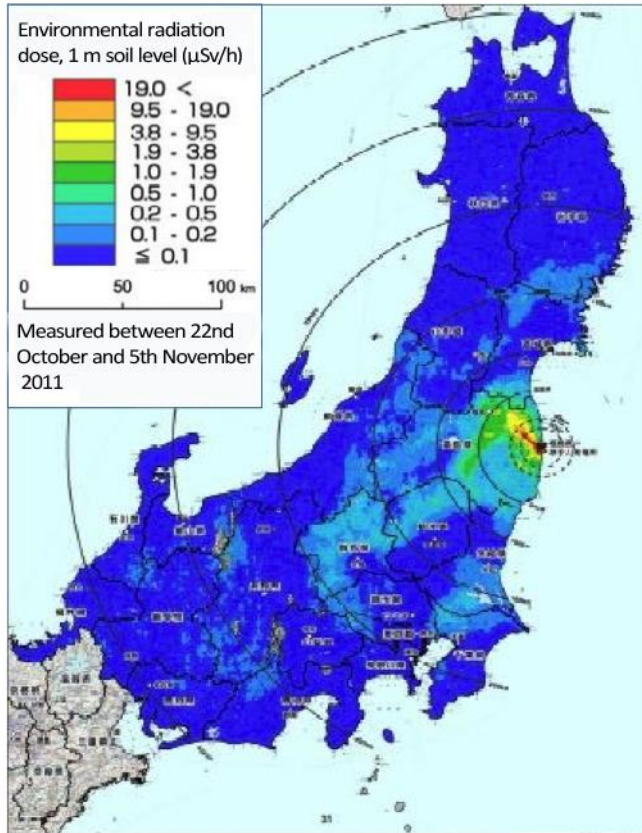
Figure 1   Radiation dose on the Eastern side of Japan (Source: Ministry of Education, Culture, Sports, Science and Technology, 16th December 2011. The map is reformed by Rina Kojima).

Moreover, since September 2011, the government has constantly revised these zones and has established three new evacuation zones (Figure 3), based on a radiation dose of 20 mSv/year, which is 20 times higher than the international limit recommended by the International Commission on Radiological Protection (ICRP 2007) for the public,[iii] although 'socio–technical controversy' (Callon, Barthe and Lascoumes, 2009 [2001]) remains concerning the health effects of low–dose radiation exposure (100 mSv or lower).[iv] According to Adriana Petryna 'this readjustment of external measures [was applied as] a political tool to 'normalize' catastrophe' (Petryna, 2013).
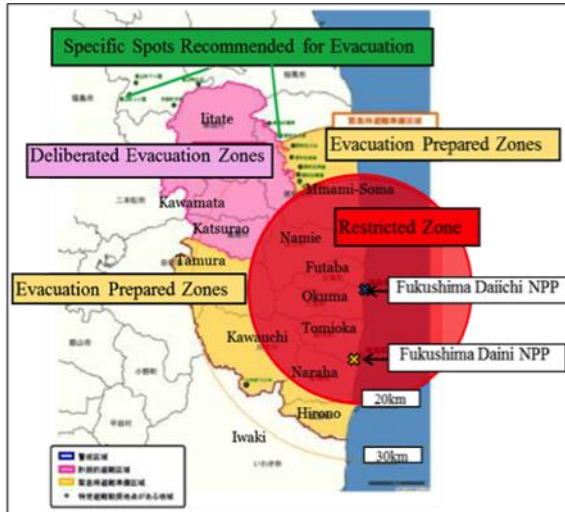
Figure 2   Initial evacuation zones (Source: Ministry of Economy, Trade and Industry, 3rd August 2011. Map redrawn by Rina Kojima).
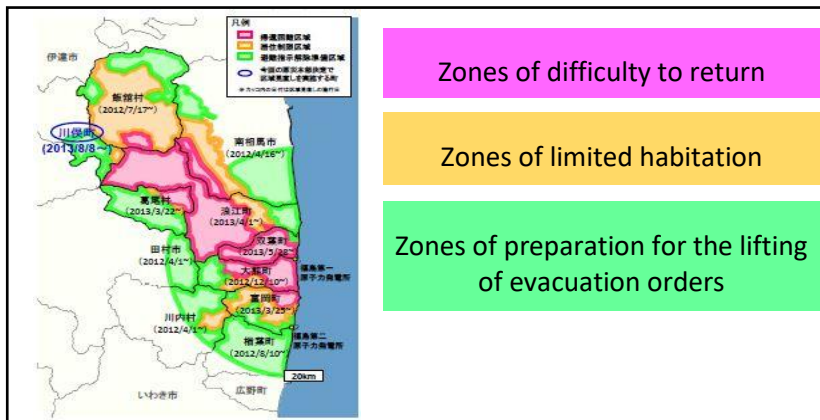
Figure 3   Revised evacuation zones (Source: Ministry of Economy, Trade and Industry, 7th August 2013. Map redrawn by Rina Kojima).

In the first zone, 'Zones of preparation for the lifting of evacuation orders', where the radiation dose was estimated to be lower than 20 mSv/year, the evacuees from these areas are invited to return after intensive decontamination work. In the second zone, 'Zones of limited habitation', the radiation dose was estimated at between 20 and 50

mSv/year. In the third zone, 'Zones of difficulty to return', the radiation dose was estimated to be in excess of 50 mSv/year even after five years.[v] This establishes a distinction between two types of forced evacuees: some who have been invited to return home and some who are not expecting to return in the foreseeable future.

This labelling of evacuation zones has strongly influenced decisions on compensation.[vi] The 'Committee for the conflicts regarding compensation for nuclear damages' (subsequently referred to as the 'Compensation Committee'),[vii] has set guidelines to determine the perimeter of compensation, guidelines that Tepco has used in setting the amount of compensation and effecting payments. Although these guidelines have allowed compensation for some of the damages arising from the accident to be paid rapidly,[viii] they do not cover all damages, notably taking little account of damages in areas outside the evacuation zones. Moreover, even inside the evacuation zones, compensation ceases after a certain time: three months after the lifting of evacuation orders for 'Specific Spots Recommended for Evacuation', one year after for 'Evacuation Prepared Zones', and until March 2018 for all revised evacuation zones except the 'Zones of Difficulty to Return' (Eguchi, 2015; Hino, 2015). According to Masafumi Yokemoto, this limited perimeter of compensation is causing conflicts between people based on whether or not their mobility decisions arise from 'economic' or 'environmental' factors (Yokemoto, 2013).

Among the forced evacuees who have been invited to return to their homes, there are some who have already returned or are expecting to return, and others who have not yet returned or are not expecting to return. The decision on whether or not to return is based not only on the attachment to home, but also on whether they have the resources – after compensation ceases – to maintain their evacuation. Moreover, as time goes by, some self–evacuees, who have received hardly any compensation, have also returned home after the initial evacuation because of financial difficulties and family problems. In fact, most of these self–evacuees are mothers and children, since the fathers remained behind to continue working; they cannot afford to maintain two households. The people affected by the accident can therefore be divided into six categories (Table 1).

Table 1   Categories of people affected by the accident.

Inside the evacuation zones		
Zones where evacuation orders are ready to be lifted	Forced evacuees	Evacuees who have already returned or are expecting to return
		Evacuees who have not returned or are not expecting to return
Zones where long–term evacuation orders have been issued		Evacuees who are not expecting to return in the foreseeable future
Outside the evacuation zones		
Areas of unrecognised risk	Self–evacuees	
	Remainers	
	Returned self–evacuees	

Valérie November analyses the relation between spaces and risks as follows: 'Given the spatial nature of risks, individuals are not passive; rather, they develop strategies based on the relationship they have with the space' (November, 2013). She distinguishes four patterns of strategies vis–à–vis spaces, highlighting inequalities in the ability or inability to move (Table 2).

Table 2   Relationship between risk and space (November, 2002; 2013).

	Mobility choices	No/few mobility choices
Stay	Defy	Be captive
Leave	Flee	Be evicted

- First case: Defy. 'The presence of risks does not necessarily create a vacuum. […] [The space's] attractiveness is strong enough to make people forget the risk; most of the population are perfectly aware of it and have means to leave the city. Nonetheless, they choose to stay.'

- Second case: Flee. 'Once a certain number of risks have been identified, resulting in increased safety concerns, [individuals choose to leave the space].'
- Third case: Be captive. 'People do not choose their habitat or its location. Being [in a space] is not to be doomed, but not having the means to move elsewhere if one is exposed to certain risks.'
- Fourth case: Be evicted. '[Residents must abandon their space] either because of the gravity of the threat or a decision by the authorities. […] In such situations, not only do residents not have a choice, but they may actually suffer a loss, as offtimes they cannot find the same standard of living elsewhere.'

Following on from this analytical framework, if we consider the case of those affected by the Fukushima nuclear accident, the first case ('defy') matches the situation of the forced evacuees who have returned or are expecting to return to their original place of residence after the evacuation orders are lifted. They choose to return to the area that they are strongly attached to, although aware of the radiation risk. They are usually older people who are long–standing residents, or people with specific local occupations. They therefore tend to 'accept' radiation risk in order to return to their homes. We cite some personal accounts from the interviews with people affected by the accident:

'Since I am old, I hope to go on living in Kawauchi village rather than in a big city, although the radiation doses in this area are a little bit higher than in other places.' (Woman aged around 60. Forced evacuee who has returned to Kawauchi village: interviewed in 2015).

'1 mSv/year is considered as a criterion that we have to respect at all costs. But, if we stand with it, we risk losing our home county. […] What is important is to realize that the human body is very resistant. Then, we have to think about the balance between this resistance and the criterion of radiation dose.' (Man aged around 60. Forced evacuee who is expecting to return to Naraha town: interviewed in 2015).

The second case ('flee') corresponds to the situation of forced evacuees who have not returned or are not expecting to return, as well as self–evacuees who choose to start new lives a long way from contaminated areas, in order to live in greater safety:

'I feel liberated from worry about radiation risk after moving to Yamanashi. When I was in Fukushima, I thought about radiation day

and night.' (Man aged around 60. Self–evacuee from Date city in Fukushima Prefecture to Yamanashi Prefecture, 350 km from the Fukushima Daiichi nuclear power plant: interviewed in 2013).

'At the beginning, I thought to return to Naraha town with my husband having a new house. But, if I do it, my children would not come to Naraha town with my grand–children. So that's why we decided to live elsewhere.' (Woman aged around 60. Forced evacuee from Naraha town who does not expect to return: interviewed in 2015).

The third case ('be captive') applies to people who remain because of inability to move. They are aware of the radiation risk, and want to live elsewhere, but cannot do so because of family and/or financial problems. In spite of the time that has passed since the accident, some wish to leave:

'I think that I should evacuate to the area where there's no radiation risk, considering the health of my children. But if I leave, I will lose my work here.' (Man aged around 40. Remainer of Fukushima city in Fukushima Prefecture, 80 km from Fukushima Daiichi nuclear power plant : interviewed in 2014).

It also applies to self–evacuees who stay away, as well as to self–evacuees who have returned home. In fact, the majority of self–evacuees are women with children; sometimes the husbands do not have same perception of radiation risk as their wives, and do not agree with their evacuation; this places enormous stress on the women, who in the end often return home in order to avoid problems with their husbands. Moreover, even after their return, they continue to be highly aware of the surrounding radiation risk:

'My husband thinks that I stay in Tokyo because I am selfish. And I feel that he doesn't agree with my decision to leave. In addition, my mother–in–law isn't at all pleased with me because I left her son alone in Fukushima. In my family, nobody supports me in continuing the evacuation.''It is now 6 months since I returned to Iwaki city with my son, but I have never let him go outside. So I try to leave Fukushima prefecture as much as possible during holidays, so that my son can enjoy some outside activities.' (Woman aged around 30. Self–evacuee from Iwaki City in Fukushima Prefecture to Tokyo Prefecture, 250 km from Fukushima Daiichi nuclear power plant, who

finally returned to her home after 4 years of evacuation: interviewed for the first time in 2013 and for the third time in 2015).

However, there are some forced evacuees who do not know whether they will remain in the place where they initially moved after the evacuation, because they have no/few choices once compensation is stopped:

'Since June 2011, I have lived in temporary housing with my son. [And since September 2012], I have received no more compensation because of the lifting of the evacuation order. If I can't go on living in this temporary housing, I have no other choice but to return to the village.' (Woman aged around 50. Forced evacuee from 'Evacuation Prepared Zone' of Kawauchi village who does not know where to go: interviewed in 2015).

The fourth case ('be evicted') corresponds to forced evacuees who are expecting not to return for a long time because of a mandatory evacuation order. As they have no choice to return, they have to think about resettling elsewhere. Moreover, they experience additional suffering, since the radiation risk raises the question of loss of identity –their home, their land, their community – rather than the question of whether or not to return. This is particularly significant in the towns of Futaba and Okuma, the places designated by the government for the interim storage of radioactive waste.[ix] The evacuees from these towns see their homelands as having been sacrificed to accommodate radiation risk from other areas:

'Radioactive waste, such as trees, flowers and soil collected in decontamination work, will be brought to Futaba and Okuma for interim storage for 30 years; during that time, there will be no reduction in radiation doses. In these circumstances, there is no reconstruction.' (Man aged around 70. Forced evacuee from Futaba town: interviewed in 2014).

As we can see, the trajectory of the people affected by the nuclear accident differs not only according to their perception of radiation risk, but also their capacity or incapacity to make mobility choices, which depends on the political reajustement of permitted radiation doses and limitations on compensation.

Legal action: social movement vis–à–vis the risks

Some people in the captive or evicted situations, who have no/few mobility choices, have filed compensation claims with Tepco either through the Alternative Dispute Resolution (ADR) processes or through the courts, because they are not convinced of the radiation risks to which they are exposed, but also 'because they are facing huge difficulties in obtaining the symbolic recognition of their suffering from the polluters and the state', as noted by Paul Jobin (Jobin, 2014).

Through the ADR, the people affected by the accident can seek compensation for damages that Tepco does not take into account.[x] On the basis of the arguments advanced by these complainants and Tepco, mediators from the Compensation Centre, which reports to the Compensation Committee, propose an amount of compensation in order to resolve the conflict between the parties as quickly as possible without litigation.[xi]

> 'Today, many people are filing a claim through ADR everywhere in Fukushima Prefecture. It shows the immense mental damage caused by living here, with anxiety relating to long–term radiation risk. In one of the districts of Watari in Fukushima City, where I serve as an official of the neighborhood association, 10% of the population have filed claims in order to express directly their indignation to Tepco and to the state. If they did not react at all, they would be compelled to accept the situation. […] With our claim for compensation through ADR, I hope that residents will be able to mitigate the mental damage and improve their lives, if only a little.' (Man aged around 60. Remainer of Fukushima City in Fukushima Prefecture: interviewed in 2015).

Tepco has to respect the resolution proposals issued by the Compensation Centre. However, it has refused some proposals that refer to the geographical perimeter indicated in the Compensation Committee guidelines.

> 'Through ADR, I sought compensation from Tepco for the financial damages resulting from the loss of my job (because of my evacuation), hoping that it would recognise that Watari district should also be designated as an evacuation zone.[xii] But Tepco insisted that 'we cannot recognise it, because the state does not; as a self–evacuee, you resigned your job and made the choice to evacuate by

yourself.' So, I only received compensation for the real cost of moving, but not for financial damages; better than nothing, but what I wanted was that Tepco's compensation should not just be limited to the actual cost of moving…' (Woman aged around 40. Self–evacuee from Fukushima City in Fukushima Prefecture to Sendai City in Miyagi Prefecture, 100 km from the Fukushima Daiichi nuclear power plant: interviewed in 2015).

In order to avoid rejection from Tepco, some people have sought compensation not through ADR, but through the courts, although this could take many years. The first case was launched by some forty forced evacuees in the district court of Iwaki City in Fukushima Prefecture in December 2012. Since then, not only forced evacuees, but also self–evacuees, including those who were initially given housing outside Fukushima Prefecture, have instituted lawsuits either collectively or individually from their place of evacuation. As of April 2015, 21 class actions had been launched, representing around 3,900 complainants, mostly against Tepco as the operator of Fukushima Daiichi nuclear power plant, and against the state as the promoter of nuclear policies (Hayashi, 2015).

'Before the accident, we used to enjoy growing vegetables in our garden and having dinner with our children and grand–children living nearby. But today (because of radioactive contamination in our garden and the evacuation of our families), we cannot do this any longer. We have lost much of our pleasure in life… Before the accident, we would have expected to live here all our lives. But now, we are wondering if we can stay here. We cannot plan for the future.''Previously, we sought compensation from Tepco through ADR for the real costs we have incurred since the accident. But now we are aiming to set up an association to launch a class action for compensation for the mental damage we have suffered.' (A couple aged around 60. Remainer of Fukushima city: interviewed for the first time in 2013 and for the second time in 2014).

'Today, the radiation dose in Iwaki City is under 0.2μSv/h, which corresponds to less than 1mSv/year, if only external exposure is counted. However, we still risk internal exposure from wind–borne radionucleides.[xiii] […] After the Chernobyl accident, the local people experienced multiple diseases. It is no longer someone else's affair. […] I am filing a class action against Tepco and the state for the damage that we have suffered since the accident. […] I want them to recognise the real damage caused by the nuclear accident.''Through

our lawsuit, I hope that we can change what the state and Fukushima prefecture decided (regarding policy for the people affected by the accident). […] Since the diseases caused by radiation can develop stochastically, the fact of 'having been irradiated' itself should be recognised as damage.' (Man aged around 40. Self–evacuee from Iwaki City in Fukushima Prefecture to Tokyo Prefecture, 250 km from Fukushima Daiichi nuclear Power Plant: interviewed for the first time in 2013 and for the third time in 2015).

The main focus of their complaints is twofold: indignation at the destruction of their living environment by radioactive contamination; indignation at having suffered irradiation or at still facing the risk of irradiation. However, their complaint also relates to the anxiety about potential radiation–borne disease. As formulated by Ulrich Beck, their feelings are provoked by 'real' and 'unreal' risks: 'On the one hand, many hazards and damages are already real today: […] On the other hand, the actual social impetus of risks lies in the projected dangers of the future.' (Beck, 1992, p. 34). In addition, Beck notes that in the risk society, people develop 'solidarity in anxiety' in order to live together and join forces.

As described by Christelle Gramaglia, '[The indignation] is not the same, it no longer has the same force once it is expressed through the law. […] It passes from a virtual state to an actualized, then realized, state' (Gramaglia, 2006).[xiv] Through legislative procedures for seeking compensation, either via ADR or court actions, the people affected by the nuclear accident are trying to actualize and realize their rights, developing solidarity in anxiety about a radiation risk that receives little recognition in society.

Conclusion

Despite the socio–technical controversy around the health risks of low–dose radiation, the Japanese authorities are still changing the evacuation zones through the readjustment of the radiation dose criteria: the accident is not over yet, but still continues to affect the populations. As time goes by, they feel increasing pressure to decide where to live, in a situation where support for mobility is unequal: they are moving away from uncertainty. However, in the anxiety caused by radiation risk, some people are coming together in solidarity to realize their right to live safely and healthily: they are moving towards certainty.

As we see, they respond to the spatial nature of risks with different trajectories in their mobility choices, while their indignation and anxiety

regarding the risk concerns different temporal scales: past present and future. With respect to the risks associated with radioactive contamination and irradiation beyond the evacuation zones and in the long term, we need to give closer and more detailed attention to the narratives of these individuals, who are experiencing a 'spatiotemporal differentiation of risks' (November, 2013) that has been sparsely acknowledged since the accident.

References

Beck, U. (1992 [1986]) *Risk Society: Towards a New Modernity*. London: Sage.

Callon, M., Barthe, Y. and Lascoumes, P. (2009 [2001]) *Acting in an Uncertain World: An Essay on Technical Democracy*. Cambridge: MIT Press.

Eguchi, T. (2015) *賠償の全体像 (A Complete Picture of Compensation)*. Institute of Disaster Area Revitalization, Regrowth and Governance, 関西学院大学災害復興制度研究所. *原発避難白書* (*White Paper on the Evacuation due to the Nuclear Accident*). Kyoto: Jinbun Shoin.

Gramaglia, C. (2006) *La mise en cause environnementale comme principe d'association. Casuistique des affaires de pollution de rivières : l'exemple des actions contentieuses de l'Association Nationale de protection des eaux et rivières (ANTER–TOS)*. Thèse, Ecole des Mines de Paris.

Hasegawa, R. (2013) *Disaster Evacuation from Japan's 2011 Tsunami Disaster and the Fukushima Nuclear Accident*. Study No. 05/13, IDDRI.

Hayashi, H. (2015) 賠償訴訟の全体像 (A Complete Picture of the Lawsuits of Compensation). Institute of Disaster Area Revitalization, Regrowth and Governance, 関西学院大学災害復興制度研究所. 原発避難白書 (White Paper on the Evacuation due to the Nuclear Accident). Kyoto: Jinbun Shoin.

Hino, K. (2015) 原発避難の発生と経過 (Evacuation Outbreak and Process due to the Nuclear Accident). Institute of Disaster Area Revitalization, Regrowth and Governance, 関西学院大学災害復興制度研究所. 原発避難白書 (White Paper on the Evacuation due to the Nuclear Accident). Kyoto: Jinbun Shoin.

ICRP (2007) *Publication CIPR 103 : Recommandations 2007 de la Commission internationale de protection radiologique.* L'Institut de radioprotection et de sûreté nucléaire.

Independent Investigation Commission on the Fukushima Daiichi Nuclear Accident (2012) *Research Investigation Report*. Tokyo: Discover 21.

Investigation Committee on the Accident at the Fukushima Nuclear Power Stations (2011) *Interim Report*. [Online] Available from:

http://www.cas.go.jp/jp/seisaku/icanps/post–1.html [Accessed: February 8th, 2017].

Investigation Committee on the Accident at the Fukushima Nuclear Power Stations (2012) *Final Report*. [Online] Available from: http://www.cas.go.jp/jp/seisaku/icanps/post–2.html [Accessed: February 8th, 2017].

Jobin, P. (2014) Beyond Uncertainty, Industrial Hazards and Class Actions in Taiwan and Japan. In Liu, T.-J. (ed.), *Environmental History in East Asia: Interdisciplinary Perspectives.* London/New York: Routledge.

Kokai, N. (2015) 「線引き」による賠償格差とそれに抗する住民の取り組み (A Difference in Compensation in Relation to the Position of 'Frontiers' and to the Resistant Action from the Population). In Yokemoto, M. and Watanabe, T. (eds.), *原発災害はなぜ不均等な復興をもたらすのか (Why nuclear accident brings unequal reconstruction).* Kyoto: Minerva Shobô.

November, V. (2002) *Les territoires du risque: le risque comme objet de réflexion géographique*. Bern: Peter Lang.

November, V. (2013) Planning, Risks and Equality. *Environment and Planning A,* 45 (3), pp. 1523–1527.

Petryna, A. (2013) *Life Exposed: Biological Citizens After Chernobyl*. Princeton: Princeton University Press.

The National Diet of Japan Fukushima Nuclear Accident Independent Investigation Commission.東京電力福島原子力発電所事故調査委員会. (2012) *Official Research Report*. Tokyo: Tokuma Shoten. [Online] Available from: http://warp.da.ndl.go.jp/info:ndljp/pid/3856371/naiic.go.jp/ [Accessed: February 8th, 2017].

Yokemoto, M., 除本理史. (2013) 原発賠償を問う――曖昧な責任、翻弄される避難者 (Question about the Compensation Due to the Nuclear Accident –Ambiguous Responsibility and Precarious Evacuees). Tokyo: Iwanami Shoten.

Notes

[i] This project is financed by CNRS (French National Centre for Scientific Research. French: *Centre national de la recherche scientifique*) between 2013 and 2015. It focuses on the grey areas after the accident, as well as the trajectory of the people affected by the accident but not recognised as victims because of the zoning criteria.

[ii] This project is financed by IRSN (Radioprotection and Nuclear Safety Institute. French: *Institut de radioprotection et sûreté nucléaire*) between 2014 and 2016. It seeks the mechanism whereby citizens' confidence in institutions was lost/generated after the nuclear accident, as well as on the modalities of the emergence of new civil experts or counter–experts.

[iii] ICRP classifies situations in which the population may be exposed to ionizing radiation into two categories. First, for '*Emergency exposure situations*' in the case of radiological emergency, the ICRP recommends that the radiation dose to which the public is exposed should fall between 20 and 100 mSv/year. Second, for '*Existing exposure situations*', in terms of the restriction on occupational exposure, it recommends that the public radiation dose should fall between 1 and 20 mSv/year. Finally, in '*Planned exposure situations*', in other word 'normal situations', the recommended public radiation dose is under 1mSv/year (ICRP, 2007).

[iv] 'Epidemiological data, on which ICRP recommendations are based, have mainly been collected and analyzed from a life span study of atomic bomb survivors in Hiroshima and Nagasaki conducted by the Japan–US joint Radiation Effects Research Foundation since 1950. The results of this research study based on that data show that, with regards to nuclear atomic bomb survivors who were exposed to more than 100 mSv of radiation dose from an atomic bomb, there is a statistically significant relationship between radiation dose and cancer rates (the higher the radiation dose, the higher the cancer rate). On the other hand, with regards to atomic bomb survivors who were exposed to less than 100 mSv of radiation dose from an atomic bomb, it has not yet been concluded due to insufficient data as to whether there is a clear relationship between the radiation dose and cancer rate. The ICRP recommendation, however, is based on a model (hypothetical theory) that, from a conservative standpoint, there is a proportional relationship between the radiation doses and cancer rates.' (Investigation Committee on the Accident at the Fukushima Nuclear Power Stations, 2011).

[v] Source: Cabinet Office group to support people affected by the nuclear accident (October 2013).

[vi] The compensation takes many forms. In this text, however, we focus solely on compensation for 'psychological damage' caused by the accident, which is set at 100,000 yen (800 euros) per person per month. Since the evacuees lost their occupations, this compensation serves as income.

[vii] Under the 'Act on Compensation for Nuclear Damage', promulgated in 1961 in Japan, this Committee was set up after the accident in April 2011, as part of the Ministry of Education, Culture, Sports, Science and Technology.

[viii] Tepco had received around 2.2 million demands for compensation as of April 2016 (http://www.tepco.co.jp/fukushima_hq/compensation/results/index–j.html).

[ix] Asahi Journal, 2nd September 2014. The installation of interim radioactive waste storage in Futaba and Okuma towns was decided on 1st September 2014. These towns agreed provided that the radioactive waste is removed within a maximum of 30 years. (https://ajw.asahi.com/article/0311disaster/fukushima/AJ201409020061).

[x] According to Noriaki Kokai, ADR is an easier procedure than lawsuits for people affected by the accident whose situation is unstable, because it is free of charge for the claim and offers a way to resolve the problems quickly. It therefore gives them an 'opportunity' to bring a rapid end to their suffering (Kokai, 2015).

[xi] The Compensation Centre had received 20,000 demands as of May 2016 (http://www.mext.go.jp/a_menu/genshi_baisho/jiko_baisho/detail/1329118.htm).

[xii] In Watari district, some 'hot spots' were identified, where the radiation dose corresponded to 'Specific Points Recommended for Evacuation'. But this evacuation order was not issued, because the residents living near these spots did not wish to leave. Fukushima City therefore decided to conduct decontamination work in this district instead of evacuation (The National Diet of Japan Fukushima Nuclear Accident Independent Investigation Commission, 2012).

[xiii] 'External exposure occurs when the radioactive source is outside the body while internal exposure occurs continuously until the radioactive source decays out through radioactive disintegration or it is excreted from the body. When radioactive material is taken in and remains in a specific part of the body, the surrounding cells of the radioactive material are

intensively exposed to radiation. This does not occur in external exposure. The ICRP recommends that internal exposure should also be evaluated based on the predicted dose (committed dose) which is expected to receive over a period of 50 years (for a minor, until he or she is 70 years old) from the time that the radioactive material is taken into the body.' (Investigation Committee on the Accident at the Fukushima Nuclear Power Stations, 2011).

[xiv] Translated by Rina KOJIMA.

Activism and Games. Exploring Boundaries

Ilaria MARIANI[*a] and Andréa POSHAR[a]

[a] Politecnico di Milano

Activism games are artifacts designed with the intention to elicit experiences that initiate commentaries and confrontations regarding political, cultural and social issues, hoping to influence players as citizens. This article observes game activism as a threefold entity that includes games as media, and players as their users and designers as those who make the games themselves, as activists. Accordingly, it explores three activism game as case studies that expand in the urban space and overlay with its practices, involving players in situated activities. As a consequence, on the one hand we discuss how these games impact on the social, political and physical context where they take place; on the other we enlighten to what extent certain authored procedures revealed goals and purposes that can question the real essence of the game, by pushing players to ask themselves 'is it still a game'.

Keywords: *Activism games; ethical agents; game design; player experience; wicked problems*

Challenging perspectives: an introduction to the topic(s)

Designing games with social impact, designers can promote entertainment and fun, but also raise awareness on topics of social matter (Flanagan, 2009; Flanagan et al., 2013; Flanagan and Nissenbaum, 2007; 2014). We address here the topic of game activism, namely games in general – video, board, pervasive games – discussing social justice issues or political change, questioning the boundaries between games and real life itself, and how these games challenge ethical reasoning about activism itself. Based on qualitative data derived from web and social media ethnography and document analysis, this article goes through three case

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[*] Corresponding author: **Ilaria Mariani** | e–mail: **ilaria1.mariani@polimi.it**

studies – (1) *Conspiracy for Good*, (2) *KillCap* and (3) *CamOver* – exploring the role of designers as activists who activate individual's perspectives and challenge the ordinary perception of the surrounding environment.

Dealing with activism means putting some efforts to make improvements in society by promoting, obstructing, or running social, political, economic, and/or environmental activities. As a counterpart of mainstream everyday practices (de Certeau, 2010), the designer who is active on the topic can pinpoint struggles of social movements (Macklin, 2010; Stokes, 2014), covering contemporary societal wicked problems (Rittel and Webber, 1974; Sicart, 2010; 2013). By designing activism games, the designer digs into problems which are currently in need of thoughtful reflection, that take into account grey areas in spite of yes–or–no answers. Because of their subjects, communicative aim and procedures, activism games can be considered part of the broader category that Bogost (2007) named *Persuasive Games* – they propose an established way of doing something employing the game rules to affect in–game players' behaviours (Bogost, 2007). In doing so, great emphasis is placed on the medium expressive capacity to invite players to experience specific perspectives of how certain processes or systems work and consequently develop an attitude towards the issue. This considering that a wealth of social issues can be transposed and exposed into games that are commentaries, and/or invite players to comment and express their opinions. Activism games become a way to interrogate existing knowledge and perspectives, making visible their actors, processes, and consequences.

Albeit the sphere of influence of procedurality is recognised and well–known, we consider crucial to rehearse the central role played by subjectivity and individuality (Mariani, 2016; Sicart, 2011) that turn activism games into ethical systems able to problematize the player's ethics or morals. A singularity of these games is that they empower players with *real* agency that impels them to take actions meant to impact on the surrounding space. These games push the line forward the fact of having game systems responding to players' actions: the 'meaningful choices' (Salen and Zimmerman, 2004, p.157) that players take have a broader impact than contributing to the narrative. As a matter of fact, these games generate 'immersive experiences', making players feel a sense of contributing on the one hand to the narrative of the in–game world and stories, on the other of impacting on the social, cultural and/or environmental context. In the light of these reasonings, what is rather interesting to discuss is to what extent these games affect the real world.

Games, designers and activism

However, before exploring how games, designers and activism are related, it is necessary to answer a simple but complex question: what do we mean with activism?

In a broad sense, activism is a political act intended to promote knowledge and/or spread political, economic, cultural or environmental issues and/or beliefs of a specific group of society. According to Thorpe (2011), activism seeks to put forward a vision for/of a better society by claiming for a change on behalf of minority groups – which are generally driven by the identification of a wrongdoing or problem that needs changing.

Andrew X (2009) introduces another perspective that acquires a further interesting meaning once confronted with games, saying that activism has its basis in the division between mental and manual labour where the activist identifies her/his role in life, like a job or career. Characterizing games on the same way, Suits (1978, p. 41) defines playing games as 'the voluntary effort to overcome unnecessary obstacles'; a concept echoed by McGonigal (2011, pp. 22–24) who stresses the game ability to make certain obstacles so compelling that players need to work harder to overcome them. Another common point regards not seeing any results in the very next future, but looking at something bigger, in the long term. Such a tendency has a specific term in the game culture, where it is one of the most important concepts: 'epic'. According to McGonigal (2011, p. 98), epic 'is how players describe their most memorable, gratifying game experiences'. Games and activism further similar in this sense: taking part in these activities, you know that you belong to a network that is *your community*.

Analysing the relationship between activism and design, Thorpe (2011) affirms it has as its linchpin the concepts of protest and resistance on behalf of excluded or neglected groups. They rely on a call for change by means of unconventional methods, especially the disruption of regular 'dominant' practices. As a result, she (ibidem, p. 6) extracts four basic criteria that define design as a practice of activism that:

- publicly reveals or frames a problem or challenging issue,
- makes a contentious claim for change based on that problem or issue,
- works on behalf of disadvantaged groups,
- disrupts routine practices.

Designers' practices: exploring boundaries

Expanding the reasoning of Gray (2016) to games in general, game activism is identified as a threefold entity that includes games as media, and players as their users, but also those who make games, the game designers (fig. 1). Designers who, referring to Flanagan (2007; 2009) and White (2013), are active agents/actors able to encourage the development of social awareness by merging or breaking spheres and boundaries (Calabrese, 1999) between what is game and what is real life, namely blurring the concept of magic circle (Huizinga, 1938; Consalvo, 2009; Montola, 2005).

Figure 1   Game activism as a system with three interwowen elements.

Thorpe (2011) states that activism can make designers more conscious of politics and provide them with tools for 'taking action'. For example, designers can develop games with the intent to raise and support social movements, taking advantage of their potentialities to trigger social empowerment and enactment (Flanagan, 2007). With this, we can broadly affirm that crafting games related to activism designers take the role of activists who ask players to 'be' activists in turn, and, to a certain extent, put into practice some everyday life's activism activity (de Certeau, 2010). This is possible by applying Bogost's procedural rhetorics (Mariani, 2016), as a way 'to make claims about how things work' (Bogost, 2007, p. 29, emphasis in original). Hence, like in an Aristotelian triangle where the speaker, the reader and the audience meet, taking the role of the activist, the designer is not only changing her/his main role, but s/he is also reinventing herself/himself toward a minority group of the society – audience. Thus, the game designer becomes an active actor (Flanagan, 2007; 2009) of social and cultural change.

Hence, we propose three case studies to explore how certain authored procedures can question the real essence of the game, pushing players to ask themselves 'is it still a game'?

At this point, we need to question the mainstream's and activist's everyday life practices (de Certeau, 2010), saying that the designer assumes the role of activist by turning strategies of the hegemonic culture into tactics used for communicate activist movements (Andrew X, 2009). Designing activism games becomes a way of social expression, a way to 'share' activism and making it 'experience–able' to someone else. Activism games locate themselves among contemporary forms of networked actions that deal with protests and investigation, being in the meanwhile alternative and complementary to existing communication, able to take advantage from the way social media facilitate exploration and diffusion of perspectives (Gerbaudo, 2012). Through activism games, designers can challenge some everyday–life boundary, putting the player in the condition to question the line between what is right and wrong, what is civic and ethical, and what is not. A condition that has a remarkable potential in opening public discourses and that strongly emerges from the second and third case study we discuss in the following. Particular attention in the incoming discussion regards the fact that boundaries can be negotiated, being part of wicked problems which lack of binary solutions.

Accordingly, we discuss how, developing games as (1) *Conspiracy for Good*, (2) *KillCap* and (3) *CamOver*, designers can create not only consciousness that alters individual's perception of their community and environment, but also sparkles questions regarding their ordinary or in–game behaviors. The research has been conducted as web and social media ethnography, investigating statements that designers and players shared online in the shape of articles and posts, interviews with key actors investigating motivations, values and strategies beyond these games.

The Internet, affirmed Castells (2009), has raised new reflections around collective actions and its interface with policymaking. As a tool of collective action, the Internet is a powerful facilitator because it simplifies the rapid organization of protests around issues of public concern. According to Calderaro (2013), online mobilizations are now breaking the existing formal hierarchy in place of traditional mobilizations and they are easily spreading as online networking. This happens because of the rapid way in which information about protests and actions can diffuse through online interpersonal networks and capture the attention of mainstream news outlets. In addition, affirms the author (ibidem), the Internet has expanded

the 'repertoire of contention' of current movements. Starting their mobilizations on the Internet and then becoming 'real', in action, the activist games discussed in the following do not only break the boundaries of everyday–life as we are about to show, but they also break all traditional hierarchy of formal collective protest mobilizations. Thus, it is for these reasons that we need to point out the role of the game designer as social and cultural changer.

Conspiracy for Good (CFG)

Conspiracy for Good is a long, distributed and complex transmedia project. It started as a commercial pilot project in a potential series of ARGs created in collaboration with Tim Kring. It included a viral teaser campaign with celebrities claiming of being 'not members', and the sponsorship of Nokia that financed the event promoting Nokia Point & Find technology.

CFG aims to create awareness and drive a real–world change. To engage and inspire people to join the conspiracy, the project relies on actively participating in the narrative. The game is based on a storytelling system that is pervasive and strongly participatory, being inclusive of an important live play component (Stenros and Montola, 2011). The designers themselves defined indeed CFG a participation drama (Whittock, 2010 in Stenrons et al., 2011), stressing the nodal role of player's actions in a complex storyline.

CFG tells the story of an evil corporation, Blackwell Briggs, and a benevolent conspiracy organization that stands up to oppose its malevolent actions. Blackwell Briggs is threatening the Zambian village of Chataika with the construction of an oil pipeline. To defeat the threat players need to fight for the cause and uncover the ongoing criminal activities. The game ran for four months online, and culminated in four live events (of about 6 hours each on the streets of London in July and August 2010), where players were asked to complete some tasks and then go on the streets, taking part in real interactions with other players and actors.

Through its gameplay this game claims to (1) provide some contributions to London–based volunteer organisations, (2) and create an experience where players are taking part in a bigger cause, and they are understanding some of it processes. Albeit an important number of participant, CFG collected several critiques; the most important is that the game partly failed in altering individual's perception of the topic. Players' stated that the awareness of being acting in a fictional space negatively impacted on the experience (Stenros et al., 2011).

Figure 2   The violinist AnnMarie on their Youtube Channel (source: https://www.youtube.com/watch?v=546izBhscYE).

Crucial in this terms is the 'non–members' page where players are asked to take a stand (fig. 2): by declaring 'not' to be member, players deny the hegemonic system and become 'conspirators'. Assuming this role, players acknowledge their participation in the game as activists. As such they could engage and even believe they can contribute to bringing social/cultural change and make the world 'a better place to be'. Nevertheless, it is important to stress that even if the position and immersion of players inside the game can be compared to the position of an activist – in this case, a game that drives change for a social cause – it is limited to a fictional world. Meaning, it brings awareness but not the social change expected (Stenros et al., 2011).

KillCap

KillCap – short for Kill Capitalism – is a game created by the founder of the non–profit canadian magazine Adbusters to fight against the ongoing hostile takeover of our environments by commercial forces. White, co–founder of Adbuster magazine, says that *KillCap* started as an attempt to create offensives all around the world, as part of a larger system of beliefs and positions, promoted in the magazine itself with an article entitled 'How to reboot capitalism' (fig. 3).

Talking about the game, Lasn (Liacas, 2013) said that he believed 'all the people that have woken up to the fact that their future doesn't compute […]

would stand up and play this *KillCap* game, to kill the current mode of capitalism and try to come up with a kind of Capitalism 2.0' (http://socialdisruptions.com/kalle–lasn–grandfather–of–occupywallstreet).
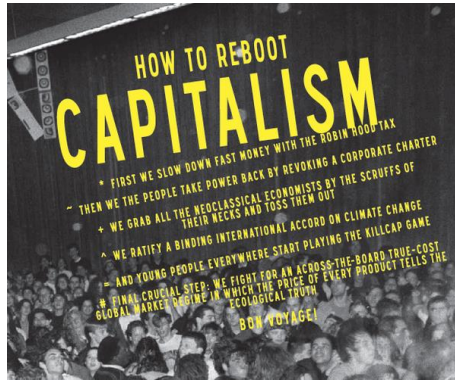
Figure 3   *Fragment of the announcement of Adbusters' points and beliefs of 'How to reboot capitalism'.*

This game intends to alter one's perception of the city, according to a perspective of re–appropriation of the public space, and gives a new idea of what it is a political act in our daily life. In this game players gain in–game experience points (blackpogs) for doing things as walking away from multinational chains (10), defacing the McDonald's' Golden Arches (15), or subverting questionable advertising (25) (White, 2013). According to White (2013) *KillCap* works by appropriating the gamespace of consumerism for radical play, where all multinational corporations become opportunity to level up. The game places inside the field of indie storytelling and roleplaying games, based on an alternative reality that is a counter–narrative that re–imagines life.

Although this game is no longer online, we consider the case study particularly pertinent to this reasoning because of the way it expands in and overlaps to the real world. *KillCap* takes place in real space where players become actors in an unfolding story whose final scene is global revolution. With this game, an entire economic, cultural and social system is put into question. Going beyond sharing ideas, it allows to put activism in practice, creating online and offline actions that drive social and cultural changes.

This reasoning is partly aligned with the non–offensive concept of critical play introduced by Flanagan (2009) to describe that play activities that

enquire or critique a status quo. According to Flanagan (2009, p.6), 'critical play means to create or occupy play environments and activities that represent one or more questions about aspects of human life [...] the goal in theorizing a critical game–design paradigm is as much about the creative person's interest in critiquing the status quo as it is about using play for such a phase change'. The concept is introduced as a different and critical approach to play and design games, and is based on the observation of games as ways to affect players. This argumentation opens some crucial discourses, enlightening the power of games that incorporate fundamental human values and psychological principles to promote learning, attitude and behaviour change (Flanagan, 2009; Flanagan et al., 2013). In this regard, *KillCap* includes challenging acts that range from boycotting a brand to the act of really damaging corporate properties, meaning, to alter the order of public space and society itself. In so doing, the game rules allow players to act within the limits of the law, but it rewards more unlawful acts. Thus, the discussion goes beyond game design, entering the field of engagement and activism: what is to be a 'good' activist and how far can an activist go with his/her engagement towards a movement?

With this, we wonder: what happens when the critique against consumerism turns into acts of destruction?

Cam Over

In comparison with the previous cases, *Cam Over* – short for Camera Over – is the most radical one. Mainly active across Berlin's subways and streets, this game was designed in 2013 to tear down closed–circuit television cameras (CCTV) in public spaces, taking the shape of a (destructive) game–competition, as the author defined it (https://camover.noblogs.org/spielidee/idea–of–the–game). It lies on the complained motivation that 'The gaze of the cameras does not fall equally on all users of the street' (https://camover.noblogs.org/faq/faq–in–english), but is selective, since CCTVs discriminate against certain groups of people that are stereotyped as criminals.

Cam Over developers and designers are unknown, but in the game webpage they explain and defend their beliefs. From FAQs we can see some of their motivational reasons: e.g. 'Video surveillance is used to monitor our lives, to control our actions, and to suppress our resistance – above all, it's against our peaceful coexistence […] we can defend ourselves against the state and against corporations and take away their sight! CAM OVER!'. On the website they also present some methods players can use to assault

cameras, ranging from using plastic bags to stickers and tapes. Beyond stimulating to put such actions in practice, *Cam Over* plainly calls its players for communicating their performances by sharing them with posts, videos, images and reports. This provides further game–points. However, because of the very nature of this game, authors warn players that concealing their identity, while not essential, is recommended.

Figure 4   *Website header with icons suggesting how to 'take care' of CCTV (source: https://camover.noblogs.org).*

As a result of its atypical gameplay and real–world consequences, *Cam Over* has been matter of discussion on different media.

Writing about the game, The Guardian emphasises that points are given with bonus scores for the most innovative modes of destruction (https://www.theguardian.com/theguardian/shortcuts/2013/jan/25/game–destroy–cctv–cameras–berlin). On the other hand, The Observer denounces the practice of tearing cameras apart in such a violent and often alarming way as a counter–productive act of activism, as vandalism with destructive and aggressive 'players' in balaclavas (fig. 5) (http://observers.france24.com/en/20130111–security–cameras–german–activists–camover–hanover–vandalism–european–police–congress–berlin–blog–surveillance). Michael Ebeling, member of the anti–CCTV groups AK Vorrat and Freedom not Fear, sustains in the same article that a better practice is making people aware of how intrusive and infesting urban surveillance is, by personifying cameras that constantly invade our privacy, following, looking and listening people without any permission.
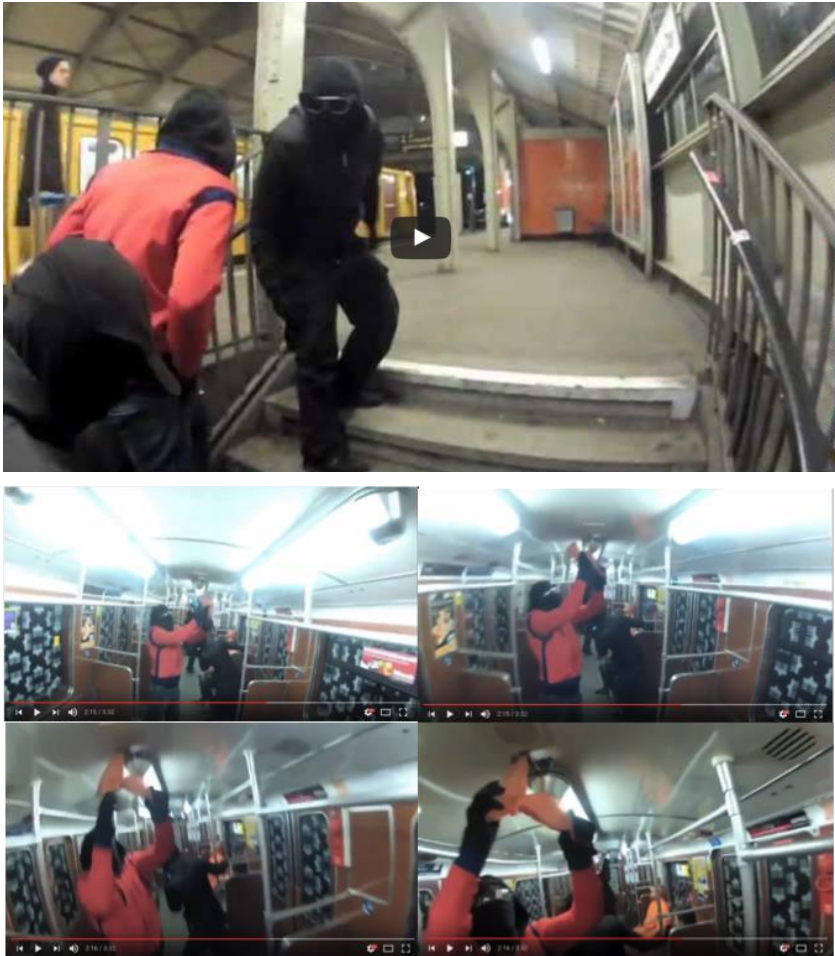
Figure 5   An assault in Berlin's Subway, uploaded on January 9th 2013 (source: https://youtu.be/2yXddUNgouM?list=PLLWWwP1Ombs1sS6Hf2kt81TyGK– 4RuAcO).

Taking into consideration social norms and morality, we can question Cam Over both as activism and as game. 'The activist is a specialist or an expert in social change' (Andrew X, 2009), and activism games invite and empower the player to be an active persona, at least during the game session (Flanagan, 2007). Thus, according to Andrew X, thinking of oneself as an activist means considering oneself as belonging to a wider community

engaged in a social cause or struggle, thinking of being more advanced than others in the appreciation of the need for social change and in the knowledge of how to achieve it. 'The activist identifies with what they do and thinks of it as their role in life' (Andrew X, 2009, p.3).

On the other hand, we can stress that *Cam Over* does not fit into the definitions of game presented in the Game Studies literature (Salen and Zimmerman, 2004), being more similar to a gamified system. If this game would have been designed as an online game, it would be into the category of mindless destruction games, online games designed for the player to move around in a virtual city and destroying all its surrounding. The point is that *Cam Over* was created to be played offline, having the public space, and objects of private and public domain deliberately destroyed or damaged. Hence, *Cam Over* masks real violent acts of vandalism; a perspective reinforced by its creator itself, who once affirmd 'Although we call it a game […] our aim is to destroy as many cameras as possible and to have an influence on video surveillance in our cities' (https://www.theguardian.com/theguardian/shortcuts/2013/jan/25/game–destroy–cctv–cameras–berlin).
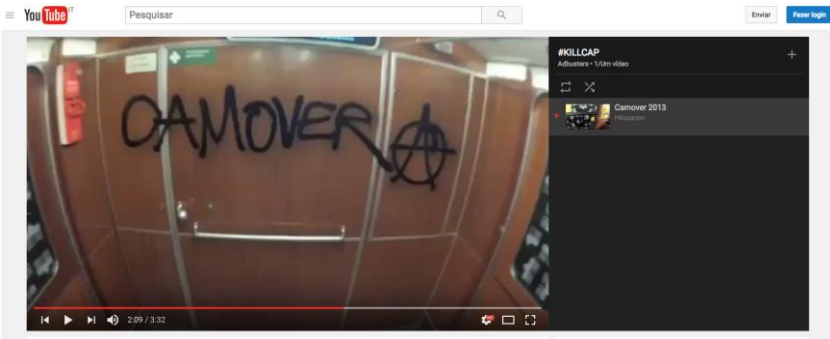
Figure 6   The signature of some 'players' on Berlin's subway.

Conclusions: more than a matter of empowerment

We introduced this paper stating that by designing games with social impact, designers can promote not only entertainment and fun, but also raise awareness on topics of social matter (Flanagan, 2009; Flanagan et al., 2013; Flanagan and Nissenbaum, 2007). Nevertheless, bringing or not social change was not the matter of discussion we intended to cover with the cases studies proposed. Our aim was to debate on the role of the game

designer in crafting such activist games and on the consequences that game immersion and motivation can raise among players. Our analysis confirms that the experiences initiated commentaries and confrontations between players regarding political, cultural and social issues, feeding in parallel several discussions among different media regarding the social impact of these games, meaning how such games actually influenced/changed players as citizens. We believe activism game designers have the duty to create innovation activating players' imaginaries by immersing them into extra–ordinary experiences (Frasca, 2001; Murray, 1997; Ryan, 2001) that can influence mindset showing interactive representations and simulation of how certain systems and processes work (Frasca, 2003). However, these games go beyond developing awareness of social struggles; by creating not only consciousness that alters individual's perception, but (ideally) real first–hand experience. Playing such games tends to have political but also ethical impact because they ask players to embody political positions and engage in political actions; actions frequently fraught with systematic provocation and revolutionary intents, that often many of them would not have spontaneously taken.

Nevertheless, designers can encourage violent acts in the name of social cause, making such intent more or less explicit to players. Therefore, especially moving through societal spaces performing activist play, it is crucial that players take into high consideration what they are allowed and invited to do within a system that is overlapped to the everyday spaces and life. A consideration particularly significant when players are real agents of action and change, 'empowered' to somehow influence the surrounding spaces and activities.

Being aware of their diversities, we can hence translate this reasoning according to the three case studies presented and their outcomes:

- Eventought CFG has a very attractive ideal and benevolent purpose, the game was not successfully able to maintain the initial expectations, in terms of empowering players to be real activists, whose decisions and actions actually impacts on the real world. Moreover, making a clear distinction between game and reality (Stenros et al., 2011), it negatively impacted on the chance to have real, situated agency.
- *KillCap* resulted more balanced on allowing players to take positions and action, boycotting shady brands and expressing their perspective. In doing so, the game allows players to decide their level of action according to their principles and will, but by in–game–

> rules it encourages clear acts of vandalism as damaging the
> McDonald's golden arches.

- *Cam Over* by its own rules plainly suggests players to be vandalic,
  using points as rewards for destructing CCTV.

These games were designed with the main purpose of activating players as activists, even if to a different extent. Thus, the boundaries we explored so far show us a panorama that is a complex wicked problem itself. Along this enquiry we have been pushed over and over to ask ourselves what is the boundary between game and real life itself. A point of controversy further nurtured by the analysis of the case studies proposed above that increased its being dense and wicked. Starting from observing how these case studies are designed to challenge the contemporary and very blurred definitions of the words that compose the practice, activism + games, we reached out to argumentations and reasonings that opened ambiguous and challenging perspectives. We put some of the tasks, activities and perspectives these game proposed into question, solicited by the way they resulted into physical outcomes. Mainly because of the very typology and outcomes of these games, we can say that by engaging with certain activism games, players are empowered to effectively participate in activities with real, more or less immediate (see cases studies presentation), consequences. Activities that raise ethical and moral questions about the role of the player in such experiences.

That being said, we conclude by acknowledging and stressing the ethical and societal role of designers within activism games design as those who have the 'power' to 'empower' and create not only a consciousness that alters individual's perception of their community and their environment, but also sparkle questions regarding ordinary as well as in–game behaviors.

References

Andrew X (2009) Give Up Activism. *Do or Die*, 9, 160–166. [Online] Retrieved from: http://theanarchistlibrary.org/library/andrew–x–give–up–activism [Accessed: December 19th, 2016].

Bogost, I. (2007) *Persuasive Games: The Expressive Power of Videogames*. Cambridge: MIT Press.

Bourdieu, P. (1984) *Distinction: A Social Critique Of The Judgement Of Taste* (R. Nice, Trans.). Cambridge: Harvard University Press.

Calabrese, O. (1999 [1987]) *La era neobarroca*. (A. Giordano, Trans.). Madrid: Ediciones Cátedra S.A.

Calderaro, A. (2013) Challenges and Opportunities of Online Collective Action for Policy Change. *Policy and Internet*, 5 (1), 1–6.

Castells, M. (2009) *Communication Power*. Oxford: Oxford University Press.

Consalvo, M. (2009) There is No Magic Circle. *Games and Culture*, 4 (4), 408–417.

De Certeau, M. (2010) *L'invenzione del quotidiano*. Roma: Edizioni Lavoro.

Gerbaudo, P. (2012) *Tweets and the streets: Social media and contemporary activism*. London: Pluto Press.

Gray, K. (2016) *Activism in Gaming Culture: Mobilizing Games, Gamers, & Gaming Culture for Change* [Online] Retrieved from: http://www.nymgamer.com/?p=12584 [Accessed: December 19th, 2016].

Flanagan, M. (2007) Locating Play and Politics: Real World Games and Activism. *Leonardo Electronic Almanac,* 16 (2–3), 1–13.

Flanagan, M. (2009) *Critical Play: Radical Game Design*. Cambridge: MIT Press.

Flanagan, M. and Nissenbaum, H. (2007) A Game Design Methodology to Incorporate Social Activist Themes. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*.

Flanagan, M. and Nissenbaum, H. (2014) *Values at Play in Digital Games*. Cambridge: MIT Press.

Flanagan, M., Punjasthitkul, S., Seidman, M., Kaufman, G., and Carini, P. (2013) Citizen Archivists at Play: Game Design for Gathering Metadata for Cultural Heritage Institutions. In *DiGRA Conference Proceedings 2013*.

Frasca, G. (2001) *Videogames of the Oppressed: Videogames as a Means for Critical Thinking and Debate*. Master's thesis, School of Literature, communication, and culture, Georgia Institute of Technology.

Frasca, G. (2003) Simulation Versus Narrative. In Wolf, M.J. and Perron, B. (eds.), *The Video Game Theory Reader*. New York and London: Routledge.

Hall, S. (1993) Encoding, Decoding. *The Cultural Studies Reader,* 4, 90–103.

Hall, S. (1980) *Culture, Media, Language*. London: Routledge.

Hall, S. (1997) *Representation: Cultural Representations and Signifying Practices*. London: Sage.

Hall, S. and Du Gay, P. (eds.) (1996) *Questions of Cultural Identity*. London: Sage.

Huizinga, J. (1938) *Homo Ludens*. The Hague: Mouton.

Latour, B. (2005) *Reassembling the Social. An Introduction to Actor–Network Theory*. London: Oxford University Press.

Liacas, T. (2013). Kalle Lasn, Grandfather of #OccupyWallStreet. [Online] Retrieved from: http://socialdisruptions.com/kalle–lasn–grandfather–of–occupywallstreet/ [Accessed: December 19th, 2016].

Macklin, C. (2010) Reacting to Re:Activism: A Case Study in the Ethics of Design. In Schrier, K. and Gibson, D. (eds.), *Ethics and Game Design: Teaching Values Through Play*. Hershey: IGI Global.

Mariani, I. (2016) *Meaningful Negative Experiences within Games for Social Change*. Doctoral dissertation, Politecnico di Milano.

Milan, S. and Hintz, A. (2013) Networked Collective Action and the Institutionalized Policy Debate: Bringing Cyberactivism to the Policy Arena? *Policy & Internet*, 5 (1), 7–26.

Montola, M. (2005) Exploring the Edge of the Magic Circle: Defining Pervasive Games. In *Proceedings of DAC*.

Murray, J.H. (1997) *Hamlet on the Holodeck: The Future of Narrative in Cyberspace*. Cambridge: MIT Press.

McGonigal, J. (2011) *Reality is Broken.* New York: Penguin.

Rittel, H. and Webber, M. (1974) Wicked Problems. *Man–Made Futures,* 26 (1), 272–280.

Ryan, M. (2001) *Narrative as Virtual Reality: Immersion and Interactivity in Literature and Electronic Media*. Baltimore: Johns Hopkins University Press.

Salen, K. and Zimmerman, E. (2004) *Rules of Play.* Cambridge: MIT Press.

Sicart, M. (2010) Wicked Games: On the Design of Ethical Gameplay. In *Proceedings of the 1st DESIRE Network Conference on Creativity and Innovation in Design*.

Sicart, M. (2011) Against Procedurality. *Game Studies* , 11 (3). [Online] Available from: http://gamestudies.org/1103/articles/sicart_ap/ [Accessed: December 19th, 2016].

Sicart, M. (2013) *Beyond Choices: The Design of Ethical Gameplay*. Cambridge: MIT Press.

Stenros, J. and Montola, M. (2011) The Making of Nordic Larp: Documenting a Tradition of Ephemeral Co–Creative Play. In *Proceedings of DiGRA 2011*.

Stenros, J., Holopainen, J., Waern, A., Montola, M. and Ollila, E. (2011) Narrative Friction in Alternate Reality Games: Design Insights from Conspiracy for Good. In *Proceedings of DiGRA 2011 Conference*.

Stokes, B. (2014) *Civic Games with 'Local Fit': Embedding with Real–World Neighborhoods and Place–Based Networks.* Doctoral dissertation, University of Southern California.

Suits, B. (1978) *The Grasshopper. Games, Life and Utopia*. Toronto: University of Toronto Press.

Thorpe, A. (2011) Defining Design as Activism. *The Journal of Architectural Education*. [Online] Retrieved from: http://designactivism.net/wp–content/uploads/2011/05/Thorpe–definingdesignactivism.pdf [Accessed: December 19th, 2016].

White, M. (2013) *Game Activism* [Online] Retrieved from https://www.micahmwhite.com/adbusters–articles/gaming–activism [Accessed: December 19th, 2016].

The Potential of New and Social Media for Environmental Activism

Richard HINDMARSH[*a] and Diletta Luna CALIBEO [a]

[a] Griffith University

Recently, many claims about the potential of new and social media to enhance civic engagement have been issued. In relation to this potential for pressuring governments, organisations, and institutions for enhancing environmental protection and sustainability, the focus of this paper lies on 'digital environmental activism'. Three meta–themes are explored: (i) 'new and social media as enabling environmental activism', (ii) 'engaging in the environmental activist terrain', and (iii) 'potential constraints to digital environmental activism'. It is found that digital environmental activism focuses substantially on chronic technological disasters and protest campaigns. Potential constraints to enhanced digital activism include expanding corporate control of new and social media, and digital surveillance. In conclusion, and informed by new and social media's main conduit of horizontal (or many–to–many) communication, we find a robust potential of new and social media to enhance activism tempered by potential constraints of increasing corporate control and surveillance.

Keywords: *New and social media; digital environmental activism; environmental politics; pressure politics; counterpublics*

Introduction

The potential of new and social media for environmental activism–or 'digital environmental activism' as we refer to–poses an emergent publicly significant topic. First, this is because new and social media are beginning to both complement and compete against conventional mass media. Media has long been a key conduit for the environmental movement to communicate issues and promote campaigns on environmental degradation (Hansen, 2010; also, Doyle, 2007).

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[*] Corresponding author: **Richard Hindmarsh** | e–mail: **r.hindmarsh@griffith.edu.au**

Second, digital technologies, as a new enabling media and knowledge source (e.g. Parks and Starosielski, 2015), have much potential to expand the repertoire of protest (Carter, 2007; Earl and Kimport, 2011). As Milan and Hintz (2013, pp. 7–8) also observed: 'New forms of networked action and informal collaboration are challenging traditional notions of the civil society … decentralized cyberactivist groups play a crucial role in building the backbone of contemporary social movements … enabling innovative forms of organization and citizen action typical of the digital age'.

In such contexts, our aim is to explore the potential of new and social media to enhance environmental activism to protect the environment and advance global environmental sustainability through social transformation; a potential so far little explored, particularly in regard to the pressure politics of environmental activism (Doyle and McEachern, 2008; Rootes, 2008). As such, digital environmental activism can be seen to blend 'active' environmental citizenship with the empowering participatory thrust of 'digital citizenship' (Bennett, 2008); as particularly informed by the online advocacy/activist domain.

The significance of exploring such potential is because of growing environmental problems worldwide that need redress, and because new and social media are now primary components of social communication, particularly relevant to action. That said, the terms 'new media' and 'social media' have some difference in meaning: new media 'refers to on–demand access to content anytime, anywhere, on any digital device', and social media 'refers to the means of interactions among people in which they create, share, and exchange information' (Southren, 2013).

Growing environmental problems worldwide include overshooting the carrying capacity and health of many ecosystems through, for example, large–scale monoculture agriculture, excessive industrial pollution, wasteful consumption, resource overuse, and anthropocentric climate change; and not least, ever–expanding population growth. Such problems have nurtured environmental movements and activism, where digital environmental activism is now increasingly apparent. Illustrative of the digital potential for enhancing environmental activism is the online Environmental Justice Atlas. It shows where the exploitation of natural resources worldwide affects populations, degrades the environment, and generates social and environmental conflicts. As such, its makers 'hope to dispel consumer blindness and suggest policy recommendations and consumption changes' (Temper, del Bene and Martinez–Alier, 2015). At the time of writing, the

Atlas featured 1658 hotspots with information supplied by activist contributors.

Claims of the potential of new and social media to enhance civic engagement particularly emerged from the mid–1990s. A key argument was that political discussion and citizen engagement would be enhanced through more universal and rapid communication access and information coverage, and easier deliberation than face–to–face forums (Dahlgren, 2006, p. 151; Fuchs, 2005; Van Aelst and Walgrave, 2002).

However, Van Aelst and Walgrave (2002, p. 465) argued that the political potential of the Internet to engage society would best be realised by those outside the boundaries of traditional public institutions or political organisations; a terrain that environmental activism often resides in, in terms of pressure politics. Yet the Internet also poses a significant conundrum for activists because it is a commercially controlled system (Penney and Dadas, 2014).

Against this background and in addressing our aim, we explore three meta–themes: (i) *new and social media as enabling environmental activism*; (ii) *engaging in the environmental activist terrain*, with subthemes of the environmental political potential of new and social media, other online environmental pressure politics, and ecologies of dissent and tactical media; and (iii) *potential constraints to digital environmental activism*.

These meta–themes were distilled from the relevant literatures in new media studies, environmental politics, and science, technology and society studies–as well as from blogs, activist media, and websites, as representing new forms of databases and archives (Kahn and Kellner, 2004, p. 94).

New and social media as enabling environmental activism

On the Internet as a facilitative context or conduit for enabling activism as a sociotechnical system (also Parks and Starosielski, 2015, p. 4), Fuchs (2005, p. 2) was notable in advocating its 'large intrinsic democratic potential' where information is shared and exchanged to produce new information, as strengthened by the communicative structure of new and social media. In contrast to conventional mass media communication based on vertical (one–to–one) communication, new and social media are largely based on horizontal (one–to many and many–to–many) communication. New and social media users can thus easily become media 'editors' and active participants (Croteau and Hoynes, 2006); for example, as bloggers.

In the social infrastructure of the Internet, vis–à–vis its technical infrastructure, digital environmental activists, as 'counterpublics' (Fraser, 1990, p. 67), expand pressure for global environmental change, if desired, with widely dispersed global user populations (Milan and Hintz, 2013; Mutz, 2006). Facilitating more this global reach 'are the speeds of mobilizations, the flexibility of mediated crowds to shift among issue foci and action tactics … both directly through digital media and indirectly via conventional mass media channels' (Bennett, Segerberg and Walker, 2014, p. 233).

On the nature of environmental activists, they are both reformist, and transformative, in seeking new ways to impact on, or pressure, existing political terrains and systems (Hudson and Kane, 2008; Parks and Starosielski, 2015). For example, environmentalist 'web–based communities' represent new forms of cultural production and ecological citizenship, whereby environmental knowledge and environmental dialogue are readily disseminated (Rokka and Moisander, 2009, p. 200).

Here, ecological citizenship or ecocitizenship aligns to the notion of cosmopolitanism citizenship in transformational sustainability transitions. As Cao (2015, p. 82) argued, most critical environmental issues including ozone depletion, nuclear waste, and climate change 'transcend national borders, and demand transnational solutions and cooperation'. But as many major environmental issues are also technologically informed, digital environmental activism also embraces 'technological citizenship' (Longford, 2005), and 'science citizenship' (Elam and Bertilsson, 2003), which robustly questions and critiques controversial science and technology, socially and environmentally.

Engaging in the environmental activist terrain

The environmental political potential of new and social media

An early demonstration of the mass environmental political potential of new and social media was in the anti–globalisation protest against the 1998 Multilateral Agreement on Investment. The protestors raised issues about 'the unequal distribution of wealth and the dubious role of international organizations like the IMF and the World Bank …' (Van Aelst and Walgrave, 2002, p. 468); with many associated adverse environmental issues. Informing the protest, Van Aelst and Walgrave (2002, p. 468) found that 'an Internet–based campaign of an international network of organisations (600 in the end) from seventy countries … led to … the failure of the agreement'.

A decade later, the first online environmental mass e–mobilisation occurred in response to BP's disastrous 2010 Gulf of Mexico 'Deepwater Horizon' oil spill. In 2014, a US District Court judge ruled that BP was primarily responsible for the oil spill due to gross negligence and reckless conduct (Robertson and Krauss, 2014). In 2015, this ruling led to a massive US$18.7 billion fine–the largest corporate settlement in US history (Wade and Hays, 2015). Part of the 'e–mobilisation' facilitated information sharing by highlighting BP's poor record of safety measures and environmental standards (Earl and Kimport, 2011). Reflecting on the social power of this new and social media engagement, Jodi Callaghan (n.d.) in her blog 'Talking logic' opined: 'Facebook … enabled these public citizens to gain groundswell at a grassroots level with the Facebook page 'Boycott BP' … having more than 675,000 members. Not only does this group have a web presence, they have a voice and they have influence'.

The BP e–mobilisation spread rapidly due to the capacity of horizontal communication (Dahlgren, 2006). However, online actions are also organised vertically from one source, particularly for public awareness and lobbying actions. Greenpeace, for example, has produced a number of very short YouTube videos, which find what is called 'rhetorical velocity' (Sheridan, Ridolfo and Michel, 2012, p. 179). One, a 45–second video called 'Stop Coca Cola trashing Australia', published 5 May, 2013, attracted almost two million hits by December 2015. It featured parts of plastic bottles killing seabirds and mentioned Coca Cola fighting proposed legislation to solve the issue, with a punch line proclaiming: 'Tell our politicians to stand up for our wildlife' (Greenpeace, 2013).

Other online environmental pressure politics

On industrial production, a key online strategy called 'political consumerism' motivates activists to 'shop for change', to make selective choices of consumer products or brands, based on social, political, environmental, and/or ethical grounds (Baek, 2010, p. 1066). Also, as counterpublics, these activists primarily use horizontal networks to facilitate 'more effective and massive pressure' (Baek, 2010, p. 1067).

'Adbusters'–which uses Twitter and YouTube in a mix of horizontal and vertical communication–proclaim themselves as a 'global network of meme warriors working to change the way meaning is produced in our society' (Adbusters, n.d.). A key practice is 'culture jamming'. It politicises 'corporate logotypes' in ethical, environmental sustainability, and corporate responsibility contexts. The aim is to affect citizen consciousness–raising

and, ultimately, value and behavioural change in today's 'runaway consumer societies' (Micheletti and Stolle, 2008, p. 761).

The success of culture jamming was demonstrated by Greenpeace in 2014 thus: 'German retailer Tchibo … promised to make sure its products are toxic–free … After more than one million people responded to Greenpeace's Save the Arctic campaign LEGO ended its 50–year link with Shell. … [and] British luxury brand Burberry made a commitment to eliminate the use of hazardous chemicals from its supply chain by 1 January 2020' (Greenpeace, 2014).

Ecologies of dissent and tactical media

The term 'ecologies of dissent' describes online protest actions particularly through Twitter. Twitter hashtags are a strategic digital media device that brings 'publics together to act in concerted or less organized ways'. For example, protests at the 2009 UN Climate Summit in Copenhagen convincingly demonstrated the deployment of twitter conversation 'streams' (Segerberg and Bennett, 2011, p. 212).

The expression 'tactical media', in turn, describes a media of 'crisis, criticism and opposition' (Garcia and Lovink, 1997). Through digital devices, 'tactical media do not just report events, as they are never impartial, they always participate and it is this more than anything that separates them from mainstream media' (Lester and Hutchins, 2009, p. 581).

Tactical media was apparent during the summer of 2003–2004 when Greenpeace Australia and the Wilderness Society established a 'Global Rescue Station' in Tasmania's Styx Valley; as a base camp for activists undertaking a vigil platform in a giant *Eucalyptus regnans*, 65 metres above ground. This initiative was part of a four–decade long campaign to protect old–growth forest wilderness from logging. The vigil's purpose was to gain conventional mass media attention to stop the logging of some of the tallest trees globally, through 'cyber–activists' pressuring the logging industry and government as a 'community of opposition' (Lester and Hutchins, 2009).

Over 19,000 online visits to the Global Rescue Station website were recorded in its first month of action. The story was then aired in conventional media particularly in Japan, Mexico, South Africa, the US, and Germany. Australian politicians visited the site, which placed the issue prominently on public, media, and policy agendas (Lester and Hutchins, 2009). On 5 July 2013, Senator Christine Milne, incumbent leader of the Australian Greens, implicitly acknowledged the communicative power of

new and social media in sending an Instagram post of the trees with the comment: 'Saved at last Styx Valley World Heritage 2013' (Milne, 2015).

Tactical media has also been adopted by whale hunting protestors in Australia's Southern Ocean to achieve online 'mediated visibility', through audio–visual footage, 'of clashes between protesters and whalers ... broadcast and streamed by news outlets, providing a shocking immediacy to the reality and danger of the 'whale wars' fought annually many miles from land' (Lester and Hutchins, 2012, p. 848). Mediated visibility thus communicates many 'hidden' environmental struggles. For example, Greenpeace has deployed this strategy to make climate change effects in the Arctic and Antarctic landscapes more publicly visible through images of retreating or cracked glaciers (Doyle, 2007, p. 129). In addition, many publics effectively conveyed the Fukushima (invisible) radiation issue through new and social media globally (Hindmarsh, 2013; Hindmarsh and Priestley, 2016).

Potential constraints to digital environmental activism

Of key importance to the potential of digital environmental activism are interrelated questions of participation and mobilisation through new and social media; which Milan (2015) also refers to as the 'material constraints' of new and social media (see also Akrich, 1992). The key questions discussed here include expanding concentration of media corporate ownership; and online surveillance. Both questions concern the new and social media capacity of counterpublics to perform effectively in protest actions over time.

The first question concerns the increasing embedment of new and social media systems within expanding global systems of corporate concentration, potentially imposing information constraints like those characterising traditional mass media. Such constraints would potentially limit democratic deliberation and knowledge dissemination though an increasing focus on entertainment, news, advertising, personal texting, and public relations endeavours (Artz and Kamalipour, 2003; Elliott and Lemert, 2006).

Concerns are thus held by digital counterpublics about 'relying on an external, corporate–owned social media platform' for their activities also in relation to potential censorship, and in narrowing activism and online deliberation (Penney and Dadas, 2014, p. 86). For example, in the 2011 Occupy Wall Street (OWS) movement, 'Twitter users apparently

encountered more direct censorship when using movement–related hashtags' (Penney and Dadas, 2014, p. 87).

Secondly, and in close relation to issues of corporate media ownership, other concerns are held about the participatory potential of new and social media (Fuchs, 2014; Taylor, 2014). First, some scholars have advanced that social media encourages individual creativity (Castells, 2009; Stiegler, 2009). As Fenton amd Barrasi (2011, p. 180) argued, 'the self–centred forms of communication that these platforms enable can challenge rather than reinforce the collective creativity of social movements'. Secondly, due to an asymmetry 'between the power of corporations and other powerful groups and the actual counter–power of citizens' (Fuchs, 2014, p. 77), not all user–generated content receives the same visibility through new and social media.

Fuchs (2014, p. 100) thus contended that new and social media are being 'colonized by corporations, especially by multimedia companies that dominate attention and visibility'. A key material conduit to domination is the global technical infrastructure of networked data centres of companies like Google. These 'media infrastructures' are comprised of broadband pipelines, cloud computing systems, digital compression centres, and protocols 'integral to the movement and storage of audiovisual signal worldwide' (Parks and Starosielski, 2015, p. 10). The argument is then that while new and social media can 'contribute to greater fragmentation and pluralism in the structure of civic engagement', corporate ownership of the expanding technical infrastructure may eventually 'undermine the coherence of the public sphere'; and thus potentially reduce or counter the democratising effect of new and social media (Bimber, 2000, pp. 332–333).

At the same time, however, regarding privacy issues of what we refer to as 'digital communication risk', competitive new media platforms have emerged to offer more privacy for users as a key sales point of selecting their platforms. In response, established new and social media companies are now also offering encrypted communication technologies. In addition, horizontal communication is being relied on more to further strengthen expanding counterpublic movements (Castells, 2009; Dahlgren, 2006).

On the coherence of the public digital sphere, Kahn and Kellner (2004, pp. 92–93) also observed that: 'Increasingly, bloggers are not tied to their desktops, writing in a virtual alienation of the world, but are posting pictures, text, audio and video … Large political events, such as the World Summit for Sustainable Development, the World Social Forum, and the G8

forums all now have wireless bloggers all providing real time alternative coverage'.

In the case of the OWS movement, for example, inclusive participation of citizens in the movement's activities strengthened through new and social media. Penney and Dadas (2014) identified several roles regarding activist participation that Twitter enabled: from 'facilitating face–to–face protests via advertisements and donation solicitations' and 'live reporting from face–to–face protests', to 'making personal connections with fellow activists; and facilitating online–based actions'.

Further, 'For protest movements like OWS that adopt a non–hierarchical, horizontal structure as a matter of political and philosophical principle, Twitter's participatory and networked structure of circulation seems to hold particular importance, as its very form resonates with these broader organizational dynamics' (Penney and Dadas, 2014, p. 89). The open–ended networking capacity of Twitter and alternative digital platforms can also be seen to align with the 'connectivity architecture' of the environmental movement, as further enabling a highly flexible and ever–changing action network of activists, groups, and communities (e.g. Doyle and McEachern, 2008; Rainie and Wellman, 2012).

The third notable concern we raise that challenges digital environmental activism is growing State propensity to build panoptic digital surveillance in the claimed interest of the 'security of the state', for example, in the adoption of online metadata surveillance strategies. Such strategies aim to protect the security of the state by detecting and monitoring online activities of potential terrorists (Lyon, 2006). As part of this development, the definition of 'terrorist activities' extended post–9/11 beyond the traditional focus on criminal activities to civic 'influencers'.

Included in this remit is environmental activism, which questionably builds on the 'ecoterrorism' frame (Taylor, 1998, p. 2; also, Calibeo and Hindmarsh, in this volume; Loadenthal, 2013). The latter is a negative serotyping frame that emerged in the 1970s in relation to highly confrontational or so–called 'radical' or 'militant' activists–particularly members of the Earth Liberation Front and Animal Liberation (Button, John and Brearley, 2002; Leader and Probst, 2004).

Consequently, for a wide range of contemporary social movement activism, digital communication risk of online surveillance through new and social media has become a potential new reality. New and social media users can then become considered 'digital suspects' (in following the concept of 'genetic suspects' coined by Hindmarsh and Prainsack, 2010, p.

2). For example, OWS activists came to learn that local protests in Massachusetts were being 'heavily monitored by law enforcement', as one OWS activist commented: 'The police department watches our Twitter like crazy' (Penney and Dadas, 2014, p. 88).

In the environmental protest arena, similar episodes have occurred that involved both online and offline surveillance strategies; from monitoring the activities of digital suspects on social media to more traditional forms of targeted surveillance including the infiltration of undercover officers among activists. For instance, shale gas drilling opponents in Pennsylvania came under State surveillance in 2010; as did activists contesting the Keystone XL tar sand pipeline project in Canada. The latter were placed under police surveillance in 2011 by the Canadian Police 'as [economic] threats to national security' (Leahy, 2013; Potter, 2011). More recently, in 2016, 'Keep it in the Ground', an environmental movement opposing drilling projects for coal mining in Colorado, was put under police surveillance (Fang and Horn, 2016).

On the effectiveness of mass online surveillance, however, Krueger (2005, p. 442) argued: 'For surveillance to discipline individuals also requires the lack of horizontal communication between individuals' (see also, Doyle and Fraser, 2010). Through new and social media, environmental activists also attempt to subvert surveillance by turning the 'watchers' into 'the watched' –a response known as 'sousveillance' or 'participatory surveillance' (Albrechtslund, 2012; Krueger 2005). Also notable is that since 2008, a series of protests has occurred, most notably in Europe and the US, against data retention, surveillance, and any relaxation of media ownership rules (Milan and Hintz, 2013, p. 17).

Conclusion

To reiterate, the aim of this research was to investigate the potential of new and social media to enhance environmental activism to protect the environment, and advance global environmental sustainability through social transformation. In considering the claims and counter claims made in relation to this potential, we are persuaded, by weight of available evidences, to posit a significantly enabling potential of new and social media for enhanced environmental activism, tempered by minimising its potential material and social constraints. Of key importance is the evidence related to horizontal communication, complemented by vertical communication and/or their mix. These communication forms are clearly significant in

informing the strategic and flexible architecture of environmental activism, thus allowing it to engage more effectively in the environmental issues terrain, in complementing and building on traditional (offline) forms of activism, pressure politics, and media targeting.

Of substance, as the Ejolt Environmental Justice Atlas and e–mobilisations and campaigns referred to above indicate, geographically remote and more 'hidden' issues will likely be increasingly revealed–including, for example, deforestation in dense old–growth forests and the Amazon, whale hunting in the vast oceans, and mining activities in remote areas. Turning to the potential constraints of corporate control and surveillance, counterpublics are already adapting to political censorship and surveillance through 'strategic new and social media'. Emergent democracy and technical critiques are also growing of whole population notions of panoptic surveillance through metadata; which involves billions of users with the hard–to–monitor horizontal communication dominant.

To conclude, it seems clear that new and social media is already enhancing environmental activism to engage more effectively in pressure politics, in tandem with conventional forms of pressure, to better protect the environment and constructively advance global environmental sustainability.

References

Akrich, M. (1992) The De–scription of Technical Objects. In Bijker, W.E. and Law, J. (eds.), *Shaping Technology/Building Society: Studies in Sociotechnical Change*. Cambridge: MIT Press.

Adbusters. (n.d.) [Online] Available from: https://twitter.com/Adbusters. [Accessed: October 5th, 2013].

Albrechtslund, A. (2012) Socializing the City. In Fuchs C., Boersma, K., Albrechtslund, A. and Sandowal, M. (eds.), *Internet and Surveillance the Challenges of Web 2.0 and Social Media*. New York: Routledge.

Artz, L. and Kamalipour, Y. (eds.) (2003) *Globalization of Corporate Media Hegemony*. Albany: State University of New York Press.

Baek, Y. (2010) To Buy or Not to Buy: Who are Political Consumers? What do They Think and how do They Participate? *Political Studies*, 58 (5), 1065–1086.

Bennett, W. (2008) Changing Citizenship in the Digital Age. In Bennett, W.L. (ed.), *Civic Life Online: Learning How Digital Media Can Engage Youth*. Cambridge: MIT Press.

Bennett, W., Segerberg, A. and Walker, S. (2014) Organization in the Crowd: Peer Production in Large Scale Networked Protests. Information, *Communication & Society*, 17 (2), 232–260.

Bimber, B. (2000) *The Study of Information Technology and Civic Engagement*. London: Routledge.

Button, M., John, T. and Brearley, N. (2002) New Challenges in Public Order Policing: The Professionalisation of Environmental Protest and the Emergence of the Militant Environmental Activist. *International Journal of the Sociology of Law*, 30, 17–32.

Callaghan, J. (n.d.) Talking Logic. [Online] Available from: http://goo.gl/mDGvht. [Accessed: September 25th, 2013].

Cao, B. (2015) *Environmental Citizenship*. New York: Routledge.

Carter, N. (2007) *The Politics of the Environment: Ideas, Activism, Policy*. New York: Cambridge University Press.

Castells, M. (2009) *Communication Power*. Oxford: Oxford University Press.

Croteau, D. and Hoynes, W. (2006) *The Business of Media: Corporate Media and the Public Interest*. California: Pine Forge Press.

Dahlgren, P. (2006) The Internet, Public Spheres, and Political Communication: Dispersion and Deliberation. *Political Communication*, 22 (2), 147–162.

Doyle, J. (2007) Picturing the Clima(e)tic: Greenpeace and the Representational Politics of Climate Change Communication. *Science as Culture*, 16 (2), 129–150.

Doyle, W. and Fraser, M. (2010) Facebook, Surveillance, and Power. In Wittkower, D. (ed.) *Facebook and Philosophy: What's on Your Mind?* Chicago: Open Court.

Doyle, T. and McEachern, D. (2008) *Environment and Politics*. New York: Routledge.

Earl, J. and Kimport, K. (2011) *Digitally–enabled Social Change*. Cambridge: MIT Press.

Elam, M. and Bertilsson, M. (2003) Consuming, Engaging and Confronting Science: The Emerging Dimensions of Scientific Citizenship. *European Journal of Social Theory*, 6 (2), 233–251.

Elliott, A. and Lemert, C. (2006) *The New Individualism: The Emotional Costs of Globalization*. Oxon: Routledge.

Fang, L. and Horn, S. (2016) Federal Agents Went Undercover to Spy on Anti–fracking Movement, Emails Reveal. *The Intercept*, 19 July. [Online] Available from: http://bit.ly/29RdGWX. [Accessed: October 17th, 2016].

Fenton, N. and Barrasi, V. (2011) Alternative Media and Social Networking Sites: The Politics of Individuation and Political Participation. *The Communication Review*, 14 (3), 179–196.

Fraser, N. (1990) Rethinking the Public Sphere: A Contribution to the Critique of Actually Existing Democracy. *Social Text*, 25/26, 56–80.

Fuchs, C. (2005) The Internet as a Self–organizing Socio–technological System. *Cybernetics & Human Knowing*, 3, 37–81.

Fuchs, C. (2014) *Social Media: A Critical Introduction*. London: Sage.

Garcia, D. and Lovink, G. (1997) *The ABC of Tactical Media, Tactical Media Network*. [Online] Available from: http://goo.gl/IS9C0z. [Accessed: October 17th, 2016].

Greenpeace. (2013) *Stop Coca Cola Trashing Australia*. [Online] Available at: http://goo.gl/v6R5Jl [Accessed: October 14th, 2013].

Greenpeace. (2014) *43 Years of Inspiring Actions*. [Online] Available from: http://goo.gl/DWcYqH. [Accessed: April 14th, 2015].

Hansen, A. (2010) *Environment, Media and Communication*. Oxon: Routledge.

Hindmarsh, R. (ed.) (2013) *Nuclear Disaster at Fukushima Daiichi: Social, Political and Environmental Issues*. New York: Routledge.

Hindmarsh, R. and Prainsack, B. (2010) Introducing Genetic Suspects. In Hindmarsh, R. and Prainsack, B. (eds.) *Genetic Suspects: Global Governance of DNA Profiling and Databasing*. Cambridge: Cambridge University Press.

Hindmarsh, R. and Priestley, R. (eds.) (2016) *The Fukushima Effect: A New Geopolitical Terrain.* New York: Routledge.

Hudson, W. and Kane, J. (eds.) (2008) *Rethinking Australian Citizenship*. Cambridge: Cambridge University Press.

Kahn, R. and Kellner, D. (2004) New Media and Internet Activism: From the 'Battle for Seattle' to Blogging. *New Media & Society*, 6, 87–95.

Krueger, B. (2005) Government Surveillance and Political Participation on the Internet. *Social Science Computer Review*, 23, 439–452.

Leader, S. and Probst, P. (2004) The Earth Liberation Front and Environmental Terrorism. *Terrorism and Political Violence*, 15 (4), 37–58.

Leahy, S. (2013) In Conservatives' Canada, It's Not Easy Being Green. *Inter Press Service*, 20 February. [Online] Available from: http://goo.gl/VLVTEb. [Accessed: January 25th, 2015].

Lester, L. and Hutchins, B. (2009) Power Games: Environmental Protest, News Media and the Internet. *Media, Culture & Society*, 31, 579–595.

Lester, L. and Hutchins, B. (2012) The Power of the Unseen: Environmental Conflict, the Media and Invisibility. *Media, Culture and Society*, 34 (7), 847–863.

Loadenthal, M. (2013) Deconstructing 'Eco–terrorism': Rhetoric, Framing and Statecraft as Seen through the Insight Approach. *Critical Studies on Terrorism*, 6 (1), 92–117.

Longford, G. (2005) Pedagogies of Digital Citizenship and the Politics of Code. *Techné: Research in Philosophy and Technology* 9 (1). [Online] Available from: http://tinyurl.com/ka39dvg [Accessed: October 17th, 2016].

Lyon, D. (2006) 9/11, Synopticon, and Scopophilia: Watching and Being Watched. In Haggerty, K. and Ericson, R. (eds.), *The New Politics of Surveillance and Visibility*. Toronto: University Of Toronto Press.

Micheletti, M. and Stolle, D. (2008) Fashioning Social Justice through Political Consumerism, Capitalism, and the Internet. *Cultural Studies*, 22 (5), 749–769.

Milan, S. (2015) From Social Movements to Cloud Protesting: The Evolution of Collective Identity. *Information, Community & Society*, 18 (8), 887–900.

Milan, S. and Hintz, A. (2013) Networked Collective Action and the Institutionalized Policy Debate: Bringing Cyberactivism to the Policy Arena? *Policy and Internet*, 5 (1), 7–26.

Milne, C. (2015) *Saved at Last. Styx Valley World Heritage 2013*, Instagram post (milne_christine). [Online] Available from: goo.gl/jvNKLr [Accessed: July 5th, 2016].

Mutz, D. (2006) *Hearing the Other Side: Deliberative Versus Participatory Democracy*. Cambridge: Cambridge University Press.

Parks, L. and Starosielski, N. (2015) Introduction. In Parks, L. and Starosielski, N. (eds.) *Signal Traffic: Critical Studies of Media Infrastructure*. Urbana: University of Illinois Press.

Penney, J. and Dadas, C. (2014) (Re)Tweeting in the Service of Protest: Digital Composition in the Occupy Wall Street Movement. *New Media & Society*, 16 (1), 74–90.

Potter, W. (2011) *Green Is the New Red*. San Francisco: City Lights Books.

Rainie, L. and Wellman, B. (2012) *Networked: The New Social Operating System.* Cambridge: MIT Press.

Robertson, C. and Krauss, C. (2014) BP May be Fined Up To $18 Billion for Spill in Gulf. *The New York Times*, 4 September. [Online] Available from: http://goo.gl/dOuAus [Accessed: December 17th, 2015].

Rokka, J. and Moisander, J. (2009) Environmental Dialogue in Online Communities: Negotiating Ecological Citizenship among Global Travellers. *International Journal of Consumer Studies*, 33, 199–205.

Rootes, C. (2008) Acting Locally: The Character, Contexts, and Significance of Local Environmental Mobilisations. In Rootes, C. (ed.) *Acting Locally: Local Environmental Mobilizations and Campaigns*. New York: Routledge.

Segerberg, A. and Bennett L. (2011) Social Media and the Organization of Collective Action: Using Twitter to Explore the Ecologies of Two Climate Change Protests. *The Communication Review*, 14 (3), 197–215.

Sheridan, D., Ridolfo, J. and Michel, A. (2012) *The Available Means Of Persuasion*. Anderson: Parlor.

Southren, J. (2013) The Difference between New media and Social Media. *Social Media for Lawyers*, 29 April. [Online] Available from: http://goo.gl/VlLByi. [Accessed: September 10th, 2014].

Stiegler, B. (2009) The Carnival of the New Screen: From Hegemony to Isonomy. In Snickars V. and Vonderau, P. (eds.), *The YouTube Reader*. Stockholm: Mediehistoriskt.

Taylor, A. (2014) *The People's Platform: Taking Back Power and Culture in the Digital Age*. Toronto: Random House Canada.

Taylor, B. (1998) Religion, Violence and Radical Environmentalism: From Earth First! to the Unabomber to the Earth Liberation Front. *Terrorism and Political Violence*, 10 (4), 1–42.

Temper, L., del Bene D. and Martinez–Alier, J. (2015) Mapping the Frontiers and Front Lines of Global Environmental Justice: The EJAtlas. *Journal of Political Ecology*, 22, 255–278.

Van Aelst, P. and Walgrave, S. (2002) New Media, New Movements? The Role of the Internet in Shaping the Anti–globalization Movement. *Information, Communication & Society*, 5 (4), 465–493.

Wade, T. and Hays, K. (2015) BP Reaches $18.7 billion Settlement over Deadly 2010 Spill, *Reuters*, 2 July. [Online] Available from: http://goo.gl/sdPKVb. [Accessed: December 17th, 2015].

Ecology of Technology and the Commodification of Inuit Country Foods

Alexander CASTLETON[*][a] and Carlos NOVAS[a]

[a] Carleton University

This paper explores the recent controversy over Inuit selling meat from the animals they harvest. At the heart of this controversy are divergent understandings of this practice: some suggest that this practice enables Inuit hunters recuperate expenses related to hunting, while others argue that commodifying meat is contrary to Inuit customs. A matter of concern in this controversy is how some hunters use Facebook to sell meat from their catch to distant populations, leading to worries over the potential over–hunting of caribou herds. In this paper, we argue that Facebook and more generally the Internet, can be understood as part of an 'ecology of technology' of hunting that also includes objects such as snowmobiles, GPS, rifles, and ammunition. We draw upon Claudio Aporta's (2013) notion of an ecology of technology to draw out the contours of our case study and to think of this concept in relation to the social construction of technology and actor–network theory.

Keywords*: Inuit; technology; hunting*

Introduction

Inuit live in a mixed economy of 'traditional' subsistence – consisting in the harvesting of animals and plants – and the market economy (Huskey, 2010; Southcott, 2005). In many cases, the income received from participation in the market economy supports traditional subsistence activities, as money is needed to buy, repair or replace hunting equipment such as snowmobiles, gas, rifles, bullets, or knives. In recent years, Inuit have started using Facebook to auction their catch – a new way of commercializing country foods. Many groups have appeared on Facebook, such as *Iqaluit Auction Bids*, where photos of country foods are displayed and offered for sale to potential buyers. Most communities across Nunavut

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[*] Corresponding author: **Alexander Castleton**| e–mail: **alexcastlef@gmail.com**

have sell/swap Facebook groups. This might seem simply as the adoption of a tool such as Facebook to carry out an age–old practice beginning with the first contacts with American and European whalers; at this time, Inuit turned the animals they hunted into a commodity by selling them to the non–Inuit, or exchanging them for other goods (Searles, 2016, p. 200). The commodification of the hunt can furthermore be evidenced when Inuit were resettled into communities by the Canadian government. This resettlement generated a greater need for cash among Inuit and furthered their integration into the market economy; the outcome of this led to Inuit's selling of country foods, which also prompted the government to sponsor different programs aimed at Inuit selling their catch (Gombay, 2005a, pp. 118–119). The issue at hand, however, is that experts have suggested that the use of Facebook to sell country foods has led to the decline of caribou herds. A 2012 news article from the Canadian Geographic magazine stated 'Iqaluit Sell/Swap, an open group on the popular social networking site [Facebook], serves primarily as a convenient place to auction off old children's clothes or fix–er–up cars. But lately, some members have been offering up bounty from their latest hunting trip such as caribou or arctic char – for a price. It's an avarice born of desperation' (Doyle, 2012). The traditional social norm for Inuit is that food must be shared – Facebook sell/swap groups have altered traditional food–sharing practices according to James Eetoolook (cited in Weber, 2014) of Nunavut Tunngavik (an Inuit political organization).

In this article, we explore the relationship between the commodification of country foods, technology, Facebook, and hunting in Nunavut by building from anthropologist Claudio Aporta's notion that technology should be understood as an ecosystem affecting people's lives (Aporta 2013). We articulate this notion with the concept of mutual constitution of people and technology coming from the social construction of technology literature (e.g. MacKenzie and Wajcman, 1999). Furthermore, we add a layer to the analysis using tools from actor–network theory (ANT) arguing that Aporta's concept falls back into a subject/object dichotomy (see Latour, 1993) by not clearly accounting for the distribution of agency across human and non–human actors (Whitridge, 2004a, p. 450). Therefore, his ecology of technology notion could be also articulated with ANT's principle of symmetry (Callon, 1984).

Given that observers have pointed out the relevance of Facebook as a channel through which to sell country foods, we will pay special attention to the role of information and communication technology (ICT) in Inuit

lifeworlds. First, however, we will provide a brief introduction to the meaning of hunting in Inuit culture.

Inuit hunting

For Inuit, life is attached to place, land and animals. As Gombay (2005b, p. 419) explains: 'There are supernatural ties between humans and animals, and so animals must be respected.' Inuit morality asserts that hunters should only kill what they need and show respect to the animal that is giving itself to the hunter. Respect and gratitude to the animal encompasses sharing it with others and is embedded in the belief that sharing will ensure success in future hunting expeditions (Gombay, 2005b, pp. 420–421).

Hunting is a central aspect of Inuit identity (Searles, 2002; Wenzel, 1991). As Stairs and Wenzel (1992) indicate, the core of the relationship between Inuit and animals is the recognition of equality and that they both participate in a shared environment. Inuit have traditionally held great respect for the animals they hunt; this respect encompasses using every part of the animal, in addition to sharing food, as 'no one, whatever their circumstances, need to go without food or shelter' (Wenzel, 2009, p. 92). In fact, Inuit harvesting 'is embedded within a social relational continuum in which the individual harvester in extracting food from the environment works as a medium through which community and environment are integrated' (Stairs and Wenzel, 1992, p. 3). Therefore, all Inuit food, called *niqituinnaq* (ibidem.), unifies environment, community and identity. This encompasses sharing the hunt and the idea that food from harvested animals should be common property. 'An Inuk must approach animals with an attitude of respect for co–resident being and intend that the products of the animal generosity be available to all those with whom the harvester may have contact' (ivi, p. 5). The practice of sharing, called *inummariit*, is of utmost importance, as it shows the continuation with all beings. An Inuk does not hunt solely to eat, 'but also to structure his community, and ultimately to build a cognitive model of the world by which he is defined and directed' (ivi, p. 7). To be *inummarik* (singular of inummariit) means being a genuine person, namely, living in accordance to the correct ethical principles toward the environment, community, animals, and people. By sharing, the structure of society is affirmed and re–structured. Niqituinnaq entails the generous exchange between animals and humans, and through these exchanges identities are established. The animal's generosity to the hunter should be recognized by making it available for sharing within a community.

Through these relations of reciprocity, the hunter is a vehicle between the environment and humans. In this sense, Stairs and Wenzel (1992, p. 10) write: 'Generosity is simply normal to the central cultural feature of inummarik living. Ongoing generous interactions, circling through all the elements of the human and non–human environment', are essential in sustaining a genuine 'eccocentric' existence'. Subsistence activities and eating are very important in participating in this connection, through which the substance of animals is incorporated into the body.

Inuit hunting and Facebook

A report from the Department of Environment of the Government of Nunavut (DoE, 2014) has stated: 'This increase in caribou harvesting is likely a result of a developing export market using social networking site like 'Facebook' and 'sell & swap' to sell Southampton Island caribou to other Baffin Island communities'. In 2013, the Government of Nunavut biologist Mitch Campbell said that some Hunter and Trappers Organizations were expressing concern about Internet sales of caribou meat. In an interview for CBC News, he stated 'from our calculation, it was almost the subsistence harvest doubled, because of internet sales' (CBC News, 2013).

A recent news article from Nunavut's main news outlet, *Nunatsiaq online*, also points to internet sales as one of the suspects of the Kivalliq region's decrease in the number of caribou: '…internet caribou meat sales and other factors are seriously impacting the Kivalliq region's Qamanirjuaq caribou herd.' The executive director of the Beverly and Qamanirjuaq Caribou Management Board – a co–management body with representatives from provincial, territorial, and federal governments, as well as Aboriginal groups and impacted communities – declared that 'One of the things we're really concerned about is wastage and internet sales from the Kivalliq region over to Iqaluit', and that 'no one keeps track of Nunavut caribou meat sales over the internet'. The article points out that 'they have no hard numbers, but based on anecdotal evidence from community members, they suspect the amount of meat sold and shipped out of Kivalliq might exceed the subsistence hunt in that region'.

Even though selling food has been a long–standing practice that has helped Inuit negotiate the social changes they have rapidly gone through (Gombay, 2005b), the over–hunting of caribou and their wastage indicates a shift in inummariit, namely, the meaning of animals, the land, and the role of people and hunters. This shift, we argue, needs to be interpreted

according to the technological constellation in which Inuit live. A concept such as 'ecology of technology' developed by anthropologist Claudio Aporta (2013) from his studies in Inuit traveling and way–finding is useful to understanding Inuit social change. This concept, however, could be articulated with tools from the social construction of technology literature, as we discuss below.

Inuit's ecology of technology

Aporta's (2013, p. 254) definition of 'ecology of technology' should be cited *in extenso*:

> 'Technologies (contemporary technologies, especially) are ecologically related to each other. The GPS user deals with a whole structure of technologies and of social organizations. The answer to his/her special question comes from a background of extremely complex systems where technologies interact with other technologies, and also with people, and through people. GPS, in this sense, must be understood ecologically. That is, in connection with the other technologies whose ecology is shared by GPS. These technologies are connected to each other, and they depend on each other to exist. In the social analysis of technology, GPS will not undermine or enrich people's perception of the world, as GPS is in fact a part of an increasingly interconnected ecosystem of technologies. In social analysis of technologies, it is this ecosystem (and not individual technologies in isolation), which may affect people's lives.'

Several interpretations can be found in the existing literature on the relation between Inuit and technology. The older scholarship tends to argue that technology is either a factor destroying the fabric of Inuit society or a means to its salvation. However, there are more complex analyses on the mutual shaping of Inuit traditional practices and technology, such as Aporta's (Aporta, 2013; Aporta and Higgs, 2005). The significance of the complex views on the relationship between Inuit and technology comes from the fact that technology seems to have impacted a social institution central to Inuit culture, which is to share food. Weber (2014) writes, that some people might call selling animals 'a betrayal of sacred Inuit traditions', and he quotes James Eetoolok from Nunavut Tunngavik, who said that 'it's not the Inuit way of life to sell to others.' This traditional view, however, is

undergoing change in relation to the ecology of technology that Inuit now live in and which shapes their practices – an ecology that now includes snowmobiles, gas, rifles, bullets, GPS, satellites, the Internet, and Facebook. An ecology of technology framework enables understanding of the mutual shaping of Inuit traditional practices and technology and works to create distance from determinist/essentialist views on Inuit culture and technology.

A brief review of the literature on Inuit and technology will clarify this point. In 1977, Dicks discussed the impact of the introduction of the dial phone in the Arctic, and suggested that rapid technological change created problems for Inuit culture. Dicks (1977, p. 127) asks 'Has Inuit social organization been able to keep abreast of rapid change in its technological apparatus? Or has a gap developed between these two facets of the culture? Such a gap can generate stress as a society struggles to deal with unexpected options which new technologies present'. Dicks (1977) used indicators such as increases in crime rates in several communities to show that fast social change fostered by technology had been harmful to Inuit culture. Similarly, Savard (1998) reflected on the introduction of the Internet in Nunavut. On the one hand, he acknowledged some of the benefits such as: better communication amongst a disperse population, enhanced social cohesion, better governmental coordination, and modernization of Nunavut's economy. On the other hand, he suggested some of its negative consequences: 'Nunavut's Inuit may not be sheltered from the impacts of using the Internet. On the contrary, they risk being the first victims of cybernetic metaculture. Young Inuit cybernauts will see their aboriginal values confronted by non–Aboriginal ones, the latter often taking precedence' (Savard, 1998, p. 89). And he goes on to affirm: '…the tool used in cyberspace – the computer – is a prolongation of another European cultural evolution, writing (…) Therefore, not only are the Inuit obliged to appropriate a tool that is centrally foreign to them, but they are also confronted with values that are completely different than their own (…) The Inuit have a tendency to appropriate these media, to want to make them tools for the promotion of their culture. But when all is said and done, what we are left with are issues, ways of doing things, and rhetoric that are essentially Anglo–European, rather than Native' (ibidem.)

The problem with these two accounts of technology and social change (Dicks, 1977; Savard, 1998) is that they employ a static understanding of culture, rather than a dynamic one, and do not account for the mutual shaping of technology and culture. Oudshoorn and Pinch (2003) have

referred to this dynamic as the *co–construction* of users and technology, and Judy Wajcman (2015, p. 33) explains that 'materiality and sociality are constitutive of both activities and identities'. Therefore, 'a conception of technology as a sociomaterial practice recasts agency as emerging from the interconnections between people and things, the ensemble of human–machine interaction'. In a similar fashion, Akrich (from an ANT perspective which we will bring into discussion below) explains a *co–constitution* of people and technology when 'people are brought into being in a process of reciprocal definition in which objects are defined by subjects and subjects by objects' (Akrich, 1992, p. 222). This type of reasoning is in line with what anthropologists such as Salzman (1980) write about indigenous people's social change, where 'social change is much less a society becoming something quite different than a society manifesting its fluidity and variability by reordering its parts, stressing some parts at the expense of others, and in this fashion, achieving flexibility and adaptability in both form and substance.'

Dicks (1977) and Savard (1998) by giving technology a deterministic role in Inuit lifeworlds fail to account for the agency of Inuit in appropriating technology to suit their needs. Drawing from Aporta and Higgs (2005) study on the use of GPS systems in Inuit wayfinding, they show how previous research such as Kemp's (1971, p. 115) 'who challenged the predominant ideas of tradition, stating that if a snowmobile is perceived to have greater utility than a dog sled, then the ownership of a snowmobile will become one of the criteria defining the traditional Eskimo hunter'. This type of analysis points to the mutual shaping of technology, identity and culture. For Rasing (1994, p. 68, in Aporta and Higgs, 2005, p. 739) one of the major effects of the introduction of the rifle in Igloolik was that 'hunting in general became a more objectified and less intimate interaction with nature because animals could be killed from greater distances and more animals could be secured'. Aporta and Higgs (2005) understand the relation between rifles and Inuit by considering the broader context of the changes brought by contacts with traders. They write: 'Rifles represented an improvement in hunting technology, increasing the possibility of success in the hunt and, therefore, its productivity, but they need to be understood within the context of trading and, to some extent, trapping. Traders brought with them not only the rifle and ammunition but also myriad items that were highly appreciated by Inuit populations across the Arctic (e.g., wooden sleds, canvas tents, steel knives, axes, Primus stoves, sugar, flour). Trading introduced novel goods into Inuit lifeworlds, but also reduced the time available for hunting as

trapping for skins became a significant economic activity that enabled trading to take place. Rifles and ammunition also needed to be traded. This complex relation between rifles, hunting, and trading has been clearly explained by Rasing (1994, p. 63): 'A reduction of available hunting time could to some extent be compensated by the acquisition of more adequate weapons, which, in fact, was the main reason for families to engage themselves in trapping'. Firearms, therefore, were both the result and enforcers of the new economic context of trading.'

This idea of mutual constitution of people and technology, through which Aporta and Higgs describe the relation between Inuit and rifles, also explains the commodification of meat. In order to hunt, money is needed to buy, maintain and repair a snowmobile, in addition to gas, rifles, ammunition, tents, GPS, and appropriate clothing. Hunting requires an investment of between $15,000 to $23,400 Canadian dollars (Weber, 2014). There is a complex relation here between rifles, hunting, Facebook, and selling meat. In fact, anthropologist Edmund Searles (2016) has pointed out an existing tension between Inuit who believe that hunters should be allowed to sell meat to support the cost of hunting, and those who believe that sharing is a key factor of being Inuit that in turn establishes the boundary with the non–Inuit. Searles, however, suggests that allowing hunters to sell meat will allow them to be more self–sufficient, generous and productive if they can both sell and share (Searles, 2016, p. 210), thus he proposes the idea of allowing meat to be a semi–public good. Searles' proposal aims to suggest that the meaning of animals, hunting, and what is to be a hunter, has changed according to an ecology of technology involving different human and non–human components. In other words, the land, animals, and hunting have been mutually shaped in relation to the technology involved in the process.

Ecology of technology and actor–network theory

A further step in conceptualizing the relation between Inuit and Facebook sell/swap pages could be taken by conceiving the process of commodification of meat through actor–network theory (ANT). In fact, it could be argued that Aporta's notion of an ecology of technologies as being inseparably related to each other which determine peoples' actions, expresses a rather similar idea to that of 'sociotechnical imbroglio' (Latour, 1992) or 'hybrid collectifs' (Callon and Law, 1997), where action is inseparable from both the human and non–human actors (or actants).

However, when Aporta (2013, p. 254) writes that people are immersed in an ecology which '*may* affect people's lives', he is falling into what ANT would say is a false dichotomy between subject/object, people/technology (Latour, 1993). According to ANT, humans' actions are indistinguishable from the network in which they find themselves, where non–humans are as important in establishing social orders. We never face objects or social relations on their own; rather, we face chains of associations of humans or non–humans (Latour, 1991). Therefore, saying that an ecology of technology *may* affect people's lives, falls short: agency is produced within heterogeneous networks of human and non–human actors (Law, 2008).

Previous research on Inuit from an ANT perspective helps to clarify this point. For instance, Whitridge (2004a) challenges the dichotomy between Inuit 'place' and Western 'space', arguing that there is no such difference. It depends on how many entities are enrolled in a network, where 'Space and place are merely analytically circumscribed moments of a complex, hybrid human spatiality' (2004a, p. 228). He writes that 'The triumph of Western spatialities is a consequence not of their transcendent objectivity, but of their close historical articulation with states, corporations, and various fields of technoscience over the course of the emergence of a hegemonic global capitalism' (2004a, p. 218). In fact, Whitridge (2004b) uses ANT quite illustratively to show how Thule whale hunting evolved according to the enrollment of different elements in the network of hunting, where he treats human and non–human elements symmetrically thus showing the implications that changes in harpoon heads had in the configuration of hunting procedures and of life in settlements (2004b, p. 464). Therefore, ANT 'provides an analytical paradigm that allows us to unfold the hybrid scripts and programs and translation networks of which the stones and bones were once a part' (2004b, p. 467).

It is true that, as Aporta (2013) writes, the devices that Inuit use are part of an interconnected network. For instance, GPS cannot work independently from the electricity needed to charge them, fuel, generators, satellites, and so on. But this notion could be more fruitfully developed with the ANT perspective that scholars such as Whitridge (2004a; 2004b) develop. Aporta seems to conceive an autonomous human agent that finds herself with technological resources at her disposition, whereas ANT stresses the relationality of entities within a network whose identities are defined according to the network they belong, and where the properties of all the enrolled entities seem to derive from their respective positions within the

network (Murdoch, 1997). Agency, then, is distributed through the elements enrolled in the network (see Law, 2008; Callon and Law, 1997).

When it comes to the controversial commodification of country foods by Inuit, there have been similar experiences in other displaced indigenous groups. For example, Awuh (2015) describes the experience of the Baka from Eastern Cameroon and how resistance to conservation efforts could be conceived as deriving from failed translations within a conservation network. Displaced from the region where they traditionally lived justified by a rhetoric claiming that they would benefit from the amenities provided by permanent settlements, the Baka betrayed (Callon, 1984) the conservation network by turning to illegal hunting in nearby reservations thus generating an income through selling the meat of the animals they hunt.

Similarly, Inuit commodification of country foods involves a heterogeneous network of entities, one in which Facebook has been recently enrolled and translated as a platform to sell meat. As described above, this is indeed a controversial matter in so far as it alters one of the fundamental traits of Inuit identity which differentiates them from the Qallunaat (non–Inuit), namely, that of sharing food. In a context of high unemployment and food insecurity, Inuit, like the Baka, have turned to the commodification of country foods – a practice that leads to the risk of over–hunting.

Even though selling meat is not a new practice for Inuit, Facebook sell/swap pages alter the scale of this practice and translate it into a commodification–of–meat network. These pages can also be seen as strategies that displaced people such as the Inuit use to resist their unfavorable condition (Awuh, 2015) characterized by high unemployment and extremely high suicide rates, (see Hicks, 2007). This sort of resourcefulness is what Inuit define as *Qanuqtuurniq* (being innovative and resourceful) and which is one of the Inuit societal values fostered by the Government of Nunavut. From an ANT perspective, *Qanuqtuurniq* could be defined as the ability to combine and translate heterogeneous elements in particular ways, as is the case of the commercialization of country foods, because 'Society is composed from the bottom up by intersecting and overlapping networks and not by a totalizing, hierarchical grid or structure that exists apart from its local manifestation' (Whitridge, 2004a, p. 467).

Conclusion

In this article, we have tried to challenge some of the existing scholarship which posits an essentialist/determinist perspective in relation to Inuit and technology. These outdated views fail to understand cultures as flexible and open to change through a mutual shaping of technology and culture. The evolution of the scholarship regarding Inuit and technology has shown a progress from essentialist/determinist perspectives to the nuanced co–constitution of both.

In order to explore the commodification of country foods, we drew upon Claudio Aporta's notion of 'ecology of technology' to explore the constellation of cultural and technological practices that enable this controversial economy to take shape. We argued that it is important to look at the network that enable Inuit to sell the meat from the animals they harvest through the interconnected set of technologies (snowmobiles, gas, rifles, bullets, GPS, satellites, internet, and Facebook) that affect the ability of Inuit to weave together a network that enables them to hunt and generate an income in a context of high unemployment and food insecurity. Furthermore, we articulated Aporta's notions alongside the concept of 'mutual constitution' of society and technology, which is key in the social construction of technology approaches such as those developed by MacKenzie and Wajcman (1999) and Akrich (1992). Applying these concepts, we suggested that the shift in Inuit practices – such as the current commodification of country foods which some see as a violation of a traditional Inuit custom – must be understood within a context that explores the mutual shaping of technology and culture.

References

Akrich, M. (1992) The De–Scription of Technical Objects. In Bijker, W. E. and Law, J. (eds.), *Shaping Technology/Building Society: Studies in Sociotechnical Change*. Cambridge: MIT Press.

Aporta, C. (2013) From Inuit Wayfinding to the Google World: Living within an Ecology of Technologies. In Miggelbrink, J., Habeck, J., Mazzullo, N. and Koch, P. (eds.) *Nomadic and Indigenous Spaces: Productions and Cognitions*. Farnham: Ashgate.

Aporta, C. and Higgs, E. (2005) Satellite Culture: Global Positioning Systems, Inuit Wayfinding, and the Need for a New Account of Technology. *Current Anthropology*, 46 (5), 729–753.

Awuh, H.E. (2015) Adaptive Livelihood Strategies in Conservation–Induced Displacement: The Case of the Baka of East Cameroon. *African Studies Review*, 58 (2), 135–156.

Callon, M. (1984) Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St. Brieuc Bay. *The Sociological Review*, 32 (1), 196–233.

Callon, M. and Law, J. (1997) After the Individual in Society: Lessons on Collectivity from Science, Technology and Society. *Canadian Journal of Sociology/Cahiers canadiens de sociologie*, 22 (2), 165–182.

CBC News (2013) Selling Caribou Meat Online May Hasten Herds' Decline: Biologist. Hunters Using Facebook to Sell Meat to Communities where Caribou is Scarce. [Online] Available from: http://www.cbc.ca/beta/news/canada/north/selling–caribou–meat–online–may–hasten–herds–decline–biologist–1.1311871 [Accessed: December 10th, 2016]

Dicks, D. (1977) From Dog Sled to Dial Phone: A Cultural Gap? *Journal of Communications*, 27 (4), 120–129.

DoE (2014) *Supplementary Submission to the Nunavut Wildlife Management Board*. [Online] Available from: http://www.tunngavik.com/files/2014/05/2014_03_30_GN–Supplemental–Submission–to–the–NWMB–TAH–for–Southampton–Island–Caribou.pdf [Accessed: December 10th, 2016].

Doyle, S. (2012) Food insecurity and Facebook. *Canadian Geographic.* [Online] Available from: https://www.canadiangeographic.ca/article/food–insecurity–and–facebook. [Accessed: December 10th, 2016]

Gombay, N. (2005a) The Commoditization of Country Foods in Nunavik: A Comparative Assessment of Its Development, Applications, and Significance. *Arctic*, 58 (2), 115–128.

Gombay, N. (2005b) Shifting Identities in a Shifting World: Food, Place, Community, and the Politics of Scale in an Inuit Settlement. *Environment and Planning D: Society and Space*, 23 (3), 415–433.

Hicks, J. (2007) The Social Determinants of Elevated Rates of Suicide among Inuit Youth. *Indigenous Affairs*, 4, 30–37.

Huskey, L. (2010) Globalization and the Economies of the North. In Heininen, L. and Southcott, C. (eds.), *Globalization and the Circumpolar North*. Fairbanks: University of Alaska Press.

Kemp, W.B. (1971) The Flow of Energy in a Hunting Society. *Scientific American,* 224 (3), 105–115.

Latour, B. (1991) Society is Technology Made Durable. In Law, J. (ed.), *A Sociology of Monsters: Essays on Power, Technology and Domination*. London: Routledge.

Latour, B. (1992) Where Are the Missing Masses? The Sociology of a Few Mundane Artifacts. In Bijker, W.E. and Law, J. (eds.) *Shaping Technology/Building Society: Studies in Sociotechnical Change.* Cambridge: MIT Press.

Latour, B. (1993) *We Have Never Been Modern*. Cambridge: Harvard University Press.

Law, J. (2008) Actor–Network Theory and Material Semiotics. In Turner, B.S. (ed.),*The New Blackwell Companion to Social Theory*. Oxford: Blackwell.

MacKenzie, D. and Wajcman, J. (eds.) (1999) *The Social Shaping of Technology*. Buckingham: Open University Press.

Murdoch, J. (1997) Inhuman/Nonhuman/Human: Actor–network Theory and the Prospects for a Nondualistic and Symmetrical Perspective on Nature and Society. *Environment and Planning D: Society and Space*, 15 (6), 731–756.

Oudshoorn, N., and Pinch, T. (eds.) (2003) *How Users Matter: The Co–construction of Users and Technology*. Cambridge: MIT Press.

Rasing, W.C.F. (1994) *Too Many People: Order and Nonconformity in Iglulingmiut social process*. Nijmegen: Rish & Samenleving.

Savard, J. (1998) A Theoretical Debate on the Social and Political Implications of Internet Implementation for the Inuit of Nunavut. *WicazoSa Review*, 13 (2), 83–97.

Salzman, P.C. (1980) *When Nomads Settle: Processes of Sedentarization as Adaptation and Response*. New York: Bergin/Praeger.

Searles, E. (2002) Food and the Making of Modern Inuit Identities. *Food and Foodways*, 10 (1–2), 55–78.

Searles, E. (2016) To Sell or Not to Sell: Country Food Markets and Inuit Identity in Nunavut. *Food and Foodways*, 24 (3–4), 194–212.

Southcott, C. (2005) Globalization, Culture, and Northern Identities: Some Considerations for a Northern Dimension Foreign Policy. *Polar Geography,* 29 (2), 103–118.

Stairs, A. and Wenzel, G. (1992) I Am I and the Environment: Inuit Hunting, Community, and Identity. *Journal of Indigenous Studies*, 3 (1), 1–12.

Wajcman, J. (2015) *Pressed for Time: The Acceleration of life in Digital Capitalism.* Chicago: University of Chicago Press.

Weber, B. (2014) Inuit Hunting Market: Cultural Betrayal or Necessity? Study Says Selling Hunted Meat is One Way to Ensure Food Supply Gets to All

Families in Nunavut. *The Canadian Press.* [Online] Available from: http://www.cbc.ca/news/canada/north/inuit–hunting–market–cultural–betrayal–or–necessity–1.2616577 [Accessed: December 10th, 2016].

Wenzel, G. (1991) *Animal Rights, Human Rights: Ecology, Economy, and Ideology in the Canadian Arctic*. London: Belhaven Press.

Wenzel, G. (2009) Canadian Inuit Subsistence and Ecological Instability – if the Climate Changes, Must the Inuit? *Polar Research*, 28 (1), 89–99.

Whitridge, P. (2004a) Whales, Harpoons, and Other Actors: Actor–network Theory and Hunter–Gatherer Archaeology. In Crothers, G.M. (ed.), *Hunters and Gatherers in Theory and Archaeology*. Carbondale: Southern Illinois University.

Whitridge, P. (2004b) Landscapes, Houses, Bodies, Things: 'Place' and the Archaeology of Inuit Imaginaries. *Journal of Archaeological Method and Theory*, 11 (2), 213–250.

Latte e Lotte. On the Difficulty of Dairy Farmers, Vending Machines, Microbes and Cows of Becoming a Movement

Alvise MATTOZZI[*a] and Tiziana PICCIONI[b]

[a] Free University of Bozen–Bolzano; [b] Independent Researcher

Between 2004 and 2009, Italian dairy farmers have contributed to establish a network able to rearticulate milk's and other dairy products' everyday sale–purchase and consumption practices. Such rearticulation has been also possible because the emerged network allowed to completely bypass the dairy processing industry by directly selling blast–chilled just milked milk through vending machines.

The proponents of the raw milk project have set the foundations for the constitution of a network that would go beyond the exchange of goods, seeding a possible movement able to reconfigure the actual system of social relations within the dairy context.

Such reconfiguration of the dairy sector has not occurred and the network has gone through a process of disarticulation, as soon as a series of attacks by media and institutions put it under pressure.

The narrations of the dairy farmers show that, despite their attempted struggles and despite the unexpected forms of solidarity the experienced, they felt isolated and left alone. What has then happened so that some of the conditions favourable to the emergence of a collective actor able to mobilize itself did not fully developed or have even been jeopardized?

Keywords: *Alternative food networks; Italy; material participation; mobilization; raw milk*

Introduction

Between 2004 and 2009, Italian dairy farmers have contributed to establish a network able to rearticulate milk's and other dairy products' everyday sale–purchase and consumption practices. Such rearticulation has

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[*] Corresponding author: **Alvise Mattozzi** | e–mail: a.**mattozzi@unibz.it**

been also possible because the emerged network allowed to completely bypass the dairy processing industry by directly selling blast–chilled non–pasteurized just milked milk through vending machines – raw milk vending machines (RMVM) (fig. 1).

The proponents of the raw milk project have set the foundations for the constitution of a network that would go beyond the exchange of goods, seeding a possible movement able to reconfigure the actual system of social relations within the dairy context.

Figure 1   An example of raw milk vending machine and its facility (photo Tiziana Piccioni).

Such reconfiguration of the dairy sector has not occurred and the network has gone through a process of disarticulation, as soon as a series of attacks by media and institutions put it under pressure.

In this paper, we will account for the lack of a movement around raw milk by considering the role the very raw milk played within the network.

The paper is based on a research developed longitudinally in three different moments of the raw milk network's trajectory: 2007–2008 (Piccioni, 2008; 2010); 2010–2011 (Mattozzi and Piccioni, 2012) and 2015–2016.

The research is localized in three North Italian regions: Lombardy, Trentino–South Tyrol and Veneto. Besides documents and ethnographic observations, the research is mainly based on interviews (see Table 1).

Table 1   List of interviews carried out up to now.

period / interviewed	April 2007 September 2008	November 2015 May 2016
public health service officials	6	5
public officials of the agriculture and environment sectors	2	–
agronomists working for farmers' organizations	3	3
dairy farmers	5	17
dairy industry director	1	2
RMVMs' builders	1	2
members of lifestyle movements organizations (Haenfler, Johnson and Jones 2012)	–	3
dairy shop owner hosting a RMVM	–	1
Total	18	33

The present paper has been conceived by both authors together. For practical reasons, Tiziana Piccioni wrote the following paragraphs:

- 'Introduction';
- 'The relevance of the raw milk network for dairy farmers';
- 'Accounting for a missing mobilization – Mapping raw milk's public'.

Alvise Mattozzi wrote the following paragraphs:

- 'The Italian raw milk network';
- 'Attack and crisis';
- 'Accounting for a missing mobilization – Our approach';
- 'Conclusions: reconstructing a missed mobilization'.

The Italian raw milk network

The Italian raw milk network has emerged from an idea proposed by an agronomist working for the stockbreeders' association (APA) of Como and Lecco. At the turn of the millennium, this agronomist – whom we can call 'the initiator' – noticed the hard times, which dairy farmers were going through. Thus, he started to look for a way to re–appropriate part of the value produced by farmers and expropriated by the dairy industry – to use van der Ploeg's (2008) words. As the initiator told us:

'Here is the concept from where we started. We see that the dairy farmer gets the 25% of the final price–per–liter of milk – today is even less, […] the more time passes, the more the difference. And

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the goal was: from 25%, let us try to bring everything back home' (agronomist 1, Lombardy, 2008).

The idea was simple: a short chain to bypass processing industry and its costs. As we can see, the initiator 'script' was focused on 'economic sustainability'. However, we would be misled if we thought that the re–appropriation was considered only in strict economic terms. On one hand, the possibility of bypassing the dairy processing industry was seen as a way to 'acquire bargain power' (farmer 1, Lombardy, 2016). On the other hand, what was also sought by farmers was a re–appropriation of their work and a recognition of their work:

'The idea is that together with the product, with the farm, you sell other things: culture, history, our history' (agronomist 1, Lombardy, 2008).

In order to realize such a short chain farmers needed the right mediations. The initiator thought that delegation to machines was the best way to actually 'bring everything back home'. Indeed, dairy farmers – he thought – should not have wasted time and money in pouring and bottling. Thus, the idea was to pass from the ladle – which has always been a possibility – to an automatic dispenser. These automatic dispensers were thought to be placed on farm premises. This choice was not only grounded on the ease of maintenance, but also on the principle of attracting consumers in the farm in order to 'sell [them] [...] culture [and] our history'.

However, in 2005 a farmer from a small village of the Brescia province, together with an agronomist as consultant, decided to put the RMVM off farm premises, in the main square of his village. The sudden success of the off farm premises machine has been the start of a fast diffusion of these machines (fig. 2) and of a further growth and stabilization of the network born around them (fig. 3).
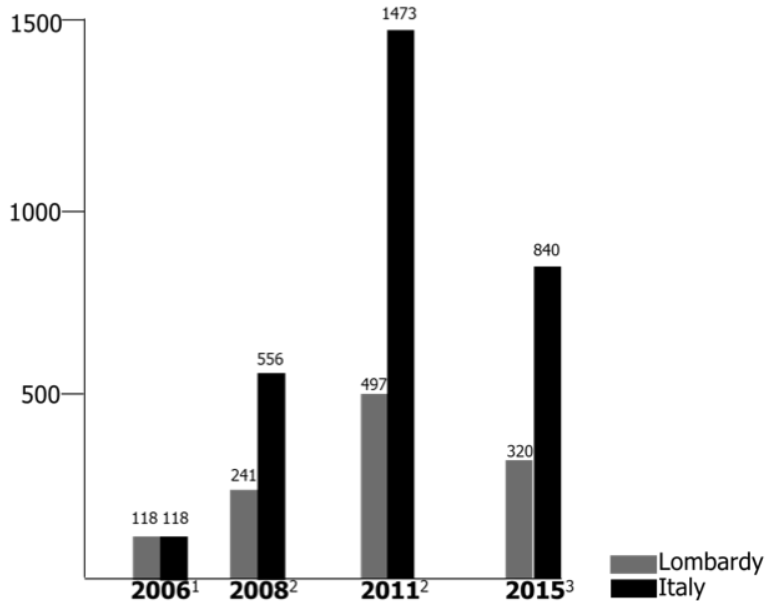
Figure 2   Diffusion of RMVMs in Lombardy and in Italy. Data are a personal elaboration from various sources: [1] Pinducciu (2008) which elaborates data from ARAL (Lombardy Regional Association of Cattle Farmes); [2] Zampieri (2011) which elaborates data from milkmaps.com; [3] PNI 2015 Annual Report for the Italian Minister of Health which elaborates data provided by the Regional Health Units.

The relevance of the raw milk network for dairy farmers

As we said, establishing the raw milk network had a relevance for the farmers that went beyond the pure economical re–appropriation.

During the first phase of the trajectory, when the network was growing and interest toward it was shown by consumers, media and institutions, dairy farmers selling raw milk started to intensify contacts among themselves. On such base, a collective perspective started also to form, as a farmer engaged in the development of the network told us:

'Yes, yes. It has been nice, because with raw milk there has been such a union, among, farmers… strong… because when something works,

one sees a way through… a revenue that allows him to go on with his activity, improving it, acquire more pride for what you do. Also these elements unite' (dairy farmer 1, Lombardy, 2016).
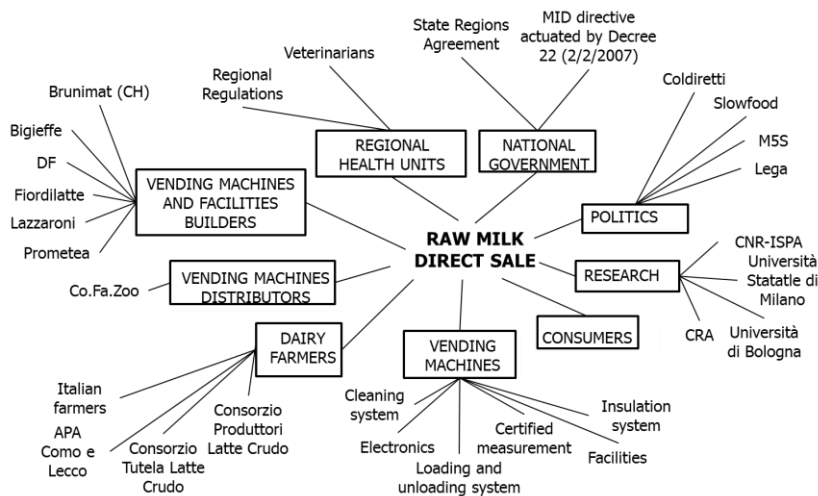
Figure 3   The Italian raw milk network (our elaboration based on our data).

And indeed, on a more formal level, two organizations – two consortia – unifying dairy farmers selling raw milk were created: Consorzio di Tutela del Latte Crudo (Consortium for the Defence of Raw Milk), based in Crema, and Consorzio Produttori Latte Crudo (Consortium of Raw Milk Producers), based in Brescia.

The fact that the consortia were two, related to two different ways of thinking the development of the raw milk network, is a hint to possible differences and cleavages that somehow could have had a role in the non–development of a movement. Here, we will not take such issue into account. However, we must also say that, for a brief period, when under attack by media and institutions, the two consortia united.

Besides unity among themselves, dairy farmers selling raw milk also experienced new forms of solidarity in relation to consumers. Beyond the close relations that could emerge between producers and consumers around RMVMs (Mattozzi and Piccioni, 2012; Piccioni, 2010), in certain cases they also turned in forms of more 'political' solidarity. For instance, a dairy farmer whose farm was threatened to be evicted, managed to keep it also thanks to the help of the neighbourhood. As he told us:

'I would be sorry to close the vending machine because, indeed, we have this feeling of participation of the people. And for me the presence of this aspect is also important' (dairy farmer 2, Lombardy, 2016).

Thus, as we can see, through the experience of unity, through the emergence of organizations and through the solidarity expressed by the neighbourhood, an embryonic movement related to raw was in place.

Attack and crisis

Despite raw milk's success, the rising diffusion of RMVMs (fig. 2), the growth and ongoing stabilization of the raw milk network (fig. 3), all this has suffered a severe setback (fig. 2).

In fall 2008, something happened:

- on the 2nd of October 2008, a parliamentary question (De Castro et al., 2008) asked the Minister of Health to warn consumers that the only way to consume raw milk was through boiling;
- on the 3rd of December 2008 a scare campaign was started by *Il riformista* (Meldolesi, 2008), a secondary Italian newspaper. The article, which title is 'Raw Milk. A fad that takes you to the hospital', had as a starting line: 'To drink non pasteurized raw milk is like playing at Russian roulette', followed by 'If you are lucky you can save up to half Euro per liter. If you are not, you can get a pathogen bacterium and end up on dialysis or even kick the bucket'. It brought as proof of infection the alleged case of a child fallen sick after having drunk a glass of raw milk from a RMVM;
- in the following days, the alleged cases of infection reported by media ranged between two and nine;
- on the 10th of December the Minister of Health issued an ordinance obliging owners of RMVMs to append on them a notice saying 'to be consumed after boiling' and forbidding to have tools, like plastic glasses, enabling drinking raw milk directly at the facility.

On gross, we can say that between 2009 and 2015 half of the machines closed down and, for those remaining, raw milk sales halved or become one third – quite suddenly, already during the days of the scare campaign, as farmers told us.

Despite farmers' attempts to organize a collective response to the attack – through legal appeals, conferences, communication campaigns, lobbying –

nothing really worked, so that the raw milk network started to be little by little disarticulated.

Why has this attack been successful in disarticulating the raw milk network? Why did those taking part in the network and enjoying it not transform their relations into an actual movement? Why farmers, RMVMs, microbes, cows, milk have not been able to contrast the scare campaign?

Accounting for a missing mobilization

Our approach

In order to account for the missing mobilization of the raw milk network, we propose a mapping of the various positionings of the actors composing the 'public', the 'community of the affected' (Marres, 2012) by raw milk, and hence by microorganisms present and developing with/in milk.

In this way, we intend to give relevance to the mediation carried out by 'materiality' in letting emerge and in configuring issues around which a 'public' gathers, positions and differentiates itself, generating dynamics of conflict and collaboration among actors. In other words, in order to account for the missing pro–raw–milk mobilization, we intend to take into consideration the mediation of non–humans in political dynamics.

Of course, milk and its microorganisms are not the only actors that mediated the raw milk issue. Still considering 'materiality', we could have focused on the mediation carried out by RMVMs and their facilities. However, here we have preferred focusing on the very raw milk. We have, indeed, already accounted for the role of RMVMs somewhere else (Mattozzi and Piccioni, 2012; Piccioni, 2010). Moreover, the controversy around raw milk addressed first and foremost raw milk itself and not other actors.

Milk, and especially raw milk, can be and can become many different things and can interact with other actors in many different ways. It can easily rot and become a dangerous harbinger of more or less serious intoxications, in relation also to the features of whom is drinking it (species, age, health, etc.), but it can also ferment and become a dainty dish for some; it can be a rich and health–giving drink, easily digestible with a specific flavour or it can be a too fatty drink with a too strong flavour; it can give way to cream, butter, buttermilk and it can become yogurt, cheese and many other foods of various consistencies. Thus, milk, and especially raw milk, is 'multiple' (Mol, 2003), and through its multiplicity it offers – disposes or affords – various positionings in relation to the practice to which it takes

part. Thus, milk is basically a virtuality disposing various relations, of which only some are actualized.

Mapping raw milk's public

If we listen to dairy farmers and agronomists, we would hear that raw milk is a good of higher quality, rich of good bacteria and enzymes. Raw milk is considered by farmers, good not only in terms of flavour, but also in terms of health: not only it is more digestible, especially by people intolerant to milk, but it is also health–giving: it reduces, for instance, the probability of developing allergies. Moreover, it is a precious product, easily transformed into tasty and health–giving cheeses and other dairy foods.

The initiator would qualify raw milk as an

'exceptional [product]. Therefore, it is a wealth for humans and for everybody. If they [scientists] […] carried out researches, they would have seen those enzymes, because they are there' (agronomist 1, Lombardy, 2015).

In short, from this first positioning farmers and agronomists enact raw milk not only as good, but also as something that makes you feel good.

However, dairy farmers know really well that raw milk is an issue. It must be taken care of. In order to do so they manage it through dairy echnologies and their competences, verified through analyses and controls.

For instance, we were told:

'[In the past] structures were as they were, cleanliness… Today, I do not say that you are in an operatory theatre, but – let's say it – almost. The product [raw milk] helps a lot and then the blast chilling within two hours stabilizes the microbial load right away and it is very important… […] it is a stable product, isn't it? We […] carried out analysis, even before installing the vending machine… and so […] four days later, the properties of the product did not vary […] this is also why in the end you are safe… you have evidence in your hand… you do not say 'I suppose', because you have analyses and you see that the product […] holds' (dairy farmer 3, Trentino, 2016).

'In any case, I do drink raw milk. Once I would not drink it […] before starting to carry out analyses, I too would boil it […] because if you do not know, it is right to boil it' (dairy farmer 4, Veneto, 2015).

Veterinarians of the Public Health Local Units share a similar positioning: for them too milk is an 'issue to be taken care of'. Indeed, they enact milk as

a 'breeding ground' for bacteria (veterinarian 1, Veneto, 2015). Thus, veterinarians, who have to control its state and, through it, its management, tend to give relevance mainly to pernicious bacteria coming from the outside or coming from the cows. However, they, like the farmers, take into account that these pernicious bacteria can be managed.

> 'We have actually seen that the risk is quite contained if you deal with a conscientious operator who carries out intense and correct control procedures. You cannot dismiss it, for sure we cannot say that a raw milk has a level of risk like those of a cheese, maybe from pasteurized milk, rather than… [raw meat] or a cooked ham or even to raw meat. That is, raw milk is… in itself a breeding ground for microorganisms. Microorganism that can be… that can be brought from the exterior, that is environmental ones, that will… will contaminate the product […] or… they can be actually internal to the very milk, like pathological bacteria, which are transmitted directly from the cow. Eeeh... since a processing intervention is missing downstream, it is clear that, if there is a sin, it stays… it can be even amplified, through, for instance, a thermic mishandling' (veterinarian 1, Veneto, 2015).

> '[…] Specifically for the Escherichia Coli O157 there were… supplementary controls were devised, because it was already known from scientific literature that it was actually the biggest danger. Because, in the end, the others are still pathogens which give you clinically manageable forms. Because passing a week on the WC, it could even be not a nice thing, but normally it is not incompatible with life; send children in dialysis, maybe permanently, is another matter' (veterinarian 2, Trentino, 2015).

A completely different positioning is the one assumed by the dairy industry – represented by Assolatte –, by certain politicians asking more rigid norms for raw milk's sale, by media through the scare campaign, by institutions through the ordinance.

The Parliamentary question signed by Paolo De Castro et al. (2008) and other MPs of the Italian Democratic Party (at the time on the opposition), underlines the risk of raw milk for direct consumption, stating the impossibility for the short chain to ensure a safe product, 'differently from the industrial production'.

The dairy industry, has tried to counter the sale of raw milk in various ways, always presenting itself as the guarantor of a safe product, as the

obligatory passage point in order to get a safe product, which would, despite all the efforts by dairy farmers and by the good bacteria, be dangerous. For instance, as shown in a 2007 Assolatte's document, technicians working for some of its associates were monitoring RMVMs, signaling that the product was not within health standards.

Il Riformista, the newspaper that started the scare campaign, has later assumed such position, too.

There are also other actors that placed themselves in relations to these main 'positionings' (fig. 4 [a]). SlowFood and Coldiretti are among the most relevant ones. They act as 'lifestyle movement [or practice–based movement] organizations (LMOs)' (Haenfler, Johnson and Jones 2012). Dubuisson–Quellier, Lamine and Le Velly (2011), have shown that LMOs mediate between a certain practice and a more general public, the consumers. Because of this role, LMOs such as Slowfood and Coldiretti can have a relevant influence for the building of a mobilization.

We deem that the scare campaign and the ordinance rearticulated the various positionings adding a fourth possible one: 'threat' (fig. 4 [b]). That is, milk as an unruly object which cannot actually be stabilized and which, thus, cannot be trusted: it can always change and betray, unless is weakened, through boiling, for instance. We can see this positioning acquiring relevance in both the words of Coldiretti's and SlowFood's officials:

> 'Coldiretti has made food safety its principle battleground. I mean…
> we are saying, already since few years that if NAS [food safety police
> forces] control more, they are right […]. Thus, before a health issue,
> what could Coldiretti say? The very Coldiretti said 'Beware, Beware!''
> (Coldiretti's official, 2016).

> 'We received letters and there were articles of people that accused
> us of being those who threatened public health. I mean when the
> game gets very tough, I do not say you withdraw, however – I mean –
> at a certain point…' (SlowFood's official, 2016).

It is important to notice that in a previous part of the interview, the SlowFood's official, talking about politicians that did not defend raw milk – thus, not talking about SlowFood – said:

> 'Nobody, maybe, wanted to take also the responsibility… what if did
> it occur that someone got something because he had consumed raw
> milk? – something possible, because it can happen…' (SlowFood's
> official, 2016).

Therefore, milk can be a threat, not only for those drinking it, but also for those defending it or becoming its spokespersons.

Thus, through the scare campaign and the ordinance milk has been enacted in another way, giving way to a possible rearticulation of the public and of their positionings.

This new articulation among other things had the effect to mine possible alliances among actors in order to face the scare campaign and the ordinance. This is quite clear as for the relation between farmers and veterinarians of Public Health Local Units. Indeed, since the beginning, veterinarians have been addressed by farmers and by the agronomists working with them in order to make the raw milk network possible – the proponents, for instance, addressed themselves to the Lombardy Regional Health Unit in order to know about the feasibility of the project.

After the ordinance, veterinarians have been required to state what advised, even though they well know, like the dairy farmers, that what is prescribed – i.e. 'boiling' – damages milk and makes all the work carried out, and all the care taken by, dairy farmers meaningless:

> 'For sure it [the raw milk sale] has been strongly hit by the thermic processing issue. It is actually not compulsory because, if someone wants to consume milk as it is, she can also do it. The difference is that there is now a nice notice – as the Ordinance requires – that says 'to consume after boiling'. Actually, a much less penalizing process for product quality would be enough [heating it at 70°], because boiled milk is actually not like the raw one, it gets a cooked taste, becomes browner, loses vitamins, loses nutritional principles assumed as noble' (veterinarian 2, Trentino, 2015).

> 'For me it would be easier [to say to the consumer]: let's boil it in order to avoid… but no! I cannot say something like that, because I know that properties will be lost, won't they? And so it does not have any sense, does it? It does not have any sense…' (dairy farmer 3, Trentino, 2016).
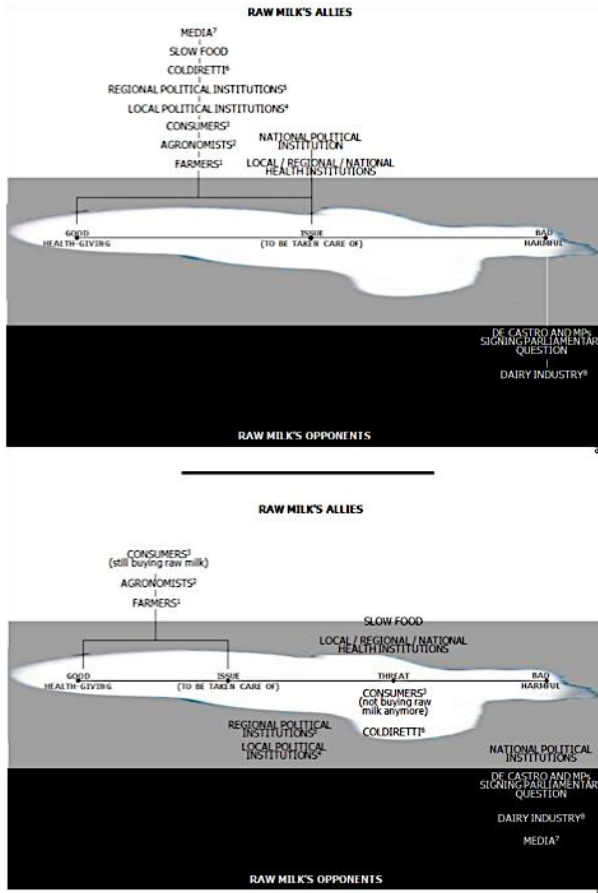
Figure 4   Positionings in relation to raw milk: a) at the moment of the Parliamentary Question signed by De Castro et al. (October 2nd, 2008); b) after the scare campaign launched by Il Riformista (December 3rd, 2008).

Taking into account the mapping and the various positioning assumed by the actors we can say that a mobilization – intended in generic terms – did not develop because a 'mobilization' – intended in more technical terms (Callon, 1984) – has not had the chance to take place, given the unstable ontology of milk. Callon (1984) describes 'mobilization' as the last phase of the process of 'translation' in which a sole and ultimate spokesperson is able to displace all the actors at once. As we have seen, after the scare campaign, where milk and its microbe can go or what they can do is not completely

foreseeable, nor completely controllable, therefore no actual spokesperson can arise: it could be too easily betrayed by milk.

Farmers, on their part, have tried to play the role of spokespersons for raw milk, but have been too weak to play it also for the rest of the actors – especially for most of the consumers who have been the first to betray them, probably also because of the lacking role of LMOs.

Table 2   Presence of movements' preconditions.

Elements considered within the 'Classic Social Movement Agenda for Explaining Contentious Politics' (McAdam, Tarrow and Tilly, 2001)	Actualization of these elements in relation to the raw milk network.
Presence of social change as a background	Changing conditions of agriculture in a globalized agricultural market
Opportunity and threat	The direct sale through RMVMs provided the opportunity to challenge the present setting of the milk production chain, without too many consequences for farmers.
Mobilizing structures	The two raw milk consortia and also the initial support of LMOs like Slowfood and Coldiretti.
Framing process	A shared narrative of re–appropriation of revenues and of recognition.

Conclusions: reconstructing a missed mobilization

There are many reasons for the missed formation of a movement in defence and support of raw milk. In the present paper, we focused on one of them: the mediating role of milk as a multiple object.

If we consider how movements start, according to the 'Classic Social Movement Agenda for Explaining Contentious Politics' (McAdam, Tarrow and Tilly, 2001, 16–18), we can see that many of the preconditions for the emergence of a movement were there (Table 2).

Once under attack, the embryonic movement has neither been able to act as one, nor to stay unite, despite various attempts and despite a shared narrative about what was happening: an attack by the dairy processing industry backed by politicians working for it. Such narrative assigned to raw milk's opponents a great strength, against which the raw milk embryonic movement felt weak. Disagreement around the repertoire of possible forms of protests and counteractions (protests, legal appeals, counter campaign)

emerged and organizations started to falter, leaving individual farmers alone.

Besides its internal difficulties, the raw milk embryonic movement has not been able to spread and involve other actors, like the consumers. Therefore, it has not been able to actually give life to a 'lifestyle' or 'practice–based' movement.

Our account has shown how the lack of involvement of consumers can be attributed to a lack of involvement of LMOs which, in turn, has been disposed by the role of the very raw milk within the entire controversy: it provided various non compatible positionings, thus mining possible alliances that would have given more strength to the raw milk movement.

References

Callon, M. (1984) Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St Brieuc Bay. *The Sociological Review*, 32 (1), 196–233.

De Castro, P., Andria, A., Bertuzzi, M.T., Mongiello, C., Pertoldi. F., Pignedoli, L. and Randazzo, N. (2008) *Parliamentary question to the Italian Minster of Welfare (Work, Health and Social Policies) – Act n. 4–00607, Seat n. 64.* Available from: http://www.senato.it/japp/bgt/showdoc/frame.jsp?tipodoc=Sindisp&leg=16&id=312565 [Accessed: January 3rd, 2017].

Dubuisson–Quellier, S., Lamine, C. and Le Velly, R. (2011) Citizenship and Consumption: Mobilisation in Alternative Food Systems in France. *Sociologia Ruralis*, 51 (3), 304–323.

Haenfler, R., Johnson, B., and Jones, E. (2012) Lifestyle Movements: Exploring the Intersection of Lifestyle and Social Movements. *Social Movement Studies*, 11 (1), 1–20.

Marres, N. (2012) *Material Participation: Technology, the Environment and Everyday Publics*. New York: Palgrave Macmillan.

Mattozzi, A. and Piccioni T. (2012) A Depasteurization of Italy? Mediations of consumption and the Enrollment of Consumers within the Raw–Milk Network. *Sociologica*, 3. [Online] Available from: http://www.sociologica.mulino.it/doi/10.2383/72702 [Accessed: January 3rd, 2017].

McAdam, D., Tarrow, S. and Tilly, C. (2001) *Dynamics of Contention*. Cambridge: Cambridge University Press.

Meldolesi, A. (2008) Latte crudo, la moda porta in ospedale. *Il Riformista*, December 3rd.

Mol, A. (2003) *The Body Multiple: Ontology in Medical Practice*. Durham: Duke University Press.

Piccioni, T. (2008) *La performatività dell'oggetto tecnico. Alleanze, saperi e pratiche attorno al distributore di latte crudo*. Master Thesis. Padova: Università di Padova.

Piccioni, T. (2010) Sulla delega alle macchine. L'oggetto come attore sociale nella reintroduzione del latte crudo tra i consumi alimentari. *Tecnoscienza*, 1 (1), 11–38.

Pinducciu, D. (2008) *Esperienza di filiera corta: la venidta diretta del latte crudo attraverso i distributori automatici*. Pisa: Laboratorio di studi rurali Sismondi.

van der Ploeg, J.D. (2008) *The New Peasantries: Struggles for Autonomy and Sustainability in an Era of Empire and Globalization*. London: Earthscan.

Zampieri, G. (2011) *La vendita del latte crudo in Veneto. La diffusione dei distributori di latte crudo in Veneto – I risultati dell'indagine di Veneto Agrocoltura*. Legnaro: Veneto Agricoltura.

Decomposing and Reassembling Energy Grids as Socio–Technical Apparatuses

Dario PADOVAN[*a] and Osman ARROBBIO[a]

[a] Università di Torino

This contribution is aimed to provide a deeper and more complex frame for the energy smart grid implementation. To accomplish this task, we use two main perspectives. The first one is to conceive energy grids as technological zones, in which standard metering, communication infrastructures, and social evaluation assemble. The second one is to conceive energy grids as an apparatus in which asymmetries of many kinds constitute the ontology of the grid itself.

Keywords: Energy grids; smart grids; apparatuses

Introduction

Smart grids are tools that can make imaginable the management of 'direct interaction and communication among consumers, households or companies, other grid users and energy suppliers' (European Commission, 2011). A smart grid allows for savings, allows for good and real–time information, and connects providers and users. Yet, what is still lacking in the claim for smart grid is an ontological dimension of interaction among energy, grid and human agents. In our idea, it is not enough to enunciate an amount of technical characteristics that should mark the grid and its smartness. What we are trying to do is to provide a deeper and more complex frame for the energy smart grid implementation embracing not only the technical but also human agency. To accomplish this task, we use two main perspectives. The first one is to conceive energy grids as technological zones, in which metering standards, communication infrastructures, and socio–technical evaluation bring together. The second one is to conceive energy grids as apparatuses in which asymmetric lines of

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[*] Corresponding author: **Dario Padovan** | e–mail: **dpadovan@unito.it**

power, knowledge, information, decision–making, and intensity constitute the ontology of the grid itself. A smart grid that wants to align or flatten the original disparities making itself more effective must change by actualizing its creative potential. In so far as an apparatus such as an energy grid is constituted by heterogeneous components such as corporate actors, people and devices, its ordering is always unstable and challenged by the mutating conditions of environment. However, despite the fluctuating orders, everything that happens and everything that appears into the grid correlates with orders of differences: of level, temperature, pressure, tension, potential and intensity. When aligned, these differences produce new configurations between the elements of the grid. These new alignments are those that allow the grid to be smart.

The difference between a today's grid and a smart grid of the future is mainly in the grid's capability to handle higher levels of complexity in an efficient and effective way (European Commission, 2011). The EU described smart grids as 'energy networks that can automatically monitor energy flows and adjust to changes in energy supply and demand accordingly' (http://ec.europa.eu/energy/en/topics/markets–and–consumers/smart– grids–and–meters). Combining information on energy demand and supply, they can allow grid operators to better plan the integration of renewable energy into the grid and balance their networks. Smart grids also open up the possibility for consumers who produce their own energy to respond to prices and sell excess to the grid. However, despite the plethora of demonstration projects, the smart grid system is still much in the making, and there is still a gap between the ideas of the future system and the practical realisation of these ideas (Gram–Hanssen, 2009). In order to get an effective transition toward smart grids, important aspects that are so far considered merely technological have to be managed, faced, and where possible, overtaken.

The conceptual framework of this work mainly derives from, and was mainly tested against, the results of an empirical investigation carried out in Turin in 2014 and 2015. The investigation, consisting of thirty–eight interviews and three focus groups, was part of a project aimed at integrating ICT solutions (e.g. simulation and efficiency engines, data visualization tools) in the Turin district heating system. Interviews were aimed at identifying the features of the Turin district heating system through the various perspectives of the many roles that are played in it. Professionals of the energy utility and public administrators were involved into research activities as well as the building managers, energy managers and building

users of a sample of both private (apartment buildings and a student residence) and public (university facilities, public offices and schools) buildings all situated in a single pilot district. While certain topics were emphasized, according to interviewees' roles and competences, discussions were in general about: their working/heating practices; the energy information and data they use/receive related to their work/consumption practices; their knowledge and perception about the functioning of the heating systems and network.

Conventional thermal grids

Elements of smartness already exist in parts of existing grids. But these elements have to be integrated and harmonized. The traditional or conventional paradigm is based on passive distribution and one way communication and flow between suppliers and consumers. This is dramatically true mainly for thermal grids. They convey energy by using water as a carrier. Water, hot or cold, is conveyed through underground hubs, to the buildings' heat exchangers and then distributed among final users. Thermal grids are not only a set of technical devices aimed at the provision of warmness or coldness, but a more complex arrangement of technical objects, practices and rules regulating and compensating the actions or conditions performed by agents. In our case, the thermal energy grid regulates and performs the comfort conditions of building users in two aspects. First, by determining provision of thermal energy and deciding costs and conditions of use. Second, by providing people with some tools in order to freely and autonomously control the energy apparatus. This latter, at least in our investigation concerning the district heating of Turin, is very limited. Set point temperatures and heating time schedules are often not controlled by the final user. Compared with electric energy grids, thermal grids are so unmanageable by the final users that we got the idea that they are still victims of a centralized and untouchable power. This condition arises obviously an asymmetry of power that is at the core of socio–technical apparatuses developed in the context of modern society. Here we provide some possible interpretation of smart grid making in order to foster an interplay of technical and social agents and agencies to reach a real smartness.

Technological zones

Thermal grids are situated socio–technical systems powered by long–distance fuels that combine hard technical infrastructures and devices with expectations of ordinary and pre–established actions and behaviours from both distributors and final users. In this sense, they need for working repetitive interactions among all human agents and technical devices involved and locally composing the grids. A thermal grid can also be understood as a technological zone that develops in extensity where differences and intensity are reduced thanks to standardized techniques, procedures, and spatial forms. Investigating the functioning of transnational economic arrangements, Barry (2006) suggests that technological zones take one or a mix of three forms:

a. metrological zones;
b. infrastructural zones;
c. zones of qualification and improvement.

Technological zones described by Barry (2006) are 'forms of space which are neither territorially bounded nor global in their extension, yet are of considerable political and economic significance'. This definition fits our idea of energy grid in the sense that even it is deployed at the rather local level, the energy flowing into it comes from different and often very globalized sites and infrastructures (Urry, 2014). However, due to the nature of our investigation, our focus is on agents acting where the grid is deployed, on a space of place 'within which differences between technical practices, procedures or forms have been reduced, or common standards have been established' (Barry, 2006). We believe that the analytical approach of 'technological zones' to investigate energy grids is plausible in order to pinpoint hotspots and difficulties in the process of smartness.

Metrological zones

At the core of smart grid is a metrological zone based on smart metering. Without a homogeneous metrological zone where power metering is standardized in order to make all agents aware of their contribution to the grid functioning, we find no smartness. When coupled with smart metering systems, smart grids reach consumers and suppliers by providing information on real–time consumption. This process is called feedback. Feedback is claimed to be a strong condition for the grid's smartness (Pullinger, Lovell and Webb, 2014). The assumption behind a smart metrological zone is that energy consumption behaviours can be altered by reminders on energy consumption data provided by ICTs devices, and that

consequently behaviour can be monitored and changed where needed (Cakici and Bylund, 2014). However, the main problem still refers to the poor diffusion of data on consumption along the grids. As in the case of a primary public school that we investigated, when asked about the data used to monitor energy consumption, school manager said that she never saw any. She claimed also that she is so targeted by an information overload those data concerning energy consumption are easily lost in the overall flows of data. In short, not only public institutions often do not get comprehensive data about their consumption, but also it disperses among increasing flows of information. As claimed by the City energy manager, until a few years ago the Municipality knew anything about the consumption of their buildings. There was just a unique yearly bill with the total amount to pay. 'And that was the knowledge we had about our consumption' (City energy manager).

Infrastructural zones

The development of common connection standards makes it possible to integrate systems of provision, distribution, and communication, as well as to exclude providers and consumers who do not conform to them. Connection standards allows remote reading of meter registers by metering operators and by third parties. Moreover, these functionalities allow facility for both on–demand and frequent regular readings being available to the meter operator. The provision of meter reading information by the supplier to the customer is thus very crucial. This would include interval readings or peak demands where the tariff is based on these; ability of linking several meters (electric, gas, water, etc.) into a single Smart Meter System; correct billing. Infrastructural zones are thus zones of interoperability among different agents. It means that the thermal system must be monitored using sensors, collecting and crossing data, performing algorithms, building platforms, enabling feedback processes.

These infrastructural zones serve to make social practices of heating and cooling possibly less disordered or redundant compared to what they already are. Infrastructural zones also serve to reduce the power disparity and differential among agents, that is an ontological condition of smart energy grids. However, research on feedback effects illustrates its own limits for fostering behavioural change. In our investigation, we found that thermostatic valves, that are a very crucial metrological device and are always associated with smart grid deployment, are also a problem (at least initially) as claimed by a building manager. 'The first year [following the

valves installation] someone pays double the amount they previously paid. That is because the forecast budget is based on the cubic meters of the flats [...] People don't understand. They go crazy!'. The elderly have also difficulties in managing thermostatic valves, in reading consumption, and finally in compensating the initial expense with energy saving. In short, as observed also by Hargreaves, Nye and Burgess (2010), householder's interaction with feedback is marked by contrasting aspects. On one side, overtime, smart energy devices could gradually become 'backgrounded' within normal household routines and practices, increasing the householders' knowledge of and confidence about the amount of energy they consume. On the other side, however, beyond a certain level and for a wide variety of reasons, these devices do not necessarily encourage or motivate householders to reduce their levels of consumption. Once equipped with new knowledge about their levels of energy consumption, householders soon realize the limits to their energy saving potential. Moreover, they might experience an over engagement with the device. Thus, householders progressively develop some disappointment, lose their dedication to the metrological apparatus, and become frustrated by the absence of wider policy and market support.

Zones of qualification and improvement

Smart energy grids imply the existence of a zone of assessment, in which evaluations related to the qualifying of grid and on the capacity of the grid to allow comfort while saving energy are performed. The development of common regulatory or quality standards has become critical to the government of energy. Such standards govern the quality of practices enabled thanks to energy, which may exist within a particular domain. Necessarily, such standards depend on the development of various technical devices, which make it possible to assess and compare the quality of practices performed. We may speak of the existence of a zone of qualification when the technical devices allow for practices that meet common criteria, such as environmental standards.

The problem is that, the way for facing the human scope in energy grids is mainly psychological or behavioural, what that has been termed by Elizabeth Shove the ABC (attitudes, behaviour, change) syndrome (Shove, 2010). Our exploration confirms that this is the main vision shared by designers, engineers, and different public and private energy managers. Behind this approach is the idea that individuals are fully rational beings and that they should be aware of what they are consuming and dissipating in

both monetary and thermodynamic terms. Conversely, energy is for people a volatile and sometime invisible object, difficulty understandable in its nature. This makes energy management and conservation practices both difficult and unusual. The more modern energy systems provide increasingly invisible means of meeting demands for heating and cooling. Warm water that flows seamlessly and silently into homes meeting our demand of comfort makes it without any notable trace of their presence (Ehrhardt–Martinez, Donnelly and Laitner, 2010; see also Schwartz et al., 2013). The only way to get an account of energy use are the practices that people perform thanks to energy. Household's everyday practices are indicators of how much energy is consumed and dissipated, the involuntary way to make energy visible.

Socio–technical apparatuses

Technological zones are mainly technology–oriented. It is not wrong to depict energy grids in terms of technical standardization but this seems to exclude something else. Here we broaden the Foucauldian perspective suggested by Barry embracing the very interesting concept of dispositive or apparatus forged by Michel Foucault along all its oeuvre (see Agamben, 2009; Bussolini, 2010; Raffnsøe, 2008).

An apparatus is 'a thoroughly heterogeneous set consisting of discourses, institutions, architectural forms, regulatory decisions, laws, administrative measures, scientific statements, philosophical, moral, and philanthropic propositions–in short, the said as much as the unsaid. Such are the elements of the apparatus' (Foucault, 1980, p. 194). The apparatus itself is the network that can be established between these elements, but it is also an assemblage or a hybrid of technical and social elements, which has the strategic function in a given moment to respond to an urgency. Foucault refers to the apparatus as a device consisting of a series of parts arranged in a way so that they influence the scope. An apparatus indicates an arrangement that exerts a normative effect on its 'environment' because it introduces certain dispositions.

According to Foucault, there are two important moments in the apparatus's genesis. A first moment is oriented to a prevalent strategic objective. In a second step, the apparatus is constituted and enabled to continue in existence insofar as it is the site of a double process. On the one hand, there is a process of 'functional over–determination'. Each effect – positive or negative, intentional or unintentional – enters into resonance or

contradiction with the others and thereby calls for a readjustment or a re–working of the heterogeneous elements that surface at various points. On the other hand, there is a perpetual process of 'strategic elaboration' that allows the apparatus to establish and reproduce different fields of power relations (Foucault, 1980, p. 195). Being its nature essentially strategic and teleological, it implies a certain manipulation and a rational and concrete intervention in the relations of forces, either to develop them in a particular direction, or to block, stabilize and utilize them. Finally, apparatus is also always linked to certain limits of knowledge that arise from it and, to an equal degree, condition it. In short, an energy grid is a set of strategies of the relations of forces supporting, and supported by, certain types of knowledge.

Foucault applies his concept of apparatus to asylums, prisons, schools, factories, and hospitals, as apparatuses of disciplining, normalizing, and securing practices. In our view, it appears reasonable to apply the apparatus's concept to energy grids. Norms are thus developed and inscribed into a play of power, aimed to overcome resistances, to change inertial habits and to orient future choices. Data standardization and collection is crucial to monitor the functioning of the energy grid, to drive it toward more efficient ways to provide and use energy, and to discipline agents for more appropriate behaviour. Infrastructures provide the architectural frame in which power and prescriptions flow. In the case of the energy grid, 'functional over–determination' refers to the interactivity between effects of constructive or destructive interaction/interference that might create a need to adjust or rework the connections between elements. A perpetual process of 'strategic elaboration' happens whereas the strategic objective is the reduction of energy dissipation alongside the grid. This energy grid transition is not irenic, but constellated by more or less critical contradictions that ask for perpetual adjustments. This holds for example the interest of provider to provide increasing amount of energy or the aspiration of the final user to freely use the desired amount of energy without constraints, or again the right of final users to exercise a quasi–total control on their piece of apparatus.

What we discovered is that our actors would take place inside the apparatus, cooperating in it, sharing the power circulating in it. The problem is that they cannot do it because they are 'off–grid', separated from the apparatus or deprived of their potential or virtual agency to act on it. Moreover, when they are incorporated into the grid, they fight with the grid's devices, that resist any intervention and intrusion. As claimed by a

public building manager, he essentially tries to develop 'some friendly relations with the thermal apparatus'. He tries to enable a dialogue with it:

'It should not be difficult to control thermostats: it is just about setting the temperature. In reality it does not work in this way [...] The problem is that only those who have installed the implant can act on the system. We need autonomy to act directly upon the system. This is what is lacking due to the system design. Corporate policies aimed at reducing consumption have been activated, but if there is no control on the thermal system, if there is no feedback with devices, if these devices are out of user control, it is impossible to implement any energy regulation policy' (Building manager, public building).

Final users expect to be active grid supporters and not only passive objects of grid, aiming to drive and sway technological improving dynamics, as in the case of the public building managers. They also are not really persuaded to interact permanently with devices. in order to improve their performance.

This dilemma regarding practices into the grids arises a broader general question regarding the role of technical devices and artefacts in the evolution of the apparatus. Foucault mentions material arrangements as part of the apparatus, but he does not pay much interest in developing this, as it would deserve. He only alludes the ways in which technical apparatuses provide intimate, pervasive, and profound reconfiguring of practices performed by agents, and that this reconfiguring is often unstable and unfixed. The definition of apparatus provided by Deleuze sounds more fitting our idea of energy grid, underlining the disconnected and rather precarious character of such ensemble of heterogeneous elements.

'But what is a dispositif? In the first instance it is a tangle, a multilinear ensemble. It is composed of lines, each having a different nature. And the lines in the apparatus do not outline or surround systems which are each homogeneous in their own right, object, subject, language, and so on, but follow directions, trace balances which are always off balance, now drawing together and then distancing themselves from one another. Each line is broken and subject to changes in direction, bifurcating and forked, and subject to drifting. Visible objects, affirmations which can be formulated, forces exercised and subjects in position are like vectors and tensors. Thus the three major aspects which Foucault successively distinguishes,

Knowledge, Power and Subjectivity are by no means contours given once and for all, but series of variables which supplant one another' (Deleuze, 1992, p. 159).

Readjusting the notion of apparatus, moving it toward a consistent materiality where the inseparability of objects and subjects is acknowledged, it can give energy grid a different interpretation, allowing the pinpoint of a surface where to attach strategy of transition. In short, a conventional energy grid is an apparatus in which humans act as depending from devices driven by incorporated knowledge and language. A smart energy grid is an apparatus in which devices and humans try to communicate to adapt to new conditions.

Transitional apparatuses as new frame for energy policy

Because of path–dependency mechanisms deployed by the development of fossil fuel conventional energy grids, the transition toward smart energy grids must start from them. A counter–apparatus, far more suitable and acceptable for current purposes of energy transition of those existing nowadays, can be built only on already existing infrastructures. Consequently, we need to know how conventional grids work and where their potential for change is. As technological zones they are rather rigid, linear, inelastic and thus useful only to a certain extent. In the case of the district heating the situation is even worst in the sense that the rigidity and path dependency of co–generation apparatuses is very strong: likely will be very tough to emancipate this energy provision from its fossil fuel primary source. Moreover, the socio–technical vision of grids transition is considerably naïf: the list of stuff that 'should be done' is not enough to ensure a successful transition.

The notion of apparatus or dispositive seems us more useful to adopt strategies of transition. This notion is similar to concepts such as assemblage (DeLanda, 2006) and arrangement (Schatzki, 2011, 2015), which outline a relational system for dissimilar elements and practices. Apparatuses, assemblages, and arrangements are concepts that often overlap, and that at the empirical level can operate symbiotically to explain the forging and emerging of practices such as energy production, distribution, usage, and dissipation. However, that of apparatus seems us a more intense, dynamic, and agential concept than the other ones. The co–evolution of varying lines

and strata of practices, techniques, discourses, and singularities establishes it. An apparatus is more concerned with its security and functional certainty than an always virtual and a never fully actualized assemblage. Moreover, it is purpose–oriented in the sense that an apparatus organizes people, artefacts, enunciations, and things according to functions, statuses, and relations of agents involved in it (Schatzki, 2015). Finally, it denotes large systems of real life with a relevant time–space dimension, such as energy systems, which are incessantly changing. Regarding energy grids, it is undoubtable that they are greatly concerned with their security and continuity in time and space. They aim toward clear purposes, are spatially deployed, and they are under an incessant process of change depending on the practices performed within them.

Our approach is close to a sociology of flows as it has been suggested by Mol and Spaargaren (Mol and Spaargaren, 2005), developed on the basis of Castells and Urry seminal works (Castells, 1996; Urry, 2003). The notion of apparatus might help the development of a very challenging sociology of flows, still undertheorized, mainly from the point of view of regulation. An apparatus focuses on strategic practices aimed to cope with problems of security: spaces and technologies of security, treatments of the uncertainty, and forms of normalization of human conduct (Foucault, 2007, p. 25). In this sense, the apparatus is much more oriented toward clear goals implying a flexible management of flows than the Urry's vision for which flows have no goal or end and tend to generate via iteration complexity, instability, uncertainty (Urry, 2003). To obtain a safe circulation of people, money, commodities, energy and so on, and to secure stocks depending from flows but also generating them, an apparatus must regulate flows. In doing that it generates a circulating and securing power which, on its turn, often generates resistance, tensions, ruptures, protests. The analysis of conflicts, manipulation, and efforts to access or appropriate flows, as well as resistance to escape the regulation of flows, is matter of investigation for a sociology of flows.

The fact that human agents always belong to apparatuses and act within them, means that apparatuses exercise a certain power on them but also that agents can change them performing their own practices or fighting with them (Agamben, 2009). In other words, apparatuses change to secure their own continuity and the 'immortality of society' (Garfinkel, 1988). However, as explored by Deleuze (1992), each apparatus shows lines of breakage and fracture. Sometimes these are situated on the level of powers; at other times on the level of knowledge; other times more at the level of structures

of practical action. More generally, it should be said that the lines of subjectivation indicate fissures and fractures. Change depends on the content of the apparatus, and each apparatus deserves its own diagnostic, its own archaeology. Moreover, an apparatus creates a propensity for certain types of events, a trend that some things 'happen'. The application of this concept to an energy grid opens up the possibility of its change towards the smartness. Can an apparatus become smart, flat, democratic, equal or differentiated in its functions and provisions? Might an apparatus such as a thermal grid be designed and managed in order to raise insensible but enduring changes in the agents' performance? Or to be flexible enough to change in virtue of agents' performance?

Asymmetries of energy and power

Thermal (also electric) grids are complex apparatuses of connection of different agents, equipped with different power of influence and intervention on energy flows. It is in some way self–evident the fact that big energy providers and final users are very asymmetrical in the influence on energy management. In their working, thermal grids bring and convey both energy power for heating and social power in forms of rules, norms, and dispositions. Our investigation rises up the problematic of the flows and links between energy and power as well as of the way in which their processes change the actual configurations. The agents of those processes and how their nexuses and relationships work out, become a matter of investigation. How is the power of power maintained, conditioned and disputed by coalitions of agents, dominant and resistant, performing different but interlinked social practices from which these emerge? (Mitchell, 2011). This asks for analysis of how power flows through complex systems, how it supports and makes existing positive and negative feedback loops between production and consumption of energy, how technical devices, knowledge, enunciations, build up energy machines, regimes, apparatuses, that make society likely. Social forms, as living systems, depend upon flows of energy maintaining their systemic viability far from thermodynamic equilibrium (Smil, 2010). Since only the simplest forms of energy may be harnessed without infrastructures, energy resources are always mediated through socio–technical systems (Smil 2010, p. 12) and human labour that give them a particular social configuration in order to make apparatuses working. Energy and its carriers are basic commodities that are essential in the production of all commodities (including labour

power). Energy keeps different forms aimed to sustain the metabolic reproduction of a number of different social subsystems and agents (Padovan, 2015a; 2015b; Padovan, Martini and Cerutti, 2015).

In their effectiveness, energy networks are analogous to social networks, been made of the same substance: a variable and disparate assemblage of natural, technical, and social elements, a continuous process fostering differences and repetitions. As in the social networks, in which power flows reproducing asymmetries and differences (but also negating them), in these technical networks energy flows reproduce asymmetries and dissimilarities. The analogy can go further whereas we pinpoint dynamics of energy/power circulation, security, and control: how is the grid governed? Who benefits in terms of energy provision, consumption and comfort? Is the smart energy grid a dispositive that assures a win–win mechanism? Our investigation tried to give some answers to these questions, not looking at thermal grids as a vertical apparatus going from the centre to the periphery, but understanding energy/power circulation by looking at its extremities, at its outer limits where it becomes capillary (see Foucault, 2003). For instance, we discovered continuous attempts made by final users to understand how much they are consuming, how to save energy, how to regulate temperature, how to intervene on devices, how to make the apparatus more flexible.

Conclusions

Our goal, inspired by Foucault and Deleuze, has been to analyse energy/power regulation at the point where it is invested in real and effective practices, where it relates directly to what we might call its object, its target, its field of application, or, in other words, the places where it produces its real effects (Foucault, 2003, p. 28). Rather than asking ourselves who simply rules or governs the grid, we should try to discover how multiple bodies, forces, objects, desires, thoughts, are gradually and materially constituted as subjects in the making of the thermal grid. It might be a matter for a renewed sociology of flows because, for instance, we realized that conventional grid leaves agents in a state of blindness regarding the heating system functioning. On the other hand, the deployment of smart grids implies a process of subjectivation whereas agents are invested by a twofold dynamic of freedom and individual responsibility. Together with water, grid also conveys data, prescriptions, rules, and codes, aimed to discipline and regulate users' practices, from

connection to payment. Agents can bend, made some conditions, the grid toward their own goals, or can refuse at all the regulating power conveyed by it. Forms of adaptation, rejection and manipulation constellate the grid, becoming sources of controversies and conflicts mainly in buildings where different tenants experience different intensities and performances of the grid, or in different areas where grid shows some malfunction. Finally, the transition process towards the smartness is often, if not always, seen as a simple addition of different technical operations. From our point of view, these operations are too naïf, socially inappropriate, and driven by a mechanic and linear causality. We suggest thinking in terms of apparatus, assemblage, bundle of practices and arrangements qualified by circularity and co–evolution.

References

Agamben, G. (2009) *What is an Apparatus*? Stanford: Stanford University Press.

Barry, A. (2006) Technological Zones. *European Journal of Social Theory*. 9 (2), 239–253.

Brounen, D., Kok, N. and Quigley, J.M. (2012) Residential Energy Use and Conservation: Economics and Demographics. *European Economic Review*. 56 (5), 931–945.

Bussolini, J. (2010) What is a Dispositive? *Foucault Studies*, 10, 85–107.

Cakici, B. and Bylund, M. (2014) Changing Behaviour to Save Energy: ICT–Based Surveillance for a Low–Carbon Economy in the Seventh Framework Programme. In *Proceedings of the 2014 conference ICT for Sustainability*.

Castells, M. (1996) *The Rise of the Network Society. The Information Age: Economy, Society, and Culture, Volume 1*. Malden: Wiley–Blackwell.

Crockett, C. (2013) *Deleuze beyond Badiou. Ontology, Multiplicity and Event*. New York: Columbia University Press.

DeLanda, M. (2006) *A New Philosophy of Society*. London: Continuum.

Deleuze, G. (1992) What is a Dispositif? In Armstrong, T.J. (ed.), *Michel Foucault Philosopher*. New York. Routledge.

Deleuze, G. (1994) *Difference and Repetition*. New York: Columbia University Press.

Ehrhardt–Martinez, K., Donnelly, K. and Laitner, J.A. (2010) *Advanced Metering Initiatives and Residential Feedback Programs: A Meta–Review for Household Electricity–Saving Opportunities*. Washington DC: ACEEE.

European Commission (2011), *Definition, Expected Services, Functionalities and Benefits of Smart Grids*. Accompanying documents to communication from the commission to the European Parliament, the Council, the European economic and social committee and the committee of the Regions, 'Smart Grids: From Innovation to Deployment', com (2011) 202 final Brussels, 12.4.2011 sec (2011) 463 final.

European Environment Agency (2013) *Achieving Energy Efficiency through Behaviour Change: What Does it Take?*. EEA Technical report No 5/2013.

Foucault, M. (1980) *Power/Knowledge: Selected Interviews and Other Writings, 1972–1977*. New York: Pantheon Books.

Foucault, M. (2003) *Society Must Be Defended. Lectures at the Collège de France, 1975–76*. New York: Picador.

Foucault, M. (2007) *Security, Territory, Population, Lectures at the Collège de France, 1977–78*. London: Palgrave MacMillan.

Garfinkel, H. (1998) Evidence for Locally Produced, Naturally Accountable Phenomena of Order, Logic, Reason, Meaning, Method, etc. In and as of the Essential Quiddity of Immortal Ordinary Society, (I of IV): An Announcement of Studies. *Sociological Theory*, 6 (1) 103–109.

Gram–Hanssen, K. (2009) Standby Consumption in Households Analysed with a Practice Theory Approach. *Journal of Industrial Ecology*, 14, 150–165.

Hargreaves T., Nye, M. and Burgess, J. (2010) Making Energy Visible: A Qualitative Field Study of How Householders Interact with Feedback from smart Energy Monitors. *Energy Policy*, 38 (10), 6111–6119.

Mitchell, T. (2011) *Carbon Democracy*. London: Verso.

Mol, A.P.J. and Spaargaren, G. (2005) From Additions and Withdrawals to Environmental Flows: Reframing Debates in the Environmental Social Sciences. *Organization & Environment*, 18 (1), 91–107.

Padovan, D. (2015a) Assembling Societal Metabolism and Social Practices: The Dynamics of Sustainable and Unsustainable Reproduction. In Strandbakken, P. and Gronow, J. (eds.), *The Consumer in Society. A Tribute to Eivind Sto*. Oslo: Abstrakt Forlag AS.

Padovan, D. (2015b) Metabolic Exchanges and Practices of Regulation. The Assemblage of Environment and Society in Early Social Sciences. *Ecological Informatics*, 26 (1), 6–17.

Padovan, D., Martini, F. and Cerutti A.K. (2015) Social Practices of Ordinary Consumption: An Introduction to Household Metabolism. *Journal of Socialomics*, 4 (2), 1–11.

Pullinger, M., Lovell, H. and Webb, J. (2014) Influencing Household Energy Practices: A Critical Review of UK Smart Metering Standards and Commercial Feedback Devices. *Technology Analysis & Strategic Management*, 26 (10), 1144–1162.

Raffnsøe, S. (2008) Qu'est–ce qu'un dispositif? L'analytique sociale de Michel Foucault. *Revue canadienne de philosophie continentale*, 12, 44–66.

Schatzki, T. (2011) Where the Action Is. Sustainable Practices Research Group. Working Paper 1, University of Lancaster. [Online] Available from: http://www.sprg.ac.uk/uploads/schatzki–wp1.pdf [Accessed: August 2nd, 2017].

Schatzki, T. (2015) Spaces of Practices and of Large Social Phenomena. *EspacesTemps.net*. [Online] Available from: http://www.espacestemps.net/articles/spaces–of–practices–and–of–large–social–phenomena/ [Accessed: August 2nd, 2017].

Schmidt, R.–R., Fevrier, N. and Dumas, P. (2013) *Key to Innovation Integrated Solution. Smart Thermal Grids*. European Commission, Smart Cities and Communities.

Schwartz, T., Stevens, G., Ramirez, L. and Wulf, V. (2013) Uncovering Practices of Making Energy Consumption Accountable: A Phenomenological Inquiry. *ACM Transactions on Computer–Human Interaction*, 20 (2), 12.

Shove, E. (2010) Beyond the ABC: Climate Change Policy and Theories of Social Change. *Environment and Planning*, 42 (6), 1273–1285.

Smil, V. (2010) *Energy Transitions*. Santa Barbara: Praeger.

Urry, J. (2003) *Global complexity*. Cambridge: Polity.

Urry, J. (2014) The Problem of Energy. *Theory, Culture & Society*, 31 (5), 1–18.

A National Law as an Actor–network: How Guatemala's General Electricity Law of 1996 Shaped the Country's Environmental Conflicts over Hydroelectricity

Renato PONCIANO[*a]

[a] Università di Padova

This paper uses controversy mapping to study the history of Guatemala's General Electricity Law (GGEL, 1996). Particular attention is paid to the impact of the GGEL on social conflicts related to hydroelectricity. This article discusses how an array of actors –right–wing political parties and influencers, the 'El Niño' Phenomenon, the international wave of neoliberalism and a malfunctioning dam– coalesced to promote a law intended to modernize Guatemala's energy market and expand its electrical grid.

Twenty years later, GGEL remains a relevant actor in the conflicts around new hydroelectricity projects. However, counter to the intentions of its promoters, this law has helped to fuel controversy.

First, it indirectly imposes restrictions on negotiations among project stakeholders by forbidding the sale of energy to third parties; thus, it deprives actors of their strongest bargaining asset. Second, GGEL makes territorial interdependence invisible, shifting the costs and responsibilities from the government and companies to communities. Finally, while other studies have simply portrayed GGEL as a result of neoliberalism, an Actor–network theory (ANT) approach provides a broader picture of its origin and impact by taking into account the GGEL's role as a non–human actor.

Keywords: Actor–network theory; environmental conflicts; hydroelectricity; controversy mapping

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[*] Corresponding author: **Renato Ponciano** | e–mail: **renatogiovanni.poncianosandoval@phd.unipd.it**

The Guatemalan energy contradiction

Guatemala's Human Development Index is the third lowest in Latin America (United Nations Development Programme, 2016). One overlooked cause of this low score is energy. As of 2013, more than 50% of Guatemala's energy consumption came from domestic biomass, i.e., firewood (International Energy Agency, 2016), obtained in an unsustainable manner. This consumption is an indicator of environmental degradation, lack of access to electricity or gas, and a high incidence of respiratory diseases. Reducing the use of unsustainably obtained biomass and replacing it with a sustainable source would be a good step toward improving Guatemala's human development.

Guatemala has the potential to achieve this improvement. The Guatemalan government's document *Política Energética 2013–2027* (Guatemala, Ministerio de Energía y Minas, 2013) estimates that less than 15% of the country's energy potential for hydroelectricity is being used currently. That potential supply is enough to satisfy current and future domestic demand and even export energy to neighbouring countries. This potential contrasts with the current reality that 40% of the country's electricity is generated using imported fossil fuels (Guatemala, Ministerio de Energía y Minas, 2016a), which causes higher prices and larger carbon emissions.

A common sense perspective would mean that these two situations have a common solution: exploit the underused renewable resources to make the supply of energy larger and cheaper, especially for that portion of the population with the lowest human development. This solution would allow them to abandon their unsustainable firewood use and its negative impact.

In 1996, the Guatemalan Government claimed that it would address this problem by privatizing the public electricity utilities and passed the General Electricity Law, which de–monopolized the electricity market. The idea was that the necessary expansion of the electrical grid would be fostered by competition and private investment. Now, 20 years later, there are 19 hydroelectric power plants in operation, and another 30 will start operation within the next five years. It would seem that this is a story of policy success, and of a government working to improve people's lives.

However, the expansion of hydroelectricity resulted in conflict with a significant part of the nearby communities. Orantes (2010) reported that in 2010, there were verified reports of 27 protests or conflicts in 9 departments (provinces), where a total of 18 projects were authorized or in operation. This aspect of the expansion of the electrical grid was

unexpected, and it delayed, and in some cases completely halted, the development. Something clearly was not taken into account when this endeavour started.

This article reports the partial results of a research project on this hydroelectricity expansion in Guatemala. The project consists of two parallel inquiries, one of which is a map of the controversy around hydroelectricity projects. As the cartography of the controversy advanced, one element emerged as central to the issue: Guatemala's General Electricity Law of 1996 (GGEL). Hence, a more precise account of its history is needed. That is the main purpose of this paper.

Theoretical and methodological framework

This case is analysed using Actor–network theory (ANT). ANT, according to Latour (2005), is both a theoretical and a methodological approach to social research. One of the most important contributions of ANT is the principle of symmetry (Latour, 1987) which, among other things, states that, in research, non–humans are to be treated equally as humans, i.e. studied in the same way. Therefore, non–humans can be actors (or as Latour calls them, 'actants') and are capable of agency in the face of others. This fits particularly well in this case, since the principal subject is a non–human entity, Guatemala's General Electricity Law (GGEL). The purpose here is to show the network of actors and trajectories that converged in the passing of this law, but also how those actors, and even others, were also influenced or transformed by GGEL.

The methodological dimension of ANT is usually referred to as controversy mapping (Latour, 2005). A good introduction to the subject is the article by Venturini (2012) that details how ANT's approach translates into method guidelines. As an example, this method has been applied successfully in the work of Neresini and Lorenzet (2016) to cases in the Italian context. Furthermore, dedicated software tools have been developed recently for mapping controversies, thus allowing researchers to organize, analyse and visualize information on actors and events (Sciences Po Medialab, 2016).

The narrative presented here is part of the first phase, based on document research and journalistic coverage of the events; in particular, the online archive of *Crónica* (Universidad Francisco Marroquin, 2013), a Guatemalan magazine that was published from 1987 to 1998, and was one of the most credible sources of the time. Every news story, opinion article or

small note in *Crónica* related to the Guatemalan electrical grid was registered in a spreadsheet. Then, a timeline that pointed to key actors and events was made based on that list. Additional sources were used to establish connections among them, with the aid of digital resources.

Assembling GGEL: How Chixoy Dam, neoliberalism and an armed conflict converged in a new electricity law

For the purpose of this paper, a good starting point is the development of the largest publicly–owned hydropower plant in Guatemala: Chixoy (1978–1985). This project was designed to provide more than 50% of the electricity needed in Guatemala at the time, and bring stability to the electrical grid. However, its development turned out to be a managerial nightmare: it took more than twice the projected building time, its budget quadrupled (from USD $187 million to almost $800 million) and when it was finally opened in 1983, a critical flaw in the tunnels delayed its operation until 1985 (Velásquez and Mazariegos, 1991). But the problem was not solely inefficiency; the plant was built within a context of a state effectively under the control of the military as a result of an armed conflict with a leftist guerrilla movement. This conflict became, around the time that Chixoy was being developed, a human rights tragedy, since the Guatemalan Army started massacring entire Mayan villages as part of its war strategy. One of the best documented episodes was the Rio Negro Massacre, in which more than 500 people were killed, including women and children. It was perpetrated in order to evict the Maya that lived in the area destined to be flooded by the Chixoy dam (Comisión de Esclarecimiento Histórico de Guatemala, 1999).

Two public utilities in a military–dominated state

Just the Rio Negro Massacre is enough to think of Chixoy as one of the most shameful episodes in modern Guatemalan history. But Chixoy also represented the inefficient management of the state in those times. In a government controlled by a military undertaking counterinsurgent operations, military commanders devised corruption networks that were so powerful that they have survived to this day. In its efforts to uproot them, Guatemala is the first country in the world to have an UN–approved foreign Prosecutorial Commission to fight them, the International Commission

against Impunity in Guatemala (CICIG) (Comisión Internacional contra la Impunidad en Guatemala, 2016).

After a coup in 1982, and a new Constitution in 1985, Vinicio Cerezo, from the left–centre party Democracia Cristiana became (in 1986) the first democratically–elected president of Guatemala in decades. The year after his election, the first crisis of the electrical grid occurred, when the water level in the Chixoy Dam descended below its functioning minimum. A report from *Crónica* at the time cited as causes the inadequate operation and maintenance of the plant and deforestation in the surrounding area. Old thermal power plants were reactivated to avoid power outages countrywide (Anahté, 1987).

The government entity in charge of the electrical grid in most of the country was the *Instituto Nacional de Electrificación* (National Institute of Electrification, INDE), except in Guatemala City and three departments, where it was the *Empresa Eléctrica de Guatemala* (Guatemalan Electrical Company, EEGSA), a mixed–capital company owned mostly by the State. The situation at the time is described in the webpage of INDE's labour union, STINDE, as follows: 'full of cronies and overstaffed; management engaged in labour abuse to the extreme of assault; constant sexual harassment to women, layoffs without justification; all–level corruption, and intervention by the military' (STINDE, 2015).

Operational malfunctions and overall mismanagement continued over the years. The energy crisis reached a peak in 1991 when, in addition to all its problems, a drought caused by the climate phenomenon *El Niño* reduced the level of water in Chixoy dam to a historic low. Two months of programmed power outages were scheduled to prevent the collapse of the electrical grid (Velásquez and Mazariegos, 1991). Again, in 1994, there was another period of power outages, when *El Niño* returned (Mazariegos and Morales, 1994), this time under President Ramiro De León (1993–1996). The disastrous situation of the electrical grid was, by then, the centre of a public discussion about the reforms needed to guarantee the energy supply for the country. At this point, it is useful to change the focus onto the political and ideological debates of those decades that shaped the response to this crisis.

A turn to the right everywhere

Politically, the tide turned to the right worldwide between 1970 and 1990, in what now is called the rise of neoliberalism (Monbiot, 2016). Guatemala was no exception. A key figure in promoting neoliberalism in Guatemala was Manuel Ayau, a member of the Guatemalan elites (Casaús

Arzú, 2007, p. 138). He was a member of the classical liberal elite Mont Pelerin Society and the most vocal right–wing intellectual of the late 20th

François Mitterrand
presidente socialista de Francia, para modernizar su economía, ¿qué hizo?

Privatizar

Fue el presidente socialista de Francia, François Mitterrand, quien inició las privatizaciones en su país hace más de una década. Privatizó empresas estatales de servicios, industria y finanzas. Además, el pueblo francés participó, a través de la compra de acciones, en estas empresas.

Privatizar no es ideológico,
PRIVATIZAR ES MODERNIZAR

Figure X   Ad in an issue of Crónica Magazine (Anahté, 1997). Licensed under a Creative Commons Attribution–NonCommercial–NonDerivative license 3.0. Available at: http://cronica.ufm.edu/index.php/DOC468.pdf.

century in Guatemala. In 1959, he founded the first conservative think–tank in Guatemala, and Francisco Marroquín University (UFM) in 1971 (Ibargüen, 2010). UFM is an institution that, according to an article in the conservative magazine *National Review* (Nordlinger, 2016), 'classical liberals or Reagan conservatives [call] too good to be true'.

Ayau and other people linked to the UFM promoted in the media the classic neoliberal agenda: deregulation, privatization and the downsizing of the government. As early as 1972, Ayau was arguing for the privatization of public companies (Ayau, 1972). These ideas started to permeate the thinking of mainstream political parties and government officials. According to STINDE, the first privatization attempt of the electric utilities in

Guatemala occurred in 1986 (STINDE, 2015), during the Cerezo Administration, which by reputation was a left–centre government.

Successive administrations were gradually more right–leaning and pro–neoliberal ideas. President De León, for example, was from a centrist party, but in power, his policies became conservative and business–friendly. The media at the time also advanced the neoliberal agenda; it was also championed by business associations and think tanks. Take for example the advertisement above (fig. 1) with no sponsor from 1997. It reads: 'What did Francois Miterrand, socialist president of France, do to modernize its economy? Privatize (…) to privatize is not ideological, to privatize is to modernize'.

President De León presented in 1995 the first GGEL bill, which was portrayed as the solution to the problems plaguing the electrical grid, but it did not make it through Congress. Alvaro Arzú, another member of the historical elite of Guatemala (Casaús Arzú, 2007, p. 92) from the Partido de Avanzada Nacional (National Advancement Party, PAN), won the next elections. His administration promoted a clear neoliberal agenda, including selling public electric utilities and opening the electricity market (García Kihn, 1996). The most important piece of legislation for these transformations was GGEL. After some opposition, their bill passed in 1996 (Morales Monzón, 1996).

Figure 2 provides a visual presentation of the array of actors that led to the GGEL. To summarize:

(a) A weak state controlled by the military in the midst of a counterinsurgency war results in the inefficient and corrupt management of the public electricity utilities.

(b) The climate phenomenon *El Niño* repeatedly led to droughts that affected the capacity of Chixoy, the largest hydroelectric power plant in Guatemala, creating a power crisis.

(c) The inadequate government response of a series of programmed power cuts and a return to importing fuel for power generation makes energy policy a national matter with public pressure to restructure the electricity sector.

(d) An international political turn toward neoliberalism Guatemala manifests as progressively more right–wing administrations inclined to neoliberal ideas.

(e) The advancement of the neoliberal agenda by think tanks, traditional elite members and 'Reagan conservative' academics in Guatemala led to privatization being the favoured policy response.

(f) All of which converged into a solution to the electricity problem: the GGEL of 1996.
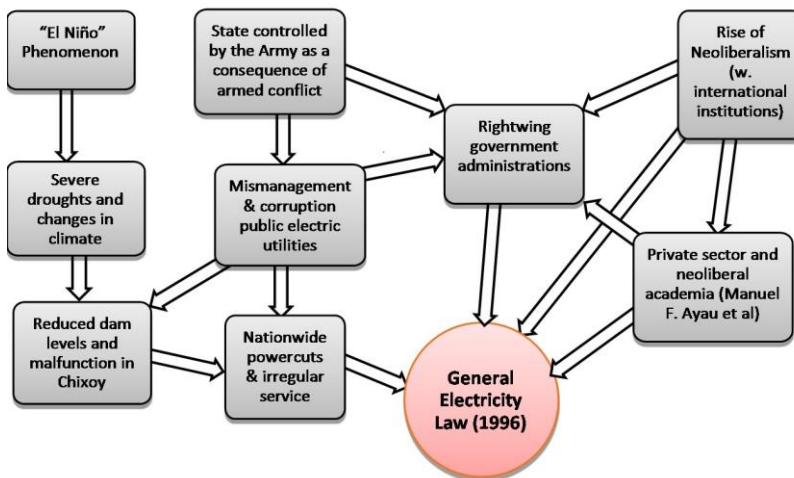
Figure 2   The network that originated GGEL (prepared by the author).

How GGEL became an influential actor on the network that originated it

The opening statement of the GGEL declares: 'Since the supply of electricity doesn't satisfy the needs of the Guatemalan population, it is necessary to increase its production by means of the liberalization of the market' (Guatemala, Congreso de la República, 1996, p. 1). It assigns to the Ministry of Energy and Mines the responsibility of the electricity sector, and among other provisions, also:

1. Declares that the generation of electricity does not need special permits other than those in the Constitution and the laws of the country, unless it uses state property (such as hydroelectricity).
2. Declares that the price of electricity is determined freely between the agents of the market (generators, distributors, transportation and commercialization companies, and wholesale buyers).
3. Creates the National Electric Energy Commission (*Comisión Nacional de Energía Eléctrica*, CNEE), the authority in charge of GGEL,

overseeing prices, especially for small users and provides arbitration between agents of the market.

4. Creates the figure of the Wholesale Market Manager (Administrador del Mercado Mayorista, AMM), whose functions are coordinating the energy market and guaranteeing the safety and supply of the electrical grid.

5. Establishes that no company can operate simultaneously two or more activities of the electricity business, and gives INDE and EEGSA one year to split into different companies. [This provision was introduced to mitigate the 'natural monopoly' status of the electrical grid (Michaels, 1993)].

The first wave of the energy expansion: thermal power plants

The following events can be grouped as the set–up stage for the expansion of the energy market:

1. May, 1997. First National Electric Energy Commission (CNEE) is appointed (Comisión Nacional de Energía Eléctrica, 2001).

2. October, 1997. INDE is divided in three companies: EGEE (generation), ETCEE (transmission), and EDEE (distribution and commercialization). Later, EGEE would be divided in DEORSA (Electrical Distributor of the East) and DEOCSA (Electrical Distributor of the West) in preparation for its privatization (Instituto Nacional de Electrificación, 2013).

3. July, 1998. EEGSA was sold to an international group led by the Spanish company IBERDROLA, for a price of USD $520 million (El País, 1998). Privatization was not a mandate of GGEL but a policy of the Arzú Administration.

4. December, 1998. INDE's new distribution companies, DEORSA and DEOCSA, were sold in December, to another Spanish corporation, Union Fenosa, for USD $101 million (Harris, 2002). INDE kept the other companies.

5. 2000. The National Association of Generators, ANG (Asociación Nacional de Generadores, [no date]) was founded as an industry association that represented the private electricity generation sector.

These measures successfully promoted the growth of electricity generation in Guatemala. Table 1 shows the increase in installed capacity per primary source from 1985 to 2001. In the 1996–2001 period, the overall

capacity grew 527 MW, while in the previous eleven years it only grew 362 MW. Most of it came from thermal plants (351 MW increase), and cogeneration (sugarcane bagasse) plants (120 MW); meanwhile, the increase for hydropower was minimal, only 22 MW. This was not a desirable situation; partly because of its environmental impact, but mostly because it augmented dependence on imported fossil fuels, and left valuable renewable resources unexploited.

Table 1   Guatemala: Electric generation installed capacity per year and source
             (MW). Adapted from (Paz Antolín, 2004).

Year	Total	Hydro	Geothermal	Thermal	Cogeneration
1985	783.4	488.1	—	295.3	—
1990	810.9	488.1	——	322.8	—
1996	1145.5	502.1	—	563.4	80.0
2001	1672.1	524.9	33.0	914.2	200.0

The second wave of energy expansion: hydroelectricity

In 2002, the renewable energy companies established the Association of Renewable Energy Generators, AGER (Asociación de Generadores de Energía Renovable). On its website, AGER (2016) states that its main objective is 'to organize all private entities whose main activity is the generation of electricity from renewable sources, and to set among them a unified position in all matters affecting them'.

Then, in 2003, the Guatemalan Congress passed the Law of Incentives for the Development of Renewable Energy Projects (LIDREP) which gave tax breaks to new projects. It was an initiative from President Alfonso Portillo, of the right–wing party, Frente Republicano Guatemalteco (FRG).

After the approval of LIDREP, there was an increase in hydroelectric plants. Figure 3 shows the total number per year of large private plants (more than 5 MW capacity), either in operation or approved for construction. Compared to only one plant in 1995, there were 49 in 2016.

At the same time, the number of new thermal power plants declined, starting a shift in the energy matrix of the country and in its ownership, since not only were foreign corporations investing in hydroelectricity projects, but major Guatemalan ones were, too. The largest project to date is Renace, a complex of five plants on the Cahabón River, with a total capacity larger than Chixoy (over 300 Mw). Renace is being built by the Spanish ACS for Multi–Inversiones Corporation (ICEX España, 2014), one of

the largest in Guatemala, owned by the Gutiérrez–Bosch family, another prominent group of the Guatemalan elite (Casaús Arzú, 2007, p. 100).
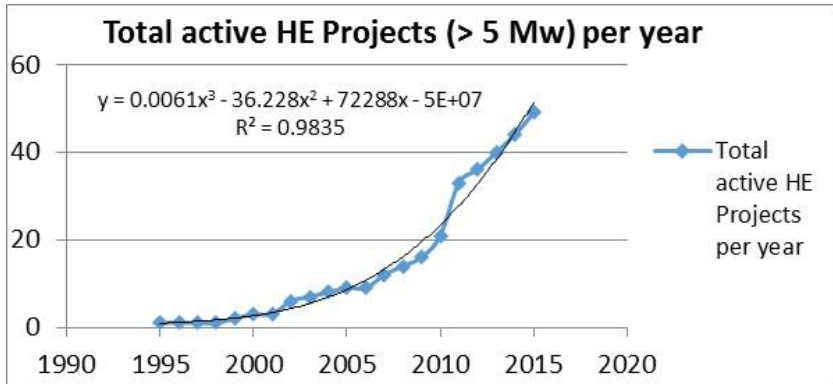
Figure 3   Total Number of HE active projects per year. Data compiled by the author from (Guatemala, Ministerio de Energía y Minas, 2016b).

The rise of conflict over hydroelectricity

The first conflict over a hydroelectric project was the Rio Negro Massacre described above. This episode is central to understanding the current conflicts, since it partially explains the mistrust that rural communities have of megaprojects (Orantes, 2010). While the Rio Negro Massacre occurred before the GGEL became law, the focus here will be those conflicts that surfaced after its approval, involving mostly private companies.

After GGEL, the first reported conflict was in the municipality of Rio Hondo, Zacapa. According to Hurtado (2006), concerns were raised after a first plant started operating in 2000; protests rose after it became public that another two projects were already in motion. After years of opposition, a public consultation vote was held in 2005, resulting in the rejection of the project by the community.

Since then, more conflicts have surfaced. Orantes (2010) reported 27 conflict situations in 9 departments as of 2010. Since 2010, there have been more conflicts, including the one that attracted national attention: the opposition of the communities of Santa Cruz Barillas, Huehuetenango, to the plant Hidro Santa Cruz (a Spanish capital project) in 2012. It escalated to such a degree that riots exploded over the murder of a community leader by company security guards; the Government responded by declaring a state of emergency and the suspension of some constitutional rights in the area (Hernández, 2013).

Recently, protests have surfaced around the Renace projects. In an article in the Spanish newspaper *El País* (Tristán, 2016), locals complained about the damages and decrease in the current they have seen in Cahabón River since the first two Renace plants were built. One person told the newspaper that the company gave away shovels and fumigators, even offered jobs and built a school, but it has not offered to supply them with electricity or potable water.

The role of GGEL in the conflicts

Today, 30 years after the Chixoy plant was finished, there are, ironically, still nearby communities that do not have electricity coverage; that is also the case with some of the new projects. Orantes (2010) found out through a survey that, for nearby communities, one of the main causes of conflict was the despoliation of natural resources by private companies that left them with no substantial benefits. GGEL failed to take into account the role of communities in the generation activity. In fact, according to its vision of a free electricity market, it forbids large generation companies to sell and distribute electricity (Article 7) or to use it as payment or as a medium of exchange for goods or services (Articles 34, 61). This prohibition makes sense, given the network that it embodies, since those measures prevent the distortion of the market. However, in the context of conflicts over resources, it is an obstacle, since the best negotiating asset for both companies and communities would be electricity access at minimum cost. Instead, GGEL contributes to creating a scenario in which the most valuable good produced in a region is taken away and used in distant, more urbanized communities; this effect links hydroelectricity to other extractive industries.

Furthermore, Martínez and Villagrán (2009) argue in their study of agrarian conflicts that the legal framework for electricity was designed to prioritize energy projects over the damages for rural communities. Orantes (2010) summarizes it by saying that the legal framework ignores a key aspect, interdependency on the use of natural resources. By doing so, it shifts the burden of the industry costs to communities, and releases the government and private companies from accountability, so they can focus on expanding the energy market with maximum efficiency.
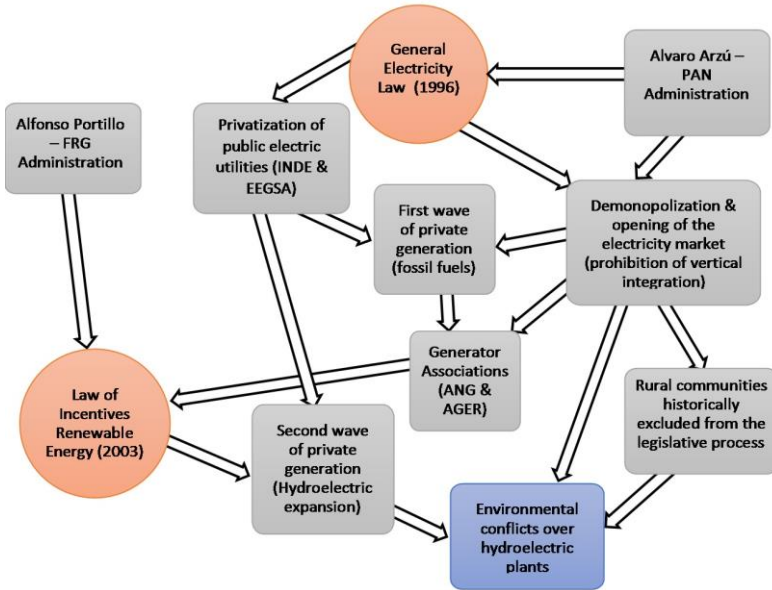
Figure 4   The network driven by GGEL and its role in the conflicts over hydroelectricity (prepared by the author).

Let us summarize the role of GGEL in this stage as detailed in figure 5:

(a) The GGEL, a law made with a vision of increasing efficiency by liberating the market, mandates de–monopolization and disintegration of the vertical structures of public electricity utilities.

(b) The Arzú administration, as part of its privatization policy, sells EEGSA and the distribution companies of INDE created by GGEL to Spanish companies.

(c) These actions cause a boom in the generation business, attracting foreign and national companies that will eventually organize in industry associations like ADG and AGER.

(d) The lobbying of AGER and ADG with the next president, Alfonso Portillo, resulted in the new law of incentives for renewable energy, LIDREP.

(e) LIDREP brought the second wave of electricity generation expansion.

(f) However, most of these new projects were met with protests and conflict with nearby communities. The latter can be attributed partly to their historical distrust of government and of foreign interventions in their territories, but also to their exclusion from the political process, exemplified in both the objectives and spirit of GGEL and LIDREP.

Conclusion

This initial account already shows some of the insights that the ANT approach has to offer. Previous studies on electricity expansion (Paz Antolín, 2004) and on hydroelectricity conflicts (Orantes, 2010) come to a similar conclusion: that the legal framework for the former was made within the neoliberal state of mind, which bet on efficiency and the free market as the solution to the urgent need to expand electricity coverage. Both studies attributed the approach of that frame to the agency of the international wave of neoliberalism of the time and its national counterparts, right–wing governments. This study shows that such a picture is incomplete, since it paints the legal frame as a mere intermediary, a vessel of the values and motives of the political elite of the period. Instead, GGEL is shown here as a mediator (Latour, 2005), an actor that not only embodies the network that created it, but also modified it. As Akrich (1994, p. 220) puts it, 'technical objects not only define actors and the relations between them, but to continue functioning must stabilize and channel these'. The focus of GGEL on efficiency and the free market eventually destabilized the hydroelectric expansion, since the network it embodied did not include the rural communities it was supposed to benefit. In other words, GGEL failed to shift to the role of mere 'silent intermediary', as technical objects do.

This account also shows partially why GGEL came into law, since it takes into account the agency of other non–human actors, beyond the political and social elite and international neoliberalism: Chixoy dam, with its maintenance and structural problems that increased the risk of failure of the electrical grid, and the 'El Niño' phenomenon, which brought climate instability and droughts that bared the fragility of the system. These not–accounted–for actors help to explain why efficiency was a central part of the proposed solution, why the law passed with little resistance from opposing parties, and why legislation that was supposed to bring a new era of wide electricity access, ended up fuelling conflicts against the very expansion it was supposed to create.

References

Akrich, M. (1994) The De–Scription of Technical Objects. In Bijker, W.E. and Law, J. (eds.), *Shaping Technology/Building Society*. Cambridge: MIT Press.

Anahté, S.A. (1987) Chixoy se Evapora. *Crónica*, 3, 11–14.

Anahté, S.A. (1997) *Crónica*, 76, 43.

Asociación Guatemalteca de Generadores de Energía Renovable (2016) *Sobre AGER*. [Online] Available from: http://ager.org.gt/sobre–ager/ [Accessed: October 14th, 2016].

Asociación Nacional de Generadores (2016) *Asociación Nacional de Generadores*. [Online] Available from: http://www.ang.org.gt/asociacion–nacional–de–generadores/ [Accessed: November 11th, 2016].

Ayau, M. (1972) *Por qué las Empresas Deben ser Privadas*. [Online] Available from: http://www.biblioteca.cees.org.gt/topicos/web/topic–272.html [Accessed: September 25th, 2016].

Casaús Arzú, M. (2007) *Guatemala: Linaje y Racismo*. Guatemala: F y G Editores.

Comisión de Esclarecimiento Histórico de Guatemala (1999) *Guatemala: Memoria de Silencio. Tomo VI: Casos ilustrativos.* [Online] Available from: https://www.plazapublica.com.gt/sites/default/files/tomo_6_y_7_anexo _i_casos_ilustrativos_1.pdf [Accessed: July 19th, 2016].

Comisión Internacional contra la Impunidad en Guatemala (2016) *CICIG – Sobre la Comisión*. [Online] Available from: http://www.cicig.org/index.php?page=sobre [Accessed: November 3rd, 2016].

Comisión Nacional de Energía Eléctrica (2001) *Memoria de Labores 2001.* [Online] Available from: http://www.cnee.gob.gt/xhtml/memo/memoria–labores2001.pdf [Accessed: November 12th, 2016].

El País (1998) Iberdrola Compra la Eléctrica Estatal de Guatemala, EEGSA, por 78.000 millones. *El País*. [Online] Available from: http://elpais.com/diario/1998/07/31/economia/901836013_850215.htm l [Accessed: October 8th, 2016].

García Kihn, J. (1996) Los Planes Privatizadores del PAN. *Crónica*, 443, 37–38.

Guatemala, Congreso de la República (1996) *Decreto 93–96*. Guatemala: Diario de Centroamérica.

Guatemala, Ministerio de Energía y Minas (2013) *Política Energética 2013–2027*. [Online] Available from: http://www.mem.gob.gt/wp–content/uploads/2013/02/PE2013–2027.pdf [Accessed: November 25th, 2015].

Guatemala, Ministerio de Energía y Minas (2016a) *Estadísticas del Subsector Eléctrico*. [Online] Available from: http://www.mem.gob.gt/wp–content/uploads/2015/06/Subsector–El%C3%A9ctrico–en–Guatemala.pdf [Accessed: August 25th, 2016].

Guatemala, Ministerio de Energía y Minas (2016b) *Listado de Hidroeléctricas Mayores a 5 MW*. [Online] Available from: http://www.mem.gob.gt/wp–content/uploads/2015/06/1._–Listado–de–Hidroel%C3%A9ctricas–Mayores–a–5–MW.pdf [Accessed: August 22nd, 2016].

Harris, C. (2002) *Rural Expansion: Network Expansion Using an Output–based Scheme in Guatemala*. [Online] Available from: https://openknowledge.worldbank.org/handle/10986/11341 [Accessed: October 14th, 2016].

Hernández, O. (2013) *Barillas Reconfigurado*. [Online] Available from: https://www.plazapublica.com.gt/content/barillas–reconfigurado [Accessed: November 10th, 2016].

Hurtado, M. (2006) *Protestas Sociales y Recursos Naturales*. Guatemala: FLACSO.

Ibargüen, G. (2010) *Falleció Manuel Ayau, Campeón de la Libertad*. [Online] Available from: http://noticias.ufm.edu/index.php/Falleci%C3%B3_Manuel_F._Ayau,_campe%C3%B3n_de_la_libertad [Accessed: September 12th, 2016].

ICEX España (2014) *Florentino Pérez Inaugura en Guatemala la Central Hidroeléctrica Renace II*. [Online] Available from: http://www.icex.es/icex/es/navegacion–principal/todos–nuestros–servicios/informacion–de–mercados/paises/navegacion–principal/noticias/4755172.html?idPais=GT [Accessed: October 9th, 2016].

Instituto Nacional de Electrificación (2013) *Empresas – INDE*. [Online] Available from: http://www.inde.gob.gt/ [Accessed: October 14th, 2016].

International Energy Agency (2016) *IEA Sankey Diagram* [Online] Available from: http://www.iea.org/Sankey/#?c=Guatemala&s=Balance [Accessed: October 13th, 2016].

Latour, B. (1987) *Science in Action: How to Follow Scientists and Engineers through Society*. Cambridge: Harvard University Press.

Latour, B. (2005) *Reassembling the Social: An Introduction to Actor–network Theory*. Oxford: Oxford University Press.

Martínez, J. and Villagrán, C. (2009) *Conflicto por el Uso de la Tierra: Nuevas Expresiones de la Conflictividad agraria en Guatemala*. Guatemala: Universidad Rafael Landívar [Online] Available from: http://biblio3.url.edu.gt/Libros/2012/confli–UsoTierra1.pdf [Accessed: November 11th, 2016].

Mazariegos, J. and Morales, C. (1994) El Lado Oscuro de los Apagones. *Crónica*, 354, 17–24.

Michaels, R.J. (1993) *Electric Utility Regulation* [Online] Available from: http://www.econlib.org/library/Enc1/ElectricUtilityRegulation.html [Accessed: November 10th, 2016].

Monbiot, G. (2016) Neoliberalism, the Ideology at the Root of all of our Problems. *The Guardian*. [Online] Available from: https://www.theguardian.com/books/2016/apr/15/neoliberalism–ideology–problem–george–monbiot [Accessed: May 20th, 2016].

Morales Monzón, C. (1996) Una Transformación Ineludible. *Crónica*, 450, 34.

Neresini, F. and Lorenzet, A. (2016) Can Media Monitoring be a Proxy for Public Opinion about Technoscientific Controversies? *Public Undestanding of Science*, 25 (2), 171–185.

Nordlinger, J. (2016). Freedom U: a Classical–liberal University in Central America, Part 1. *National Review*. [Online] Available from: http://www.nationalreview.com/article/433591/freedom–u–classical–liberal–university–central–america–part–i [Accessed: October 15th, 2016].

Orantes, P. (2010) *Comprendiendo la Conflictividad por Hidroeléctricas en Guatemala: Para Tender Puentes de Gobernabilidad*. Guatemala: IRALEP – Embajada de los Países Bajos.

Paz Antolín, M.J. (2004) Efectos de la Expansión de Empresas Transnacionales en el Sector Eléctrico en Guatemala. *Problemas del Desarrollo: Revista Latinoamericana de Economía*, 35 (137), 135–159.

Sciences Po Medialab (2016) *Tools – Sciences Po Medialab*. [Online] Available from: http://www.medialab.sciences–po.fr/tools/ [Accessed: November 11th, 2016].

STINDE (2015) *Reseña histórica*. [Online] Available from: http://www.stinde.gt/resena–historica–3/ [Accessed: July 8th, 2016].

Tristán, R. (2016) Cahabón, el Río Indígena que Seca una Hidroeléctrica en Guatemala. *El País*. [Online] Available from: http://elpais.com/elpais/2016/06/16/planeta_futuro/1466106230_360148.html [Accessed: November 10th, 2016].

United Nations Development Programme (2016) *Ranking*. [Online] Available from: http://hdr.undp.org/sites/default/files/ranking.pdf [Accessed: August 25th, 2016].

Universidad Francisco Marroquin (2013) *Crónica – Página principal*. [Online] Available from: http://cronica.ufm.edu/index.php/P%C3%A1gina_principal [Accessed: February 5th, 2016].

Velásquez, D. and Mazariegos, J. (1991) Tres Décadas de Errores en el INDE Sumen al País en la Rabia y las Sombras. *Crónica*, 192, 16–23.

Venturini, T. (2012) Building on Faults: How to Represent Controversies with Digital Methods. *Public Understanding of Science*, 21 (7), 796–812.

Il ruolo della formazione nella messa in opera dell'Efficienza Energetica nel settore edile

Francesca CUBEDDU[*a]

[a] Università Roma Tre

Le problematiche ambientali, in particolare il cambiamento climatico, modificano il quadro sociale ed economico tanto da mutare le scelte e i comportamenti degli attori sociali. L'Efficienza Energetica ha come obiettivo un beneficio ambientale e sociale, punta ad una sicurezza energetica, all'equità ma anche a porre un rimedio al cambiamento climatico. Il settore preso in analisi è quello edile poiché fa emergere in modo chiaro e distinto la scelta fra eat e heat e quali siano i criteri per cui le persone siano costrette a dover scegliere. La scelta è dettata dal comportamento, dal reddito e dalle decisioni politiche. La questione reddito potrebbe essere arginata da manovre politiche, come ad esempio l'uso di incentivi. La formazione è un elemento d'implementazione della politica dell'Efficienza Energetica che comporta negli attori sociali conoscenza e capacità di scelta. Il tema posto in analisi nella ricerca sul campo è una politica di formazione dell'Efficienza Energetica e i suoi effetti in base agli attori presi in analisi. L'azione della formazione ha come ruolo focale l'implementazione della policy dell'Efficienza Energetica. Ed è incentivando formazione ed agendo su di essa che sia possibile per il decisore politico raggiungere non solo gli obiettivi prefissati dall'Unione Europea ma anche generare crescita e sviluppo economico e sociale. L'analisi e l'interazione del modello sociale ed economico ne permette una possibile dimostrazione.

Keywords: Efficienza energetica; formazione; buona politica; modelli

Parte teorica

Le azioni umane sono il motore del cambiamento ed è con esse che la società muta. Le azioni degli individui possono essere determinate da

motivazioni logiche e non logiche (Pareto, 1988) e possono essere stimolate da differenti input.

I cambiamenti climatici sono la rappresentazione per eccellenza degli impatti causati dalle azioni degli individui.

Definire gli impatti e valutarne i danni è semplice ma difficile è trovare delle buone politiche che riducano tali problematiche. Un esempio sono le politiche energetiche, poiché oltre a contenere il concetto di sostenibilità sono politiche mirate allo sviluppo e al benessere economico, sociale e ambientale.

Le politiche mirate all'Efficienza sono centrali nell'ambito della questione energetica. 'Luce, riscaldamento, trasporti, produzione industriale: l'energia è cruciale per i servizi essenziali di tutti i giorni, senza i quali le nostre imprese non possono funzionare. Consumiamo e importiamo sempre più energia. I paesi europei hanno ben compreso che è utile agire in maniera coerente in questo settore particolarmente strategico. L'Europa si è dotata quindi di una serie di regole comuni e può avanzare nella stessa direzione per poter avere accesso a una quantità sufficiente di energia a prezzi accessibili e riducendo al minimo l'inquinamento' (Commissione europea, 2015). L'energia è un settore strategico, senza energia non è possibile vivere, è fondamentale per l'illuminazione, per il riscaldamento e il raffreddamento, il trasposto di persone e di merci, ed è a sostegno di tutti i settori economici e del progresso scientifico. Il tenore di vita dei soggetti può essere calcolato su un elevato consumo di energia, che genera però inquinamento (dell'aria, dell'acqua, del suolo e del clima) che deve essere ridotto al minimo per consentire la sostenibilità ambientale e la vivibilità delle generazioni presenti e future. Esiste una 'sociologia dell'energetica, che ha cercato di costruire una teoria generale della società a partire dall'applicazione delle leggi dell'energetica allo studio dei fatti sociali; dall'altra una sociologia dell'energia, che invece si è dedicata allo studio dei problemi sociali inerenti la produzione, il dispacciamento, il consumo, ed il risparmio di energia' (Carrosio, 2014, p. 108). Questo è importante per poter determinare che l'energia non è un elemento sconnesso alla società, ma anzi è un elemento centrale e focale. In Francia la questione energetica è ambito di molti studi e per essi la transizione ecologica è legata ad una transizione energetica. Infatti secondo i sociologi dell'energia francesi la strada per la sostenibilità è data dal trovare nuovi approcci alternativi alle solite energie. La loro visione è che per andare verso una società più sobria in energia, città, edifici, trasporti e comportamenti tutto deve divenire 'durable', ossia sostenibile (Zélem e Beslay, 2015). L'energia è l'elemento

che innesca gli ingranaggi. Commoner (Commoner, 1976, 1980) afferma che l'energia è un bene fondamentale per la dimensione sociale, poiché influisce sulla dimensione economica. Le crisi economiche sono collegate anche con le crisi energetiche. L'energia e i nuovi drive energetici possono comportare sviluppo e crescita, poiché essa rappresenta un elemento base della vita dell'uomo. Questi driver devono essere contemplati sia nell'Agenda 21 Locale sia nei sistemi decisionali. Poiché da essa dipende la vivibilità dell'uomo e il suo sviluppo, ed è per tale motivo che sia essenziale porre attenzione sia alle fonti sia alle tecniche utilizzate, poiché entrambe vanno ad incidere su determinate variabili della dimensione sociale, come ad esempio l'equità. Ivan Illich (Illich, 1973) afferma che solo un uso limitato dell'energia può comportare alti livelli d'equità nella dimensione sociale, ed inoltre, che l'equità e l'energia crescono assieme sono due variabili direttamente proporzionali. Una buona politica energetica riesce a contrastare il rapporto fra crisi economica e disomogeneità sociale.

L'Unione europea dispone di poteri e di strumenti perché sono necessari per attuare una politica energetica che punta a:

- garantire l'approvvigionamento energetico;
- assicurarsi che i prezzi energetici non frenino la propria competitività;
- proteggere l'ambiente e in particolare lottare contro i cambiamenti climatici;
- migliorare le reti energetiche.

Le politiche energetiche europee permettono: la tutela dei consumatori vulnerabili, il rafforzamento dei poteri di controllo e di sanzione delle autorità di vigilanza e le fatture trasparenti.

'La rivoluzione più attesa è però quella dei contatori e delle reti 'intelligenti', la cui diffusione dovrebbe rendere più attivi gli utenti. Le fatture si baseranno sul consumo reale e gli utenti potranno sapere all'istante quanto consumano e agire di conseguenza per ridurre la bolletta. L'UE applica strumenti di salvaguardia per garantire il rispetto della privacy e delle informazioni raccolte mediante i contatori intelligenti' (Commissione Europea, 2015).

Lavorare su politiche energetiche significa anche garantire l'energia a tutti, e non dover scegliere fra 'heat or eat'. Le leggi dell'Unione Europea sono leggi emanate dall'alto ma che devono essere adottate e modificate a seconda delle caratteristiche del luogo. È il decisore politico locale che deve scegliere cosa effettuare e quale sia la miglior strada da percorrere.

'I politici hanno preso coscienza della dimensione e dell'urgenza del problema, e recentemente molti paesi hanno introdotto ambiziose politiche sul cambiamento climatico. Negli ultimi è stata superata una soglia: la maggior parte dei leader politici è oggi consapevole dei rischi posti dal riscaldamento globale e della necessità di reagire. Questo però è solo il primo passo: l'inserimento della questione nell'agenda politica. Il secondo passo deve essere il suo radicamento nelle istituzioni e nelle preoccupazioni quotidiane dei cittadini' (Giddens, 2015, p.11).

Come scrive Giddens la necessità di reagire è l'elemento importante, poiché avere coscienza significa prendere buone decisioni. Questa buona decisone significa che viene effettuata la scelta migliore per porre rimedio alle problematiche, come l'Efficienza Energetica. Per i sociologi francesi è la soluzione alle problematiche energetiche, poiché mette in accordo lo sviluppo sostenibile e la massimizzazione del benessere dei soggetti, attraverso un approccio di cambiamento delle trasmissioni e dell'utilizzo di nuove tecnologie. L'uso dell'energia deve essere organizzato e gestito, solo in questo modo si arriva ad un concetto di sostenibilità (Zélem e Beslay, 2015).

Secondo l'Agenzia Internazionale dell'Energia (IEA, 2014a), l'efficienza energetica ha differenti benefici sia di breve che di lungo periodo. I benefici di breve periodo sono: riduzione della disoccupazione e accessibilità alla fornitura di energia. Di lungo periodo riguardano: competitività del sistema economico nazionale, riduzione dei costi in termini di salute umana, aumento della sicurezza energetica e miglioramento delle prospettive economiche: aumento dell'occupazione, sviluppo e crescita del settore, qualificazione lavorativa, creazione di nuove figure professionali e crescita del Pil. I benefici si ripercuotono su quattro livelli: 1) Individuale; 2) Settoriale; 3) Nazionale; 4) Internazionale. L'applicabilità di tale politica a livello Individuale interviene sulla salute, sulla povertà energetica e sull'aumento della disponibilità degli introiti; a livello Settoriale incide sulla produzione e competitività industriale, sulla fornitura di energia e sull'aumento del valore azienda; a livello Nazionale crea lavoro, riduce le spese energetiche, crea energia sicura (riduce la dipendenza aumentando la sicurezza energetica del Paese intervenendo sulla riduzione di quattro fattori di rischio: 1) Geologico, per la disponibilità di combustibile; 2) Politico, per l'accessibilità; 3) Economico, per la disponibilità; 4) Ambientale e Sociale, per l'accettabilità e aumento del PIL; a livello Internazionale la

riduzione dell'uso di energia comporta una riduzione delle emissioni, gestione delle risorse naturali e ha come obiettivo la crescita.

La Politica dell'Efficienza Energetica è una politica pubblica attiva, una politica di sviluppo prima ancora di una politica energetica ambientale. È una politica energetica che possiede un'intrinseca dimensione globale, in quanto è chiamata strutturalmente a fronteggiare rischi ambientali 'planetari' come il cambiamento climatico. L'azione delle politiche pubbliche ambientali e energetiche ha, in buona sostanza, una dimensione e una strutturazione 'glocale': l'implementazione nel locale ha un riverbero globale. Come tutte le politiche pubbliche, ambientali ed energetiche, anche l'Efficienza energetica, ha non solo come obiettivo un impatto sul sistema energetico e sull'ambiente ma anche sullo sviluppo socio–economico.

L'Agenzia Internazionale dell'Energia ha definito nell'Energy Efficiency Market Report del 2016 l'Efficienza Energetica come il 'primo combustibile, allo stesso livello di ogni altra risorsa energetica e in grado di contribuire alle sfide più rilevanti quali la sicurezza energetica, la sostenibilità e lo sviluppo economico' (IEA, 2016).

Quello che l'IEA pone come primo elemento è l'importanza di un processo educativo di tutti i cittadini sul significato dell'Efficienza Energetica e sui nuovi sistemi tecnologici che essa utilizza. La domanda di energia si modifica come si modifica il suo uso. La quantità utilizzata non diminuisce ma andrà a diminuire sia il suo spreco che la sua capacità inquinante.

In questo momento è la policy glocale, la policy che si sta mettendo in atto in tutto il mondo.

L'IEA ritiene che l'efficienza energetica origina importanti vantaggi per le economie emergenti e nei paesi in via di sviluppo, ridurre la povertà e sostenere la crescita sostenibile, si basa su cinque punti di forza:

1. Accesso, l'efficienza energetica può aiutare i paesi per espandere l'accesso alla fonte energetica, consentendo loro di fornire in modo efficace il potere a più persone attraverso l'infrastruttura energetica esistente;
2. Crescita/Sviluppo, l'efficienza energetica ha vari effetti positivi che favoriscono la crescita economica, per esempio migliorano la produttività industriale, riducendo le bollette;
3. Riduzione della povertà/Accessibilità, l'efficienza energetica può migliorare l'accessibilità economica dei servizi energetici per le famiglie più povere, riducendo il costo per unità di illuminazione, il riscaldamento, la refrigerazione ed altri servizi;

4. Inquinamento Locale, l'efficienza energetica (sia lato dell'offerta e degli usi finali) può contribuire a diminuire la necessità di generazione – e ridurre le emissioni associate – pur sostenendo la crescita economica;
5. Cambiamenti climatici resilienza, riducendo la necessità di infrastrutture energetiche, l'efficienza energetica riduce la quantità di risorse energetiche esposti a eventi meteorologici estremi.

La Strategia Energetica Nazionale italiana propone l'Efficienza Energetica come il massimo obiettivo da raggiungere poiché è capace di:

1. ridurre i costi energetici, grazie al risparmio di consumi;
2. ridurre l'impatto ambientale (l'efficienza energetica è lo strumento più economico per l'abbattimento delle emissioni, con un ritorno sugli investimenti spesso positivo per il Paese, e quindi da privilegiare per raggiungere gli obiettivi di qualità ambientale);
3. migliorare la sicurezza di approvvigionamento e riduce la dipendenza energetica;
4. genera sviluppo economico e di conseguenza anche benessere sociale.

Questa politica risponde alle caratteristiche di sostenibilità ambientale poiché permette la riduzione delle emissioni e un buon uso delle risorse energetiche senza diminuirne l'utilizzi e l'intensità.

Un settore, in cui è necessario applicare politiche di efficienza energetica, è quello edile. Definito come settore critico poiché il suo mutare dipende dal ruolo degli attori e dalle politiche di investimenti che sono implementate. Tale settore è considerato così fondamentale dalla UE in ordine al raggiungimento degli obiettivi 20/20/20 poiché:

1. è il settore centrale dell'economia e la sua crescita comporta un elevato aumento del PIL;
2. è circa un terzo dei consumi finali di energia mondiale.

Oltre a ciò un suo mutamento comporta un cambiamento delle condizioni di vita dei soggetti. Infatti, apportando modifiche agli edifici si va a modificare la qualità della vita del sistema sociale. Il principio dell'Efficienza Energetica è sia quello di creare edifici a energia quasi zero e che possiedano requisiti ottimali in funzione dei costi e sia riqualificare gli edifici già esistenti garantendo l'equità energetica ed una crescita economica. Sono due i poli che intervengono: impresa e cittadino. I cittadini, innescano l'esigenza di conversione tecnologica da parte delle imprese e le imprese edili eseguono da sole le direttive delle linee guida per l'applicazione della politica dell'efficienza energetica.

L'edilizia, come condizione dell'abitazione, è correlata alla situazione sociale dei cittadini. Infatti, è una delle cause della 'fuel poverty', ossia povertà energetica. Il termine fuel poverty è un termine coniato dai Paesi sviluppati per rappresentare i cittadini che non sono in una soglia di povertà massima ma che purtroppo devono scegliere fra 'heat or eat' ossia fra il riscaldarsi o il mangiare. La fuel poverty è caratterizzata dal reddito basso, dalla qualità degli alloggi, dal costo dell'energia.

I redditi bassi sono una causa frequente della impossibilità di accesso ai servizi e ai beni.

'Disporre di un basso reddito significa per una persona essere costretta a consumare meno del necessario ed a vivere in condizioni modeste. D'altro canto, esistono bisogni cosiddetti essenziali e l'energia rappresenta una di queste necessità primarie. Il bisogno di ridurre i consumi energetici al fine di combattere i cambiamenti climatici non è tema in discussione, ma il fatto che l'energia sia indispensabile per il benessere di ogni persona, povera o meno povera, deve essere riconosciuto nella vita quotidiana' (EPEE, 2010).

La Tabella 1 indica quelli che possono gli elementi positivi della applicazione della policy dell'Efficienza Energetica sia per il settore edile sia per i cittadini. Gli elementi indicati non sono solo teorici ma sono provati dagli Istituti di ricerca europei che hanno potuto constatare che sia realmente una policy di innovazione e di sviluppo. È infatti inserita fra le buone pratiche proposte per l'abbattimento della fuel poverty.

Tabella 1 Cosa comporta l'efficienza Energetica se applicata sia al settore Edile sia ai cittadini (elaborazione di Francesca Cubeddu).

Settore Edile	Cittadini
Crescita dei livelli produttivi	*Diminuzione della povertà energetica (fuel poverty)*
Nuove figure lavorative	
Investimento in Formazione	*Aumento del reddito*
Investimento in tecnologie e ricerca	*Risparmio spesa in bolletta*
Innovazione di processo	*Aumento del benessere*
Innovazione di prodotto	*Miglioramento della salute*
Aumento della competitività	*Miglioramento qualità della vita*
Competenza	*Accessibilità energetica*

Le tre buone pratiche proposte nel Progetto co–finanziato nell'ambito del Programma *Energia Intelligente per l'Europa* sono:

1. riduzione dei costi dell'energia per le famiglie;

2. miglioramento dell'efficienza energetica degli edifici occupati dalle famiglie vulnerabili, obiettivo che include necessariamente anche l'esigenza di educare le famiglie ad un corretto uso dell'energia e ad adottare comportamenti e scelte che producano effettivamente risparmio energetico;

3. consolidamento e rafforzamento dell'azione di sostegno sociale alle famiglie a basso reddito.

Queste buone pratiche sono state utilizzate, oltre che dall'Italia, dal Belgio, dalla Francia, dal Regno Unito e dalla Spagna. Questo perché vi è perfettamente la convinzione che la politica di Efficienza Energetica sia lo strumento di migliore efficacia rispetto alla riduzione dei costi connessi ai fabbisogni di qualunque utenza.

Tutte queste iniziative si sviluppano dalle politiche di efficientamento energetico, poiché essendo policies sostenibili e ad ampio respiro vanno ad intervenire su vari aspetti sociali ed economici.

In Italia vi sono differenti esempi di Social Housing come a Milano, Ravenna, Torino e Parma.

L'efficienza Energetica, essendo una policy ha necessità di sistemi che comportino la sua messa in pratica, poiché non è semplice poter mutare il comportamento dei cittadini e per una sostenibilità sociale e ambientale. Un sistema possibile è la formazione poiché comporta consapevolezza ed educa. Con soggetti informati ed educati è possibile mettere in pratica le norme e raggiungere l'obbiettivo. La sola propensione all'investimento sia della domanda sia della offerta può essere generata dalla formazione. Investire in formazione per le imprese edili significa mettersi sul mercato e ottenerne delle quote. Poiché un'impresa formata è un'impresa consapevole delle azioni da compiere e di quelle che potrebbero essere generate. Lavorare sulla formazione per un decisore politico significa non solo raggiungere una quota importante di efficienza energetica ma anche sviluppo economico, sociale e ambientale. La stessa condizione dei cittadini potrebbe mutare poiché educando tutti gli attori del sistema sociale si potrebbero dare le medesime opportunità a tutti i cittadini.

Ricerca sul campo

L'efficienza Energetica è una policy che punta ad una sicurezza energetica, all'equità ma anche a porre un rimedio al cambiamento climatico. Il settore scelto è quello edile poiché fa emergere in modo chiaro e distinto la scelta fra eat e heat e come le persone siano costrette a dover

scegliere. La scelta dipende dal proprio comportamento, dal reddito e dalle decisioni politiche. La questione reddito potrebbe essere arginata con delle manovre politiche, come ad esempio l'uso di incentivi. Il settore edile, come precedentemente affermato, è un terzo circa dei consumi finali di energia mondiale e con il conto del consumo energetico delle abitazioni è possibile valutare le problematiche ambientali, economiche e sociali. La riqualificazione è la parte significativa del settore edile, poiché è attraverso un'adeguata riqualificazione energetica che è possibile ridurre i consumi energetici e predisporre a tutti i cittadini una sicurezza energetica.

Per poter valutare l'efficacia della politica dell'Efficienza Energetica è necessario effettuare un'analisi del comportamento degli attori sociali coinvolti in rapporto ad esempio alla detrazione fiscale del 65%. Gli attori presi in analisi sono le Famiglie, le Imprese e i Formatori, questi attori costituiscono un piccolo modello definito sul quale è possibile poi eseguire un'analisi costi–efficacia (AC–E) e una analisi costi–benefici (A C–B) sul tema della detrazione statale del 65%, data sull'importo delle spese sostenute per la riqualificazione energetica degli edifici.

Prima di tutto è necessario stimare la relazione funzionale tra l'analisi del comportamento dei 3 attori ed il livello di attività del settore. Quest'ultimo è misurato con il numero degli interventi effettuati per la riqualificazione energetica delle abitazioni.

Si ipotizza che tali interventi siano il risultato del rapporto fra le attività di formazione e il livello di attività del settore. Solo con un nuovo approccio educativo e formativo è possibile ottenere un mutamento dell'attività lavorativa, del comportamento dei cittadini e delle imprese.

Queste analisi hanno come obiettivo dare una possibile metodologia di valutazione utile al decision making sul tema dell'efficienza energetica negli edifici.

Le analisi che verranno qui proposte sono di esercizio metodologico. Non può essere dato per certo che i postulati presentati siano reali, poiché le interviste effettuate sono soltanto 20 e non è un numero statisticamente significativo.

I dati utilizzati per costruire il modello derivano da un'indagine di carattere qualitativo su un campione di 13 imprese e di 7 formatori. I dati sono stati rivelati attraverso un questionario ad hoc somministrato ai differenti attori.

Le assunzioni di partenza che hanno permesso di costruire il modello riguardano i differenti attori, il loro comportamento e modo di agire. Le decisioni che sono analizzate riguardano gli investimenti in interventi di

riqualificazione energetica e in tecnologie per l'efficientamento. È da precisare che tutti i soggetti agiscono in base a calcoli razionali. L'elemento di unione tra i tre attori (Formatori, Imprese e Famiglie) è la concreta convenienza economica dell'investimento, che muta secondo le prospettive e le logiche differenti.

La prima assunzione effettuata si basa sull'analisi dell'agire delle Famiglie, che è 'razionale', poiché essi decidono di investire in tecnologie per l'efficienza energetica, creando così una domanda di interventi, se la detrazione fiscale conseguita sommata al risparmio energetico raggiunto sia superiore alle spese totali da sopportare; la seconda riguarda i Formatori e le Imprese che sono, come le famiglie, soggetti razionali; la terza osserva se l'attività di formazione influenza le imprese nell'eseguire interventi di riqualificazione, pertanto la formazione agisce sull'Offerta di interventi. Per tale constatazione si ipotizza la quarta assunzione per stimare l'influenza dei Formatori sulle Imprese; nella quinta si ipotizza che il livello di convinzione delle imprese ad investire sia espresso in base al prezzo ed in ultimo viene considerata la detrazione fiscale come elemento essenziale per la presa di decisione nell'effettuare l'investimento. Si ipotizzano tre opzioni temporali nei quali sia possibile considerare come sia più conveniente tale detrazione.

Prima di entrare nella spiegazione dei modelli è importante precisare che i modelli di stima devono essere effettuati su grandi numeri, ed utilizzando nel presente lavoro soltanto i parametri rilevati dai 20 questionari si utilizza il metodo delle repliche bootstrap, per generare 10.000 repliche dei parametri adoperati nella regressione, da utilizzare nella costruzione del modello.

Nelle assunzioni si prende in considerazione il processo di formazione e come possa influire sulla domanda e sull'offerta di interventi in Efficienza Energetica. Per analizzare tale rapporto è effettuata un'analisi costi–efficacia implementata con un semplice modello di Markov (Pintacuda, 2000), che è visibile graficamente nell'albero decisionale. Il modello di Markov è un modello stocastico che descrive attraverso le probabilità le cause che portano da un caso all'altro del sistema. In sintesi il modello di Markov modella comportamenti stocastici di un sistema in cui gli stati sono osservabili ed espliciti. Nell'albero decisionale è possibile osservare le possibili decisioni da prendere all'applicazione della policy di formazione in rapporto alla politica di detrazione fiscale.

Nell'albero decisionale, della Figura 1, sono riportate le tre policy considerate suddivise in tre diversi periodi di detrazione fiscale. Per ogni opzione è considerato il numero totale di interventi in efficienza energetica

effettuati ogni anno in uno scenario fissato a 15 anni, e osservando due opzioni: nuova formazione, oppure no. I diversi periodi di detrazione fiscale considerati sono 5, 7.5 e 10 anni. I periodi di detrazione fiscale sono stati stabiliti in base al vecchio periodo (5 anni), attuale periodo (10 anni) e media aritmetica dei due.
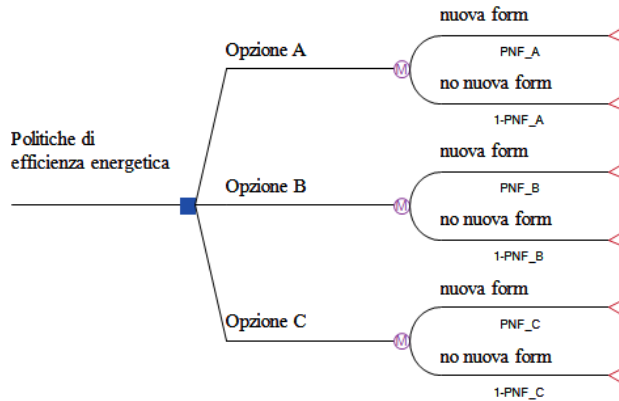
Figura 1   Albero decisionale di valutazione delle policy di formazione in efficienza energetica (elaborazione dell'autore).

Il costo totale dell'opzione di policy adottata è calcolato moltiplicando le nuove imprese formate (probabilità di nuova formazione * popolazione imprese annua considerata) per il costo della medesima, considerando il costo medio registrato per la Regione Lazio (circa 1000 euro).

Le imprese esaminate sono quelle della provincia di Roma, che sono pari a 19.115. Questo numero rappresenta il potenziale numero di imprese attivabile, ma non coincide, con il numero di imprese effettivamente attive nell'anno in questione, se fosse così vi sarebbero molti più interventi di quelli che effettivamente sono stimati. Questo però sarebbe il numero delle imprese da formare ogni anno e pertanto, se ogni impresa prendesse parte a corsi di formazione almeno una volta l'anno nei 15 anni considerati la popolazione annua di imprese su cui calcolare ogni anno nuova possibile formazione corrisponderebbe a 1278 unità.

Le imprese effettuano formazione nel momento in cui vi sono degli incentivi per la formazione e nel momento in cui è anche associata una politica di detrazione fiscale. Sarebbe necessario capire come le due politiche si relazionino. Un breve periodo di detrazione fiscale può non spingere le imprese verso una formazione poiché entra in gioco il meccanismo di mercato che muove i soggetti ad effettuare delle azioni, in

questo caso tese alla riqualificazione energetica degli edifici. Infatti, grazie ad un piccolo meccanismo di mercato è possibile muovere sia la domanda che l'offerta in un solo momento.

Il numero di nuove imprese formate è stato stimato moltiplicando la probabilità di nuova formazione per le imprese disponibili alla formazione nell'anno corrente.

Il numero totale di interventi realizzati, che si ipotizza siano il prodotto dell'attività di formazione è considerato medesimo al grado di convinzione dei formatori per il numero di nuove imprese formate. Non è facile dimostrare con i dati e l'ipotesi che la formazione produca consapevolezza economica e spinga le imprese a guadagnare mercato abbassando i prezzi stimolando così la domanda. Con tale ragionamento è possibile ipotizzare che i nuovi interventi siano da attribuire alle manovre di prezzo effettuate dalle imprese.
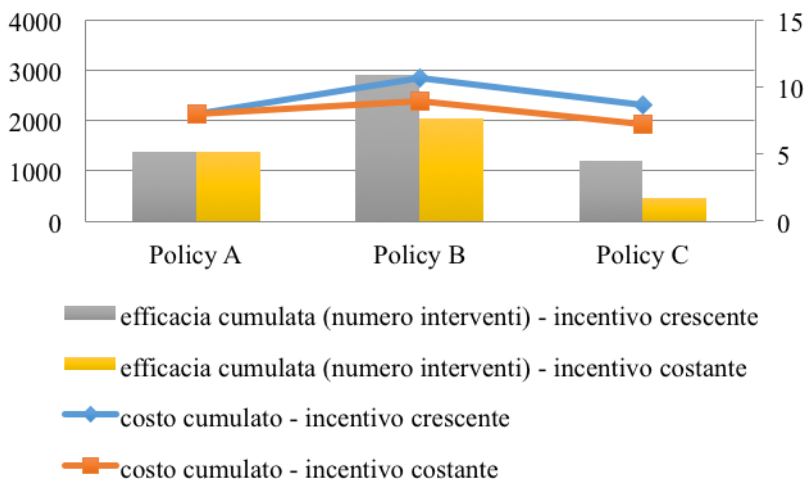
Figura 2   Costi (milioni di euro) ed efficacia (numero di interventi in migliaia) per le policy di formazione considerate sotto due diverse ipotesi di incentivo in un orizzonte temporale di 15 anni.

Come è possibile osservare dalla figura 2 analizzando le tre policy considerate nei differenti periodi, generano, rispettivamente, un totale di 1.383, 2.897 e 1.183 nuovi interventi nell'arco dei 15 anni presi in ipotesi. Il dato di costo medio dell'intervento per la provincia di Roma fornito dall'Unità dell'Efficienza Energetica dell'Enea, ed è pari a 8357 euro. La

figura 2 è ottenuta calcolando il numero degli interventi nel loro valore economico e sottraendo da tale valore il costo delle politiche di formazione ipotizzate. La figura mostra come al mutare dell'incentivazione per la politica si modifichi anche la propensione all'investimento in interventi per l'efficienza energetica. La policy A, ha lo stesso risultato poiché l'incentivo costante ha lo stesso valore dell'incentivo crescente. La durata della detrazione fiscale in 5 anni produce il medesimo risultato poiché è un incentivo di breve periodo.

Osservando le policy B e C, è possibile notare che con il crescere del tempo dell'incentivo diminuiscono gli interventi in efficienza Energetica. La diminuzione degli interventi avviene sia poiché vi è un esaurimento della policy sia poiché sono rimasti pochi soggetti a dover investire in interventi di Efficienza Energetica. La policy B è quella che ha un maggior risultato sia con un incentivo crescente sia con un incentivo costante. Nel medio periodo si osserva una crescita degli investimenti sia poiché si ha un incentivo crescente in un periodo maggiore sia poiché una buona policy della formazione conferisce sia alla offerta la propensione all'investimento.

Concludendo è possibile affermare, con l'utilizzo di dati Istat ed Enea, che la sola policy dell'efficienza energetica da sola non basta ma necessità di politiche che incentivino il suo sviluppo. Investire su attività di formazione comporta un aumento dell'attività di riqualificazione soprattutto se sostenuta e coadiuvata da incentivi. La crescita della propensione all'investimento in interventi si traduce in valore economico generato, risparmio energetico e impatti economici generati da esso, e impatto ambientale (diminuzione CO_2).

Il semplice modello utilizzato nell'analisi è soggetto di numerose e qualificanti integrazioni.

Sarebbe opportuna, ed è in lavorazione, una più raffinata analisi che ha come intento un'indagine a maggiore significatività statistica, rispetto all'esperimento qualitativo condotto, che ha il compito di manifestare il legame tra attività di formazione e dinamismo delle imprese sul mercato. L'azione della formazione ha come ruolo focale l'implementazione della policy dell'Efficienza Energetica. Ed è incentivando formazione ed agendo su di essa che sia possibile per il decisore politico raggiungere non solo gli obiettivi prefissati dall'Unione Europea ma anche generare crescita e sviluppo economico e sociale.

I modelli sono strumenti di analisi del reale poiché lo rappresentano in modo efficace e sintetico e possono essere un buon ausilio al decisore politico sia nel prendere buone decisioni sia nel monitorare il suo operato.

Il lavoro nasce come un esercizio metodologico di analisi, certo le asserzioni fatte non possono essere convalidate poiché non si hanno dati statistici che ne possano dimostrare la significatività, l'intento è stato quello di mostrare come la formazione sia un possibile strumento di mutamento, poiché con l'educazione dei differenti attori si modifica il sistema sociale. La formazione in rapporto al settore edile ha come scopo produrre investimenti, ossia la crescita degli investimenti comporta una maggiore disponibilità economica dei soggetti, una equità sociale e miglioria economica e sociale. Il significato di investimento non è soltanto economico ma ha anche un peso sociale: compiere delle scelte per creare. Il ruolo della formazione è creare soggetti che sappiano compiere delle scelte consapevoli, che sappiano che le azioni hanno delle motivazioni che mutano l'assetto sociale.

Bibliografia

Borrelli, G. (a cura di) (2015) *La Scienza Ambientale. Un Manuale per prendere Buone decisioni*. Roma: Enea.

Carrosio, G. (2014) Energia e scienze sociali: stato dell'arte e prospettive di ricerca. *Quaderni di sociologia*, 58 (66), 99–108.

Commissione europea (2015) *Le politiche dell'Unione europea: Energia. Unione Europea*: Lussemburgo, Belgio.

Commoner, B. (1976) *The Poverty of Power. Energy and the Economic Crisis*. New York: Knopf.

Commoner, B. (1980) *The Politics of Energy*. Milano: Garzanti.

Cubeddu, F. e Rao, M. (2016) Simulazione di un'analisi costi–efficacia per la provincia di Roma nel settore della riqualificazione energetica degli edifici. *ENEA Magazine. Energia ambiente e innovazione*, 2. [Online] http://www.enea.it/it/pubblicazioni/EAI/anno–2016/n–2–aprile–giugno–2016/simulazione–di–un2019analisi–costi–efficacia–per–la–provincia–di–roma–nel–settore–della–riqualificazione–energetica–degli–edifici [Accesso: 10 Aprile 2017].

Direzione Affari Economici e Centro studi (a cura) (2015) *Osservatorio Congiunturale sull'industria delle costruzioni*. Roma: ANCE.

Efron, B. e Tibshirani, R. (1993) *An Introduction to the Bootstrap*. Boca Raton: Chapman & Hall/CRC.

Enea (2014) *Piano d'Azione Italiano per L'Efficienza Energetica*. Roma: Enea.

Enea–UTEE (2015) *Rapporto Annuale Efficienza Energetica–RAEE*. Roma: Enea.

Energy Lab (2014) E*fficienza Energetica: governance, strumenti e mercato*. Milano: Ediplan editrice.

EPEE (2010) *Fuel Poverty ed efficienza energetica in Europa*. Progetto co–finanziato nell'ambito del Programma 'Energia Intelligente per l'Europa'. [Online] www.precarité–energie.org [Accesso: 10 Aprile 2017].

Formedil (2014) *Rapporto 2014. Le costruzioni di fronte alla sfida del cambiamento. Una nuova stagione per la formazione in edilizia*. Roma: Formedil.

Frick, K. (2007) *Cost Benefit and Cost–Effectiveness Analysis*. [Online] http://ocw.jhsph.edu/courses/hsre/pdfs/hsre_lect13_frick.pdf [Accesso: 10 Aprile 2017].

Giddens, A. (2015) *La politica del cambiamento climatico*. Milano: Il Saggiatore.

IEA (2014a) *Capturing the Multiple Benefits of Energy Efficiency.* Paris, France: International Energy Agency.

IEA (2014b) *Energy, Climate Change and Environment*. Paris: Insights IEA. Available from: https://www.iea.org/Textbase/npsum/EECC2014sum.pdf

IEA (2014c) *Energy Efficiency – Essentials for Policy Making*. Paris: IEA. [Online] https://www.iea.org/publications/freepublications/publication/IEA_EnergyEfficiencyIndicators_EssentialsforPolicyMaking.pdf [Accesso: 10 Aprile 2017].

IEA (2015) *Transition to Sustainable Buildings – Strategies and Opportunities to 2050*. [Online] https://www.iea.org/media/training/presentations/etw2014/publications/Sustainable_Buildings_2013.pdf [Accesso: 10 Aprile 2017].

IEA (2016) *Energy Efficiency. Market Report2016*. Paris, France: International Energy Agency.

Illich, I. (1973) *Energy and Equity*. London: Marion Boyars.

Lawson, B. (2004) *What Designers Know*. Oxford: Architectural Press.

Lorenzoni, A. (2012) *Il risparmio energetico. La più economica tra le fonti di energia*. Bologna: Il Mulino.

Pareto, V. (1988) *Trattato di sociologia generale*. Torino: Unione tipografico–editrice torinese.

Pennisi, G. e Scandizzo, P.L. (2013) *Valutare l'incertezza. L'analisi costi–benefici nel XXI secolo*. Torino: Giappichelli.

Pintacuda, N. (2000) *Catene di Markov*. Pisa: ETS.

Ryan L. e Campbell, N. (2012) Spreading the Net: The Multiple Benefits of Energy Efficiency Improvement. In *IEA Insights Series 2012*. Paris: OECD/IEA.

Zélem, M.C. e Beslay, C. (a cura di) (2015) *Sociologie de l'énergie. Governance et pratiques sociales*. Paris: CNRS Edictions.

Geo–Speculating with a Hyperaccumulator: A Former Mine in North–Rhein Westfalia from the Viewpoint of a Arabidopsis Halleri

Gionata GATTO[*a]

[a] Loughborough Design School

This paper considers a series of field–work activities conducted at the intersection of three main subjects: a speculative design installation, a plant ecotype of the hyperaccumulator Arabidopsis Halleri and a heavy metal–contaminated site located in North–Rhein Westfalia, Germany.

The paper offers a 'geo–speculative' (Gabrys, 2016, p. 139) account of a brownfield, considering how vegetal agency might open onto alternative opportunities of becoming for a polluted territory. At the core of this work is the question of how an empirical approach towards research in multispecies environments allows for a transdisciplinary mode of site–writing and can be used as ground for speculating about the future of a land. Ultimately, while reflecting on the imbroglio of scientific, ecological and speculative elements explored during the research, this work proposes that a science–informed 'act of viewing' vegetal life (Gabrys, 2012) can support the exploration of more–than–human functions and motivate the emergence of speculative processes associated with past and futures of an anthropized environment.

Keywords: *Geo–speculating; multispecies ethnography; speculative design; agency; sensing technology*

Geo–speculating with plants as a form of agency–giving

Post–industrial brownfields are delimited geographical areas whose reuse is complicated by the presence of hazardous materials (EPA US Environmental State Agency, 2009). Their history of abuse subjects them to

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[*] Corresponding author: **Gionata Gatto** | e–mail: **hello@gionatagatto.com**

pre–established protocols, consisting of practices that determine not only current uses, but also the future of these lands. This is especially true for areas contaminated with heavy metals. While in fact remediation technologies, for most of organic debris, are associated with practices of soil transformation, removal or immobilization (Zerbi and Marchiol, 2004, p. 17), any terrain that contains heavy metals needs to be mechanical excavated and treated ex–situ. These protocols often result in economically unpractical investment projects, unless in the presence of real estate development plans, a path that formalizes the destiny of metal–polluted brownfields. Such territories remain largely unused unless designated to the construction industry, which benefits from the value of a cleaner soil, especially in terms of raise in land value of the entire area (Haninger, Ma and Timmins, 2012). In a western culture where values are firmly oriented toward science, technology and economic profit (Davis–Floyd, 1992) defining a contamination purely as an object of technological domain frees soil engineers from any sense of responsibility for the ecological histories of adaptation and modes of cohabitation that evolved over time on polluted sites.

This paper reports on research that engages the support of an 'actor' who brings along its own perspective about the notion of environmental contamination, namely a species of metal–hyperaccumulator plants. Hyperaccumulators are studied within the natural sciences for their efficiency at absorbing heavy metals from polluted soil and accumulating these elements within their tissues and leaves (Plessl et al., 2005; Van Der Ent et al., 2015; Visioli and Marmiroli, 2013). The accumulated metals can then be extracted by harvesting the leaves and burning the biomass, a process known as 'Phytomining' (Brooks et al., 1998). Instead of providing an account of hyperaccumulators focused on sustainable soil management, this work engages plant's life from a sociocultural perspective. The ability of these plants to colonize contaminated areas depends on their ability to evolve ecotypes that tolerate heavy metals (Bert et al., 2000), a feature that constitutes the process of metal–uptake into a form of vegetal agency. Accordingly, agency in hyperaccumulators involves aspects such as their ability of 'witnessing' histories of human transitions on a land and the notion of cross–species evolution in multispecies environments. From a sociological perspective, however, brownfields remain socially constructed milieus whose forms, processes and materialities are strictly interwoven to the public perception of risk. Soil pollution produces neglected land, whose invisible hazardousness has the effect of originating emotional concerns

(Grasmück and Scholz, 2005), biases and 'myths' related themselves to the notion of contamination. Contaminations from heavy metals belongs to those sorts of environmental issues that rarely become actionable precisely because visually untraceable, unless by means of laboratory analysis. In a recent essay, Jennifer Gabrys (2016, p. 139) documents the emergence of explorative practices of environmental sensing oriented to visually identifying formations of invisible debris in the environment, arguing that such processes contribute to the production of geo–speculations, a term adapted from Vitaliano's notion of geo–mythology (Vitaliano, 1973).

In exploring the multiple entities that constitute a contamination and the possible forms that they could take, this work proposes that a geo–speculative account of a brownfield that considers vegetal agency might open onto alternative opportunities of becoming for those lands that overtake a technocratic approach to the issue of contamination. In this work the notion of geo–speculation refers to a mode for exploring vegetal agency by means of a speculative practice of value seeking in a metal–contaminated territory. The case study presented here involves three main 'actors'. The first is *Geomerce* (Marelli, 2015), a design installation presented in Dusseldorf in occasion of the NRW forum, which features a sensing technology tracking the real–time extraction performance of selected hyperaccumulators. The second is a German ecotype of the hyperaccumulator *Arabidopsis Halleri*, which grows on a metalliferous site located in North–Rhein Westfalia, Germany. The third is the actual site hosting the groups of plants, which is a former mine used for extracting Zinc until the second half of the 20th century.

Geomerce, a project at the intersection of plant physiology, finance and a sensing technology

This section introduces Geomerce (Marelli, 2015), a project from the author and designer Giovanni Innella. Designed to be used as an itinerant installation, Geomerce (see fig. 1) engages the behaviour of selected hyperaccumulator plants to re–think the hypothetic value of an agricultural practice. Since many of the heavy metals absorbed from these plants are in fact listed on international markets, fields and crops in this project are proposed as living financial assets and reservoirs of capitals. The objective of Geomerce consists of drawing a hypothetic scenario in which agriculture blurs with economy and farming decisions are the result of the collaborative entanglement of plants, finance and scientific progress. Presented for the

first time on the occasion of the Milan Design Week (2015) and proposed again in June 2016 for the NRW design event in Dusseldorf, Geomerce is usually composed of four main elements, two of which are here considered relevant for the purposes of this work. The first element is a series of extraction units that embeds a dedicated sensing technology capable of tracking in real–time the quantity of metal absorbed by selected groups of plants, whose roots are immersed in a hydroponic solution. Each of the units is designed to accommodate a vegetal ecotype and a solution of water mixed to a given quantity of the metal accumulated from the plant. The amount of metal absorbed from each plant's group is subsequently crossed with the real–time value of that metal in the market, using data extracted from the London Metal Exchange (LME). As a result, the value of the plants varies constantly according to both, the value of a metal and the plants' accumulation performance. The resulting data, which arguably represents the real–time financial value of the plant, is then transmitted to the second element of the installation, that is, a series of circular plotting units. Each plotter drafts a graph consisting of three data: the amount of metal absorbed from the group of plants, the real–time value of the metal in the market and a digit that assembles these two data. The latter, which is drawn hourly, expresses the speculative value–per–year of a hectare of plants according to the real–time extraction performances sensed during the course of the installation.

Figure 1   The setup of the installation Geomerce (2015) at the Milan Design Week.

Ultimately, the goal of GeoMerce is to communicate the speculative potential hidden in the metal–intake behaviour of plants, sparking simultaneously a methodological debate concerned with the meaning of interspecies engagements in situated anthropized environments.

A laboratory encounter with Arabidopsis Halleri

This section provides a descriptive account of the author's first encounter with a species of hyperaccumulators that belongs to the family of Brassicacee: *Arabidopsis Halleri*. This was organized in the form of a visit to the dept. of plant physiology of the Ruhr–Universität Bochum, in Germany and took place on the afternoon of May 19th 2016. The department has an international reputation for its expertise in the field of plants' metal–uptake, particularly in relation to scientific work conducted on the Halleri. The scope of the visit, from the author's perspective, were mainly three: gain some physiological understanding of the species and learn to identify it in its natural environment; understand how vegetal specimens are selected and sampled; obtain information about contaminated sites dislocated in the area of North–Rhein–Westfalia. From the perspective of the laboratory, this meeting was viewed mainly as an opportunity to discuss possible uses associated with a sensing technology and its transition from a speculative context into a mode of laboratory research. This work shades light mainly onto the author's research objectives, particularly the phases oriented to support the observation of vegetal life and discuss how an 'act of viewing' could motivate the exploration of speculative more–than–human functions.

On the walls of the department's entrance, where the visit began, several photographs of Halleris, each portrayed within its environment, depict different vegetal ways of co–inhabiting ecological niches, such as former industrial sites, mines, pits, but also serpentine soils, like those naturally present in areas of Cornwall and other European countries. The co–habitation, in this case, is to be interpreted as a mode for witnessing not only a space, but also a time, that is, a past that becomes witnessed by means of a hyperaccumulator's condition of existence. Similar modes of living together are the subject of analysis in Multispecies Ethnography (Kirksey and Helmreich, 2010; Kirksey, Schuetze and Helmreich, 2014), whose focus is on the entanglements of interactions and relations existing between human disturbances and entities such as fungi (Tsing, 2010), plants (Gabrys, 2012), animals (Haraway, 2007) or bacteria (Lowe, 2010). The department Director introduces the work of the lab, focusing on the

diversity of aspects composing Halleris' life. The plant is a hyperaccumulator of Zn and Cd and grows in areas polluted with heavy metals deriving particularly from industrial uses. Noteworthy, here, is the explanation of a recent work, which explored a plant's defence hypothesis, that is, a meaning standing behind Halleri's process of metal intake. Recent experiments demonstrated in fact that the accumulation of Zinc and Cadmium is ecologically beneficial for many ecotypes of this plant. The Hamburg accession, for instance, employs the toxicity resulting from the combination of metals as a mode of defence from the feeding action of lepidoptera *Pieris Napi*, sawfly *Athalia Rosae* and the insect *phaedon cochleariae,* enhancing at the same time the elemental defence of the ecotype (Kazemi–dinan et al., 2014). The resilience of Halleri is thus associated to its situated modus operandi, itself constrained not only to the anthopogenic disturbances of the territory, but also to the climate, the interaction with other species such as animal and insect and the conformation of the plant –whose roots rarely exceed the depth of 20–30 cm. The bodily shape of the plant, especially the root apparatus, articulates itself specific affordances, it is the way exploited from the plant to draw the boundaries of an ecology that is situated within the spectrum of a broader ecology. In order to experience some actual vegetal life, I am accompanied to visit the laboratory, part of which is used as a cultivation area. Here theory becomes an empirical introduction to the concept of biodiversity, which often occurs when plants are discussed in relation to their environment. Inside the lab, arranged in rows, at least two–hundreds different ecotypes of the plant are labelled one by one, each with a tag featuring a symbol, a date of collection and the provenience of each specimen (fig. 2). German, Austrian, French, Italian ecotypes grow here as more–than–human witnesses of the different disturbances emerging from the past of very situated places. The identification of Halleri in the environment, as one scientist explains, does not always require a close viewing, as this species can colonize its territory, to the point of becoming ubiquitous within certain areas and conditions.

Figure 2 Two specimens of A. Halleri from the lab of plant physiology, Ruhr–Universität Bochum.

As for most of plants, size is one of the features that qualify the well–being of a specimen: as bigger as the plant is, as better are its growth and reproduction conditions. An examination of Halleri's roots shows also that those plants propagate not only vertically, but also horizontally. On the roots are positioned the gems of the plant, serving the reproduction, a vegetal feature that contributes to Halleri's perennial life, since winter makes survival easier at the ground level and the resources can be economized in preparation for the spring. At the same time, winter makes Halleri's body dwindling to the point of becoming difficult to localize, which is one of the reasons why this visit to the lab happens in May and not earlier. Laboratory life, if you will, for plants is different from that of a real environment. As such, even though I am offered some vegetal 'clones' for my investigation, we ultimately end up discussing actual sites, with a focus on North–Rhein–Westfalia. Together with the laboratory Director, we identify a site located 100 Km away from the department, known from the scientists to guest a population of the hyperaccumulator. The motivation of proximity to the laboratory had here strategic purposes. It was interest of the author to shade light onto the mechanisms through which a speculative design installation could link plant physiology studies, a contaminated site and the public perception of value within the relation human–land–plant.

GIONATA GATTO

GoogleEarth and map overlaying: assemblying a hyperaccumulator's geo–historical account

The prospect of embarking on an ecological journey to hunt hyperaccumulators in a contaminated site presented a series of dilemmas from the planning phase: how to geo–locate the area, identify the Halleris and draw a link between those plants and the temporalities of their land? Geo–speculating with those hyperaccumulators and their territory involved here two succeeding phases. The first, analysed in this section, took place before visiting the site and consisted in anticipating plausible geographical positions for the different populations of hyperaccumulators, scripting this way a path to walk across the land; the second happened on–site and was concerned with the identification of a mode to empirically explore the relations between a plant population and the existing contaminants.

The information gathered in the laboratory included descriptions concerning the territory, its GPS position and the characteristics of the place where the presence of Halleri's was previously recorded. A web research, conducted at a later stage to collect supplementary material, reveals that the site is a former mine, built in the 19th century for the extraction of Zinc and currently contaminated with several heavy metals. The supplementary support of an old mine's plan adds visual data concerning the spatial extension of the mine's former extraction apparatus. On the map, written descriptions usefully articulate the proliferation of human activities occurred during the flourishing years of the mine. The indications specify the position of the froth floatation's zone, used to chemically separate the minerals; the thickening zone, where a gravity–based process divided selected particles from a liquid element; a tailings zone, used for the sedimentation of the post–processed mineral. The use of Google Earth –a visual and web–based geographical information program, positioned over the coordinates received from the university, offers simultaneously an aerial perspective of the entire area, disclosing what currently remains of the ancient mine. The program features a function of map overlay, allowing the superimposing of different thematic maps into a single mode of visualization. Introduced from landscape architect Ian McHarg (McHarg, 1992), the method of map overlay is an instrument designed to originate graphical models of geo–spatial content and mainly used to visualize alternatives in the configuration of space.
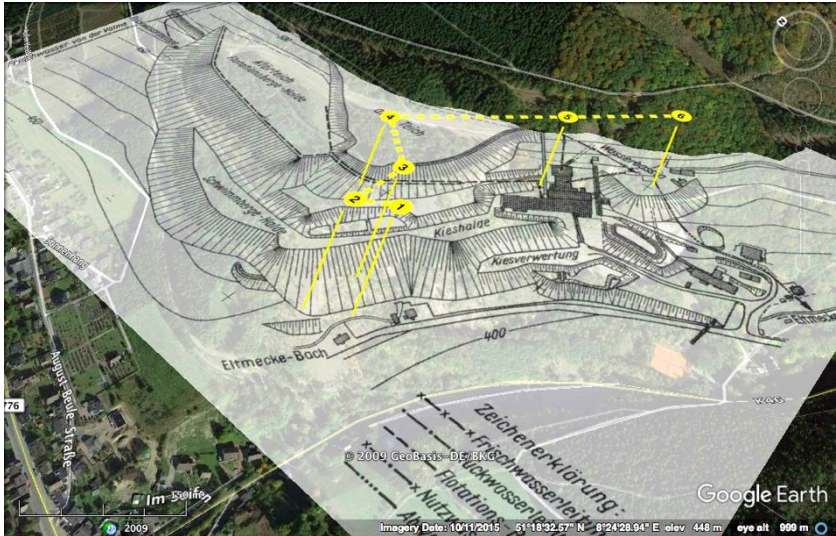
Figure 3 Map overlay on GoogleEarth, including the old mine planimetry.

The support of Google Earth, combined to the process of map overlay, proves here to be particularly useful as it enables to display both, that the territory of the mine has actually returned to be entangled with nature, and that its current spatial morphology still reveals part of its former functional settings. Such processes of visual assemblage of the site's history coupled with its actual geography, formed the basis of a scheme to begin an investigation across the multispecies territory and processes of the mine (fig. 3). It is from here that the physical exploration of the site begins.

From the lab to the site: following Halleris to retrace the story of a mine.

'How can we expect to appreciate more–than–human sociality if we can't get around the limitations of specifically human knowledge?' (Tsing, 2013, p. 28)

In this section I discuss an empirical account of my explorative path within the area of the former mine, in the perspective of drawing a rationale behind that journey in a multispecies ecology. My movements across the land were inspired from the work of Tsing and her writings on the concepts of 'Assemblages' and 'Bodily Forms' (2013, pp. 31–32), which Tsing uses as

ethnographic concepts for understanding the societies of mushrooms as exemplars of more–than–human collectives. Both notions became particularly helpful to perform the sampling of some hyperaccumulators across the ecosystem of the mine, of which this paper reports some of the key passages.

The period in which the walk took place was middle June 2016, a month in which the Halleri, according to the laboratory, should be distinguishable in the natural environment, its body well exposed with a bloom of small white flowers. Although a metal bar partially restricts accesses, most of the entry points of the mine are open to pedestrians, as a result of the land forming now part of a mining trail (Sauerlaender–Besucherbergwerk, 2010). Both, photographs of Halleris taken in the lab and the mine's planimetry support my walk, which benefits at the same time from the aid of mobile GPS. My work of plant shadowing starts from the main entrance, from where a gravel path links together the various areas of the mine. From there I head north–west, towards a zone denominated *Schwimmberge–Halde*, that forms part of the former mine's basins. Here the morphology of the terrain comprises a sloping ditch, whose entire bed is constellated with a lush group of hyperaccumulators. The closer I get, the more I realize that some of these 'specimens', compared to the ones seen in the lab, feature larger leaves, most of which shade from green into purple tones. This is particularly observable on those individuals that have a greater biomass compared to most of the other plants, as if their longer persistency on the ditch procured them this sort of aesthetic detail. What are the reasons for this oversized plants to feature this colour in such a delimited niche of land? Moreover, the hyperaccumulators that live there look extremely healthy and feature undamaged leaves as if the presence of other vegetal, insect or animal life could not influence their well–being. A causal connection between the geography of this place –where years of rain's drainage descending from the overhanging hill may have saturated the ditch bed of Cd and Zn and the healthy shape of the hyperaccumulator emerges as a possible hypothesis of more–than–human relations. Rather than focusing on the scientific reliability or efficacy of such hypothesis, what gains relevance here is another kind of empirical evidence brought about from the hyperaccumulator's condition of existence, in that being there the plant unequivocally witnesses, expresses and responses to its circumstances (Brenner et al., 2006). Throughout this walk, the act of viewing therefore becomes entangled with speculative practices about formulating hypothesis that cannot be empirically verifiable on–site, but have the advantage of

opening onto the agency of these vegetal organisms (Gabrys, 2012, p. 2929). To a certain extent, it is the very incompleteness of this practice that motivates the exploration of speculative hypothesis and supports my movements across this territory.

Figure 4   The location of the first sampling.

I decide to photograph the area, geolocate my position and sample a couple of specimens. The sampling procedure mirrors that seen in the lab's greenhouse, even though here I make use of commercial yellow tags, where I annotate information such as GPS coordinates, location's descriptions and the physical aspect of each sample (figg. 4 and 5). Whilst I dig the terrain of the ditch, using gloves as a precaution to avoid exposure to metal contaminants, I annotate that the soil here is soft, dark and damp and that the roots of the plant extend further than usual, sometimes reaching a depth of almost 30 cm.

Figure 5   Sampling protocol: GPS tagging and manual digging of a specimen.

From the area of the former pools, I move South, following a narrow green trail and enter another zone of the former mine apparatus, still part of the *Schwimmberge–Halde* and yet different from the previous location. The territory here features a wide sloping meadow, fully covered with another

group of Halleris. These plants are smaller, and yet distributed everywhere across this side of the hill (fig. 6), carpeting the land of dense white spots. The constant exposure to the sun of these individuals does not seem to help growth, in fact the height of these specimen ranges between 15 and 25 cm, with shoots that are still small, or at least smaller than in the previous location. Observing this place, the impression is that these Halleris colonized the entire area, playing a central function in its ecology, being that, apart from a few taller plants, nothing else is similarly distributed. I lay down and sample a specimen. The soil is brown and drier than the previous, and the root's apparatus of the sample looks underdeveloped compared to the other, with depth reaching a maximum of 15 cm. The roots however developed horizontally rather than vertically and their extension is entangled with the body of adjacent Halleris, to the point that it becomes difficult to identify where an individual ends and another begins. This sharing of roots might explain the ubiquity of the hyperaccumulator, in a zone where a combination of moisture's lack, sun's exposure and contaminants do not facilitate its vegetal growth. There seems to be no dominancy, but a sharing of available resources happening underground, throughout organisms and entities composing the soil of the meadow.

3
GPS:
51°18'33.7"N
8°24'19.1"E

Former Mine Zone:
Base of the mine

Plant Aspect:
small body size (H 15-25 cm.); small green leaves (15-25 mm);

Figure 6   The Schwimmberge–Halde, location of the third sampling.

Once the sampling is complete I walk uphill towards a tailings zone where post–processed material was accumulated during years of mining practise (fig. 7). Here, the population of Halleri is distributed non–homogeneously between the leftover rocks scattered on the hillside, technofossil records (Zalasiewicz et al., 2014) of past land functions. The Halleris that I sample here are rooted halfway on soil and leftover rocky debris. I pull out a specimen anchored halfway between the terrain and a rock and observe the extension and composition of root apparatus, even though aware that what I wish to see cannot come through by a simple act

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of viewing. On the rhizosphere of Halleris in fact, metal–tolerant bacteria play important roles in improving the fitness of the ecotype associated to the extraction of Zinc and Cadmium (Farinati et al., 2009). The root apparatus of this species cooperate with at least six different species of metal–resistant bacteria that promote the growth of the plant, enhancing the solubility of the metal and thus the uptake process. Those communities of bacteria, which are unique for each hyperaccumulator species and their environment, contribute to define the ecotype of each of these plants.

Figure 7   The tailing zone.

At completion of the sampling procedure, the vegetal specimens were moved into the functional settings of Geomerce and their extraction performance proposed within the context of a 4–days event that took place in Dusseldorf. Even though this work does not reflect on the outcomes of the ISE's sensing practice, it seems relevant to briefly report about the graphics printed during the course of the installation from the mechanical plotters. Crossing data from the collected Halleri's performances with the size of the area and real–time value of Zinc in the LME produced a series of numeric values that functioned as a geo–speculative mode of visualization for the hidden value of the mine's ecology, in the context of a future agro–financial economy. Such way of experiencing data for the audience of the installation opened up to a further series of debates and activities, facilitating the discussion of possible opportunities of becoming for that territory.

Conclusion

In this paper I have focused on a particular instance of human–plant engagement, reflecting simultaneously on possible ways of writing about

vegetal agency in disturbed territories. The notion of geo–speculation that I have introduced is intended as a process of exploring and examining possible futures associable with multispecies geological phenomenon that has driven the series of field–work activities connected to my journey across the land of a former mine. The research process presented here revealed how geo–speculating can be also understood as an act of anticipating and conducting research across multispecies territories, transdisciplinary practices and modes of vegetal being. Visualization software programs involving GIS (Geographic Information Systems) for instance, coupled with modes of map overlay demonstrated the potential of revealing infrastructures of not–yet–visible territories and drawing temporal associations across times and spaces. On–site, ethnographic practices driven from 'acts of viewing' (Gabrys, 2012) motivated the emergence of speculative hypothesis that embedded the potential of opening onto the notion of plant agency. I argue that the intrinsic methodological incompleteness of such practice, rather than being interpreted as a limitation, should be viewed as an opportunity for occasioning the understanding of more–than–human processes and supporting ways for exploring multispecies narratives. Finally, the described cross–disciplinary collaboration with a laboratory of natural sciences, whose proximity to the exhibition venue and land under question were chosen as two fundamental prerequisites, arguably facilitated a process of synthesis of situated science and its territorialization within the framework of a speculative design installation.

Acknowledgements

References

Bert, V., Macnair, M.R., De Laguerie, P., Saumitou–Laprade, P. and Petit, D. (2000) Zinc Tolerance and Accumulation in Metallicolous and

Nonmetallicolous Populations of Arabidopsis Halleri (Brassicaceae). *New Phytologist*, 146 (2), 225–233.

Brenner, E.D., Stahlberg, R., Mancuso, S., Vivanco, J., Baluška, F. and Van Volkenburgh, E. (2006) Plant Neurobiology: An Integrated View of Plant Signaling. *Trends in Plant Science*, 11 (8), 413–419.

Brooks, R.R., Chambers, M.F., Nicks, L.J. and Robinson, B.H. (1998) Phytomining. *Trends in Plant Science*, 3 (9), 359–362.

Davis–Floyd, R.E. (1992) *Birth as an American Rite of Passage*. Berkeley: University of California Press.

EPA US Environmental State Agency (2009) *Brownfields* [Online] Available from: http://www.epa.gov/oswer/international/factsheets/200906_eu_soils_contamination.htm [Accessed: November 3rd, 2016].

Farinati, S., DalCorso, G., Bona, E., Corbella, M., Lampis, S., Cecconi, D., Polati, R., Berta, G., Vallini, G. and Furini, A. (2009) Proteomic Analysis of Arabidopsis Halleri Shoots in Response to the Heavy Metals Cadmium and Zinc and Rhizosphere Microorganisms. *Proteomics*, 9 (21), 4837–4850.

Gabrys, J. (2012) Becoming Urban: Sitework from a Moss–eye view. *Environment and Planning A*, 44 (12), 2922–2939.

Gabrys, J. (2016) *Program Earth. Environmental Sensing Technology and the Making of a Computational Planet.* Minneapolis: University of Minnesota Press.

Grasmück, D. and Scholz, R.W. (2005) Risk Perception of Heavy Metal Soil Contamination by High–exposed and Low–exposed Inhabitants: The Role of Knowledge and Emotional Concerns. *Risk Analysis*, 25 (3), 611–622.

Haninger, K., Ma, L. and Timmins, C. (2012) *Estimating the Impacts of Brownfield Remediation on Housing Property Values*. Durham: Duke University Press.

Haraway, D. (2007) *When Species Meet*. Minneapolis: University of Minnesota Press.

Kazemi–dinan, A., Thomaschky, S., Stein, R.J., Kramer, U. and Muller, C. (2014) Zinc and Cadmium Hyperaccumulation Act as Deterrents towards Specialist Herbivores and Impede the Performance of a Generalist Herbivore. *New Phytologist*, 202 (2), 628–639.

Kirksey, S.E. and Helmreich, S. (2010) The Emergence of Multispecies Ethnography. *Cultural Anthropology*, 25 (4), 545–576.

Kirksey, S.E., Schuetze, C. and Helmreich, S. (2014) Tactics of Multispecies Ethnography. In Kirksey, S.E. (ed.), *The Multispecies Salon*. Durham: Duke University Press.

Lowe, C. (2010) Viral Clouds: Becoming H5N1 in Indonesia. *Cultural Anthropology*, 25 (4), 625–649.

Marelli, C. (2015) Geomerce. *Domus* [Online] Available from: http://www.domusweb.it/en/news/2015/05/22/gionata_gatto_and_giovanni_inella_geomerce.html [Accessed: November 14th, 2015]

McHarg, I.L. (1995) *Design With Nature*. New York/Chirchester: Wiley.

Plessl, M., Rigola, D., Hassinen, V., Aarts, M.G.M., Schat, H. and Ernst, D. (2005). Transcription Profiling of the Metal–Hyperaccumulator Thlaspi Caerulescens (J. & C. PRESL). *Biosciences. Zeitschrift für Naturforschung C*, 60 (3–4), 216–223.

Sauerlaender–Besucherbergwerk (2010) *The Mining Trail*. [Online] Available from: http://sauerlaender–besucherbergwerk.de/index.php?option=com_sppagebuilder&view=page&id=38&lang=en. [Accessed: November 9th, 2016]

Tsing, A. (2010) Arts of Inclusion, or How to Love a Mushroom. *Australian Humanities Review*, 2 (50), 5–21.

Tsing, A. (2013) More–than–Human Sociality: A Call for Critical Description. In Hastrup, K. (ed.), *Anthropology and Nature*. New York/London: Routledge.

Van Der Ent, A., Baker, A.J.M., Reeves, R.D., Pollard, A.J. and Schat, H. (2015) Commentary: Toward a more Physiologically and Evolutionarily Relevant Definition of Metal Hyperaccumulation in Plants. *Frontiers in Plant Science*, 6, 554.

Visioli, G. and Marmiroli, N. (2013) The Proteomics of Heavy Metal Hyperaccumulation by Plants. *Journal of Proteomics*, 79, 133–145.

Vitaliano, D.B. (1973) *Legends of The Earth*. Bloomington: Indiana University Press.

Zalasiewicz, J., Williams, M., Waters, C.N., Barnosky, A.D. and Haff, P. (2014) The Technofossil Record of Humans. *The Anthropocene Review*, 1 (1), 34–43.

Zerbi, G. and Marchiol, L. (2004) *Fitoestrazione di metalli pesanti*. Udine: Editrice Universitaria Udinese.

#ViewFromTheOffice: Reconceptualizing the Workplace as a Cross–channel Ecosystem

Andrea RESMINI[*a], He TAN[a], Vladimir TARASOV[a] and Anders ADLEMO[a]

[a] Jönköping University

People work on their phones while commuting, on portable computers in coffee shops, or managing strategies on Facebook. Work hours' spill over evenings and weekends. Personal and company–sanctioned devices are used in combination. Generational gaps separate digital immigrants and digital natives and the way they project technology into their lives. The workplace identifies less and less a dedicated space: any place offering the right affordances is the right place for work.

This paper details a pre–study carried out in 2015 on public and private workplaces in Småland, Sweden. The study used contextual semi–structured interviews and ethnographic observation to capture processes and behavioral patterns with the aim of assessing the impact of technology on the workplace, describe challenges and opportunities. The study conceptualizes the workplace as a digital/physical ecosystem resting on three fundamental shifts: the design shift towards user experience; the cultural shift towards a connected society; the demographic shift towards Millennials and Gen–Zers. It identifies several technological, spatial, and organizational stress points, such as the reduction in private digital and physical space and the general misalignment and disconnection between digital and physical processes, and concludes with some general design observations.

Keywords: Workplace; user experience; cross–channel; ecosystems

Introduction

#ViewFromTheOffice is a well–known hashtag used to share pictures of one's current workplace on social networks such as Twitter or Instagram. These are usually photos of anything but what we would consider 'an office':

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hotel rooms, beaches, airports, gyms, trains, and planes are some of the places commonly featured. Nonetheless, these pictures do not lie: they are meant to capture and document a transient working space usually structured around some kind of portable technology, laptops, tablets, and smartphones, coupled with urban or mobile connectivity.

Undoubtedly, personal portable computing devices do not only allow us to capture different 'views from the office', or simply enable us to temporarily turn an airport chair into a meeting space, but are also themselves part of our work environment. We work in digital space, through software applications and processes, for a consistent part of the time. Technologies such as email have become central to most workflows, with data suggesting that employee perception is that of worsening conditions due to an increase in the workload because of them (Purcell and Rainie, 2014). Furthermore, as much as our 'offices' include public spaces such as airport lounges, our digital landscapes now include both organization–owned platforms and non–traditional calendaring and productivity platforms such as Trello or Slack, Git or Google Docs, which emphasize openness, distributed control, and the possibility of a constant public–private information flow that is not usually consistent with an organization's own walled garden.

Smart Housing Småland

In an effort to shed some light on what the workplace of tomorrow might become, the team conducted a 6–month pre–study research project on local small and medium enterprises (SME), partially financed by Smart Housing Småland (Resmini, 2016; Tan et al., 2015).

Smart Housing is a regional initiative in Småland, southern Sweden, which supports and researches both innovative and sustainable building solutions using traditional materials such as wood and glass, and 'smart' environments using technology to improve living spaces. Smart Housing emphasizes innovation and business development in small and medium enterprises, since these nationally dominate the relevant industries with a staggering 99.9% (Holmström, 2016), and pursues a long–term vision of being positioned as a leading international node in sustainable housing and building, reinforced through its consolidation of strategic global alliances in research, education, and market development.

While Smart Housing's starting point is existing excellence in the areas of wood and glass construction, digital technology, open innovation, and user–

centered design methods are strongly supported as central to meeting the future housing needs of consumers and advancing the architectural quality of the built environment.

Complexity and socio–technical change

The #ViewFromTheOffice pictures testify a change in the way we identify the workplace. Its boundaries are being renegotiated, both in space, where very often a single, identifiable location or physical 'office' does not contain or exhaust the entirety of work–related tasks and activities (Harrison, Wheeler and Whitehead, 2003), and in time, with work and leisure hours bleeding into an uneasily managed continuum, especially in the service industry. Through consumer–grade technology and the changes in turn the accepted use of such technology has produced in society, any place can be the workplace under the right circumstances. We work from home, we reply to mail on the go, we fill in spreadsheets on the beach, we conclude a deal at the airport. As a result, the spatial and temporal boundaries of the traditional workplace are changing.

The workplace also faces a demographic challenge as 'digital natives' start to work side by side with so–called 'digital immigrants' (Prensky, 2001). Millennials, those born 1980–1997 (Fry, 2016), are entering the job market. In a few years, Gen–Zers, born 1998 on (Edwards, 2015), will follow. These demographic groups draw no distinction between digital and physical (Floridi, 2016): their members grew up in a world where information circulates rapidly and effortlessly, where personal technology means iPhones, consoles, and wearable devices, and where communication means asynchronous, share–on–the–spot, technology–mediated informal exchanges (Smith, 2011). They consider digital a given, and they easily flow between public and private, the workplace and the home, often through a BYOD, bring–your–own–device, approach which can generate advantages, like employee satisfaction, productivity gains, increased flexibility, and, at times, reduced costs, but also present new challenges regarding security, device compatibility and support (Capgemini Consulting, 2013).

The workplace as an ecosystem

Working from theories of conceptual blending (Fauconnier and Turner, 1998), Benyon (2014, p. 95) has introduced the concept of blended space, defined as 'where a physical space is deliberately integrated in a close–knit

way with a digital space'. This blended space is a new type of space with its own emergent structure, offering a novel, different user experience. Benyon maintains that four basic characteristics, ontology, topology, volatility, and agency, constitute the structure of a generic space shared by both physical and digital spaces: these must be carefully considered to design a good user experience.

While Beynon's conceptualization is concerned with the blending of digital with an underlying single physical location, for example a room, a more systemic perspective was introduced by Resmini and Rosati (2011) and more recently formalized by Resmini and Lacerda (2016). They consider how people choreograph their experiences freely connecting products and services through technology and propose an approach that is strategically concerned, not with individual artifacts such as a piece of software, a mobile device, or a location, but with 'the digital/physical ecosystem resulting from actor–driven choice' these artifacts are part of (Resmini and Lacerda, 2016, p. 3). Actors, tasks, touchpoints, seams, and channels are the primary elements of a cross–channel ecosystem. In the context of the workplace, this is a systemic view that embraces all the layers in the model (fig. 2).

Hence, we posit that the workplace is best approached systemically as a cross–channel ecosystem in blended space, a semantic construct spanning digital and physical. We also observe that a cross–channel ecosystem creates a distributed blended space of action which can be locally modeled through Beynon's four characteristics and systemically through Resmini and Lacerda's elements.

Methodology

The Småland region is a mature SME environment: technology–wise, most companies, if not all, have in place a legacy ICT infrastructure and the research team considered it part of the problem space. Organization–wise, the demographic shift towards Millennials and Gen–Zers and the flatter, tech–supported, transient organizational structures recently emerging in the workplace (Denning, 2014) introduce new challenges. Design–wise, the shift from performance to experience (Wright, McCarthy and Marsh, 2001), the emergence of a BYOD approach and the pervasiveness of information access, consumption, and production create new friction points and new opportunities.

A simple 4–layer model was introduced to take these observations into account (fig. 1): technology is at the bottom, as the necessary infrastructural

layer; the spatial configuration of the workplace, its spaces and locations, comes next; then the application layer: software, devices, and processes; and finally, the organizational superstructures. It is important to note that these layers reflect a scaffolding architecture and do not bear any indication of value or importance, but rather reflect an increase in the speed of change from bottom to top in accordance with pace layering theory (Brand, 1995).

The rationale, which should be tested in future studies, is that the technological infrastructure is treated as mature, proven, and relatively stable in the Swedish SME space, leading to slower change rates than those we currently have at all upper levels under the socio–technical pushes and pulls identified above.
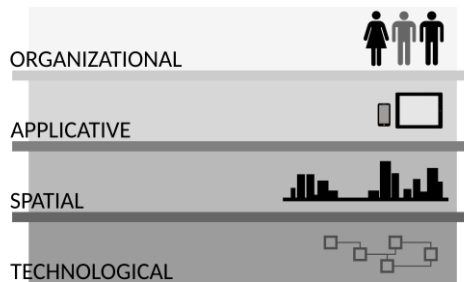
Figure 1   A (simplified) 4–layer model of workplace structure.

Thus, in respect to the goals of the project, the technological layer was considered to be a constant and emphasis was on understanding the workplace as a system of systems in which employees merge activities, processes, and artifacts, from the workplace space to software to tools and devices, into complex experiences, in accordance with Resmini and Lacerda (2016).

This led to a revised model (fig. 2): employee experience, as identified through information architecture and user experience, is a vertical process across the different layers whose technological foundations rest on an enterprise architecture, either implicit or explicit. This process is supported by a parallel ontological system that goes all the way up to business process management on the organizational layer.
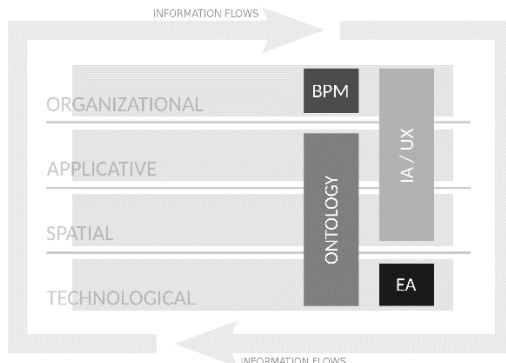
Figure 2 Revised 4–layer model of workplace structure.

The study involved two external partners: the Länsstyrelsen in Kalmar, Sweden, a mid–sized public organization of roughly 200 employees and an extremely interesting case as they were preparing to move into a completely new open space; and Pdb in Jönköping, a private consultancy company employing around 60 people and working with enterprise software.

Research was conducted on site through 12 one–hour, semi–structured interviews and through direct observation of the different spaces and daily routines in the two companies across several visits to their offices in Kalmar and Jönköping.

The interviews were transcribed, analyzed, and discussed in–team. Subsequent meetings were conducted with managers of the two organizations to share and discuss preliminary results, and a final report with conclusions and indications for further research in the area was delivered to Smart Housing Småland.

Interviews and on–site observations

Samples in qualitative research are usually purposive, with participants selected because they are likely to generate useful data for the project. In this pre–study, the twelve interviewees were suggested by the stakeholders following a request from the team to meet a significant cross section of employees in the two companies.

The participants included administrative workers, knowledge workers in different sectors, managers and one of the CEOs, all present in the workplace some or all the time. The interviews summed up here for brevity

and clarity are those with the Head of Internal Services (L1) and an administrator (L2) at Länsstyrelsen, and with the company's CEO (P1) and an accountant (P2) at Pdb.

The interviews were conducted on–site, during normal working hours, and mostly in Swedish, with a few questions asked in English when interviewees felt comfortable with the language. Observation was carried out through note–taking and the capturing of pictures by means of the teams' smartphones and camera during two different half–a–day visits.

Head of Internal Services, Länsstyrelsen

The Head of Internal Services at Länsstyrelsen considers most of his work as organizational in nature. Flow is primarily digital with a clear–cut separation between personal and work–related devices and activities:

L1: 'I use my mobile phone. And then, I have an iPad.'
Q: 'Is that mostly for mail or?'
L1: '(…) the mobile phone is for calling too, my iPad is to make sure I turn up on time. I have a calendar and I check my emails.'
Q: 'Are those yours, your personal items, or are they office items?'
L1: 'The iPads are office items. So, so it's connected to my work email and to my work schedule.'

Corporate–owned, personally–enabled (COPE) tablets were one of the major friction points between what was possible to do and what the actual use was.

L1: 'So, the only thing I really can use (my iPad for) is my (calendar) and my email, which means I don't really have use for an iPad.'
Q: 'Why is that? Is that because of architecture?'
L1: 'It's the IT architecture, yeah.'
Q: 'Are there security concerns as well or?'
L1: 'There's (a) lot of (these).'

The Head of Internal Services' job is primarily concerned with maintenance and optimization of day–to–day practices: interviews revealed how attention is mostly devoted to information flows, to decrease the inevitable and very visible frustration employees experience because of working across digital and physical processes: '(I) work with processes and then try (...) to make them (visible)'. Processes must work together even when they have opposite or conflicting goals such as 'eliminate all paper' and 'store a copy of the complete paper trail'.

L1: 'If we get it in on paper, we do digitalize the information and make sure it comes in to our IT systems and then distribute it indoors, digitally. Too much anger, frustration.'

An important part of the duties assigned to the Länsstyrelsen involves field work with local farmers and estate owners. Improvements are being considered:

L1: 'We're talking about (getting mobile bandwidth) in one of our cars (...), so when they go out they can take the laptop with them and they can access all our information digitally and have a printer for documents. (...) (m)eet the farmer, (...), document their decisions at (the) site, give the decisions. (...) (T)hat is a way of speeding things up.'

Administrator, Länsstyrelsen

Administrators at Länsstyrelsen are tasked with this field work, two–three days a week, verifying that farmers' applications for fields and pastures, for which they receive EU money, are legitimate and truthful. This is not a Länsstyrelsen–initiated process: administrators intervene after an application to the Ministry of Agriculture (Jordbruksverket) is filed, and they constantly share information with outside systems and entities. For this reason, administrators require a private space where they can take private calls, and the possibility to easily access meetings rooms when face–to–face conversations are necessary.

Administrators estimate they mostly interact with other Länsstyrelsen staff first and with farmers second, mostly via phone calls. The workload oscillates through the year, with a peak following application calls in late April and another one in October, and 'winter being slightly more quiet'.

In the field, administrators are provided with a smartphone and a handheld GPS device, both COPE, and use traditional paper maps as an additional source of information to supplement the small–screen GPS device which can be difficult to read or use in specific situations.

L2: 'We use mobile phones and one of those handheld computers (GPS) that have a map and so on (…) and paper versions of maps too because it has such a small screen (…) and you don't see that well on it.'

On–site use of the smartphone is mostly connected to taking pictures that are then geotagged. During this process paper maps come in handy again:

> L2: 'We use the mobile phone to take photos, document on it (inaudible) in it there is a GPS so you see where you are on the pasture grounds, for instance. But then you need to have a paper map anyway because the picture is so bad on the GPS.'

The smartphone was identified repeatedly during the interview as the office's, expressly used for outside work only, to the point of denying possession of one:

> Q: '(Do you check mail) on your computer or on your smartphone?'
> L2: 'The computer, I don't have a smartphone.'

When in the office, chat tools are used extensively to quickly solve small issues. Chats are not considered a communication tool, but rather a problem–solving tool.

> L2: 'We also ask each other a lot of questions via chat (…). That is the way to go if you want a quick answer.'

The interview revealed that while mail occupies a secondary role in the administrators' workflow because of the time they spend out of the office and because they manage most of their interactions via the application verification process software, handling it was nonetheless considered a burden.

An administrator's main work process was described as a complex digital/physical series of steps (fig. 3): back from an on–site visit, it takes three hours to register a case. First, images and data are transferred from the phone and from handwritten notes to a computer. This is a manual process: folders are created to sort sources out. Then maps and areas are edited through a dedicated application, and documents created for the applicant and managed through email. Then a case management application is accessed to register all the information concerning the current application. When the case is correctly filed, a printout is sent to colleagues who continue the process. This case management software was characterized as requiring too many steps even for routine operations and as difficult to use.
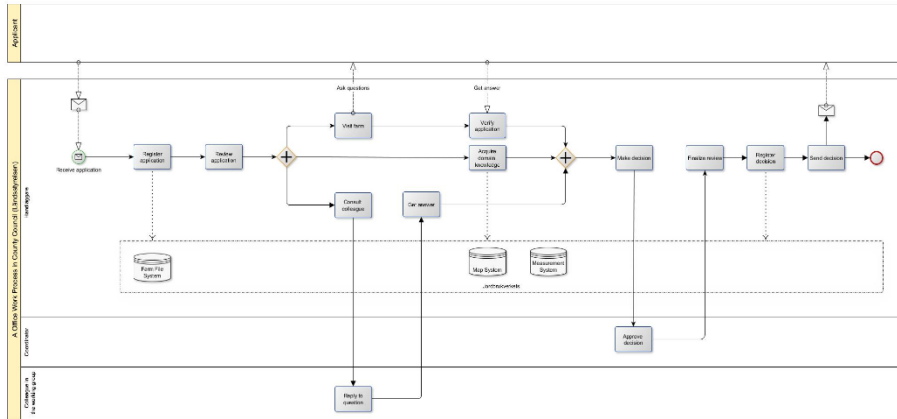
Figure 3   The administrator's main work process.

Overall, the paramount concern administrators have is of an uninterrupted communication both at the organization level, between the Ministry and the Länsstyrelsen, and internally, where a clear understanding of how the different in–house workflows interact is crucial.

CEO, Pdb

Throughout the interview, Pdb's CEO stressed how communication among the different units and between staff members is the most important issue he and the company face daily and one that is not easily solved by technology alone, even though he submits that technology should 'influence' or 'inspire' staff interactions and help 'break this spoken/written word barrier'.

Communication via email is such an integral part of work routines at Pdb that is practically taken for granted. All the same, it is not considered a useful metric to quantify one's work as the CEO does not want to confuse 'communication', a positive interaction, with 'mail exchange', a means he sees suffering from the lack of immediate feedback of verbal conversations. When correspondence evidently becomes self–serving, he steps in and 'send(s) a mail (that says) stop sending mail! Meet (face to face)'.

The CEO describes the company as a competence organization, where relationships play an important role and which is run in a rather traditional way, and where meeting face–to–face is a key moment for both daily operations and specific project work. While conceding there could be technologically–apt ways to go beyond physical interaction, he still

maintains the necessity of individual, face–to–face management. When asked if he sees his work as tied to the physical space of a specific workplace, he maintains that it is not so and that there is a complex system of symbolic company structures that is tied to the idea of the 'boss' office':

> P1: 'I don't think my job needs to be done in my room, (that is true and) it is actually a limitation. Because that room has a lot of symbolic (value), all sorts (of it), so that you know.'
> Q: 'So, you are making a conscious decision not to (meet staff there) sometimes?'
> P1: 'I think it is much better to see people in other contexts, some other room, I think that is important.'

Accountant, Pdb

The accountant's main role is that of taking care of financial operations. She carries out her tasks alone by means of a desktop computer, three flat screens, a laptop, and a smartphone, reporting directly to the CEO once a week. At times, she takes care of her assignments when on holiday:

> P2: 'Nobody does my work when I'm on holiday. Although I don't really mind: I have a place at the west coast where I stay most of the time. I can work from there if (I) want to.'

She uses one software application for invoicing, several custom Excel spreadsheets, and mail, which constitutes most of her communication work, but she says paper is still a large part of every workflow, especially in the form of documents coming in from third parties.

Results

On–site observations and interviews were used to conceptualize how the two workplaces, in the light of their different structures, goals, and organizational pains, can or cannot be described as functioning cross–channel ecosystems in blended space in accordance with the introduced 4–layer model.

Interviews at Pdb illustrated how the company aims at creating an 'inspiring environment' removing or refitting the remaining legacy spaces (such as large rooms for executives) to respond to new needs. The Pdb workplace can be clearly described, in the terms of this paper, as trying to establish itself as part of a larger cross–channel ecosystem.

Länsstyrelsen was, on the other hand, committing itself to a major spatial change with little consideration for its systemic implications. Admittedly, management was aware of how the open plan will change the way staff works, since they won't be 'chained to (their) desk', they will 'take (their) computer and go somewhere else and work' and do the same if they 'need to meet a group of people to solve a problem'. Still, an understanding of the complex feedback loops this would create is absent. For example, the new workplace requires the implementation of a Wi–Fi network (they have none today), and this will move the line between public and private usage of devices and allow an increased flexibility than stationary computing does. Tablets are considered for all administrative roles.

Interviews show how changes in this layer will also reverberate through the other layers, as per our model, challenging the conceptualization of work hours and of the office space as a single, monolithic place, and expanding workflows into ecosystem space. Management seems to consider this positively: 'we (then can) have workers who have iPads (...) with them all the time and I don't really care where they sit and work'.

The misalignment between digital and physical is especially evident at the application layer. At Länsstyrelsen, paper still is, and will remain in the foreseeable future, an important part of the workflow because of accountability and governance policies. At Pdb, on the other hand, paper is considered as mostly a necessary evil when dealing with partners or third–parties, but is slowly being pushed out of internal workflows in favor of digital for all important conversations, or of face–to–face communication for less strategic ones.

At Länsstyrelsen, data and process security is a priority. Ostensibly, this can probably be said to be true of most public structures. Security concerns make staff consider the adoption of BYOD devices into workflows as ambiguous: employee perception as it results from the interviews and observations is that COPE devices, and especially smartphones, come through as an intrusion to one's privacy and a limitation of personal space. An opening to POCE (Personally–owned, Company–enabled) devices might be able to make a difference in such scenarios.

At Pdb, these concerns are largely superseded by the necessity to communicate from everywhere and offer, especially to consultants on the field, a way to work that maximizes their time and the company's.

While at Länsstyrelsen tasks are executed twice or more, as paper becomes digital and then turns physical again across several workflows, at Pdb the uneven balancing of physical and digital often transports bad

practices from one domain to the other. Mail threads become strained conversations with little bearing on actual project outcomes, affecting productivity; face–to–face conversations concerning workplace processes must be turned into handwritten guidelines that are then turned into digital documents to be circulated.

Both organizations support working from home and working from remote, but security procedures (some required by law, some imposed by current architecture of processes and software) make it a stressful activity. BYOD devices are problematic at Länsstyrelsen: access is often a matter of rank and employees see few advantages and plenty possible intrusions.

Consequently, day–to–day work experience is hampered or hindered by the absence of seams between touchpoints in physical and digital space as employees struggle to connect disjointed flows using ad hoc fixes to bridge the two domains. This is especially visible in on–site operations at Länsstyrelsen. Direct transfer of data from the field to central systems is often impossible because of technological limitations, and staff resorts to notes on paper that need to be re–entered when back at the office. Such a procedure is conductive of delays and potentially prone to errors.

Employees experience the workplace as a badly implemented cross–channel ecosystem, a non–functional distributed blended space where digital and physical collide and where personal needs (and personal resistance to more and more diffusive control) go head to head with workplace routines.

Conclusions

We posit that to be able to mend this broken relationship and make ongoing and foreseeable trends contribute to improving the quality of the workplace experience instead of making it challenging, a shift needs to happen in the way we approach and design the workplace. Following our diagrammatic view (fig. 2), we maintain that the workplace needs to be understood as a semantic construct first, as work–related tasks are performed anytime and anywhere, where technology, physical space, activities and applications, and organizational structures are kept together through the concurrent work of the cross–layer constructs that allow employees to make sense of the overall architecture.

To this extent, we propose that such reformulated design process should consider that first and foremost *the workplace is a cross–channel ecosystem in blended space*. It does not identify a single physical location, but rather a

complex ecosystem spanning a number of different and ever–changing locations in digital and physical space connected through information flows (Resmini and Lacerda, 2016).

Because of this, *the workplace is a loosely joined structure*. This implies an acknowledgment that the sort of changes that at Länsstyrelsen seem to be connected only to the spatial layer and at Pdb to the organizational layer, have pervasive, ecosystem–level resonance and should be handled as such. Top–down approaches, such as the move to an open space layout, do not consider what the interplay between the layers allows for: they create organizational resistance as they move the bar towards a loss of personal space and an increase in control in both physical and digital space; they seemingly offer no benefits, while these belong to different layers and to the ecosystem. It must also be noted that the technological infrastructure in place already allows us to reconfigure the workplace as a loosely joined structure in more than one of the layers we used as a model: through emergent cooperation in transient teams via software and co–location, but also by making the home, or the airport, a time–limited part of the workplace.

As these changes impact the different layers, *the workplace becomes many different personal workplaces.* Within an ecosystem enabling multiple possibilities for action, employees can go through their routines in independent ways involving different configurations of the same base pool of tools, processes, locations, and people.

Figure 4 synthetically represents three hypothetical paths within a simplified Länsstyrelsen ecosystem, based on the administrator's interview (in three different shades of gray). The hexagons represent touchpoints, the individual points of interaction that allow to move a task along to completion. The presence of a seam, a threshold between touchpoints, allows progression. Lighter hexagons represent unused existing touchpoints and resources. Through consistent modeling of the employee experience at the ecosystem level, processes can be made visible, actionable, and understandable, solving one of the major issues described in the interviews.
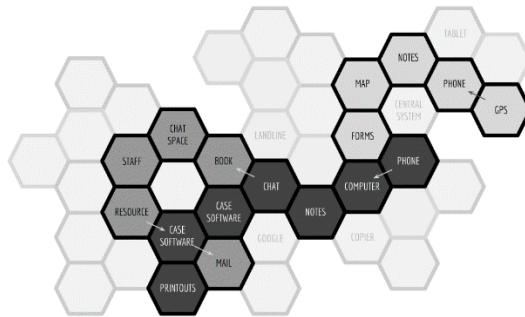
Figure 4   Hypothetical paths in an office Ecosystem.

The workplace is open 24/7 365 days a year. A loosely joined and personal workplace should allow productive access outside of standard office hours, extending its spatial flexibility into the time dimension.

This #ViewOfTheOffice proposal spans digital and physical to create a new idea of the workplace as a distributed, employee–constructed, transient, and flexible place. It presents many challenges, not least those related to data and process security, trust and control, but it also leverages the opportunities offered by current technology from a systemic perspective and reconceptualizes the workplace in terms that support the ongoing socio–technical changes.

Acknowledgments

References

Benyon, D. (2014) *Spaces of Interaction, Places for Experience*. San Rafael: Morgan & Claypool.

Brand, S. (1995) *How Buildings Learn: What Happens after They're Built*. New York: Penguin Books.

Capgemini Consulting. (2013) *Bring Your Own Device – It's all about Employee Satisfaction and Productivity, not Costs!* [Online] Available at:

http://ebooks.capgemini–consulting.com/Bring–Your–Own–Device–eBook/#/4/. [Accessed: December 15th, 2016].

Denning, S. (2014) Making Sense of Zappo and Holacracy. *Forbes*. [Online] Available at: http://www.forbes.com/sites/stevedenning/2014/01/15/making–sense–of–zappos–and–holacracy/. [Accessed: December 15th, 2016].

Edwards, J. (2015) Goldman Sachs has Made a Chart of the Generations. *Business Insider*. [Online] Available at: http://www.businessinsider.com/goldman–sachs–chart–of–the–generations–and–gen–z–2015–12. [Accessed: 15th December 2016].

Fauconnier, G. and Turner, M. (1998) *The Way We Think: Conceptual Blending and the Mind's Hidden Complexities. New York:* Basic Books.

Floridi, L. (2016) *The 4th Revolution*. Oxford: Oxford University Press.

Fry, R. (2016) Millennials Overtake Baby Boomers as America's Largest Generation. *Pew Research Center*. [Online] Available at: http://www.pewresearch.org/fact–tank/2016/04/25/millennials–overtake–baby–boomers [Accessed: December 15th, 2016].

Harrison, A., Wheeler, P. and Whitehead, C. (2003) *The Distributed Workplace*. London: Routledge.

Holmström, C. (2016) Företagens storlek. *Ekonomifakta*. [Online] Available at: http://www.ekonomifakta.se/fakta/Foretagande/Naringslivet/Naringslivets–struktur [Accessed: December 15th, 2016].

Prensky, D. (2001) Digital Natives, Digital Immigrants. *On the Horizon*, 9 (5), 1–6.

Purcell, K. and Rainie, L. (2014) Technology's Impact on Workers. *Pew Research Center.* [Online] Available at: http://www.pewinternet.org/2014/12/30/technologys–impact–on–workers [Accessed: December 15th, 2016].

Resmini, A. (2016) 'I Work Here': Cross–channel, Blended Spaces, and the Challenges of Digimodernism. *Journal of Library and Information Science*, 42 (1), 41–44.

Resmini, A. and Lacerda, F. (2016) The Architecture of Cross–channel Ecosystems. In *Proceedings of the 8th International ACM Conference on Management of Digital Ecosystems*.

Resmini, A. and Rosati, L. (2011) *Pervasive Information Architecture: Designing Cross–channel User Experiences*. Burlington: Morgan Kauffman.

Smith, A. (2011) Americans and Text Messaging. *Pew Research Center*. [Online] Available at:

http://www.pewinternet.org/2011/09/19/americans–and–text–messaging [Accessed: December 15th, 2016].

Tan, H., Resmini, A., Tarasov, V. and Adlemo, A. (2015) Workplace Innovation in Swedish Local Organizations – Technology Aspect. In Abramovich, W. (ed.), *Business Information Systems Workshops*. Berlin: Springer.

Wright, P. McCarthy, J. and Marsh, T. (2001) From Usability to User Experience. *Interfaces*, 46, 4–5.

Eco–art Projects: Semiotic Issues

Giacomo FESTI[*a]

[a] Nuova Accademia di Belle Arti di Milano

This paper proposes a semiotic contribution regarding the topic of art related to ecology. Several eco–art projects, mainly referable to a natural corpus like the website 'curating cities', are here collected into 4 main groups, each one of them being characterized by similar semiotic features. From syncretic texts to displays, from instruments to environments, art projects are diverse in term of the meaningful experience they make accessible to the addressee. The first group encompasses generative art that has textual forms as outputs, mainly centred on aesthetic research. The second group shares a projecting display that transforms a scientific data flow into a visible experience, an infoart that questions how aspects of collective activities or of the environment can be represented by abstract figures, triggering some consequences in term of public concern. A third group is centred on the creation of instruments that change the environment, problematizing the statute of art, easily overlapped to design or marketing. A fourth group contains eco–art projects fully integrated into a whole environment, whose identity is questioned. An overall comparison enlightening differential features of each group of projects is finally proposed, considering the type of immanence they offer, the relationship with technology, and the emerging statute of art.

Keywords*: Eco–art projects; semiotics; curating cities; display; Airlite*

Introduction

It is not evident to spot the relevancy of a semiotic contribution to the questions that touch the relationships between contemporary artistic practices, environmental issues and technique, especially technology. This set of entangled queries seems a more appropriate object of study for a STS research paradigm, where the point is first and foremost to follow the diversity of connections among that heterogeneous components. Even if the

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[*] Corresponding author: **Giacomo Festi** | e–mail: **giacomo.festi@gmail.com**

purified scene of art consumption in a typical space of exposition could marginalize the agentive role of objects enlightened by STS theories (see for instance Latour, 2005, pp. 63–86), STS has already been able to open a questioning of some aesthetic issues, showing for instance the effect of a piece of contemporary art in the negotiation of the identity of the museum as institution (Yaneva, 2003). Nevertheless, wide space for further research is recalled (Benshop, 2009), especially for an eco–art that pretends not only to impact on public awareness but also to transform the environment itself, as we will see.

In search for an access point, it has to be noted how the number of publications devoted to the topic of eco–art is rapidly growing, like the monographic number of the journal *Third Text* witnesses (Demos, 2013; see also its prosecution in the book of 2016) as long as several essays taking their move from more or less recent expositions that had eco aspects since the title (Alfrey, Daniels and Sleeman, 2012) or even framing researches commissioned by institutional subjects (Carruthers, 2008). Among these publications, the book of Linda Weintraub *To Life! Eco art in Pursuit of a Sustainable Planet* (2012) stands out, since it tries to move beyond a simple anthological presentation of contemporary artists or a historical narrative (even if present). Weintraub is elaborating an integrated mapping, where distributing contemporary eco–artists, after featuring 4 general axis: i) the artistic genre that is practiced, being painting, sculpture, performance art, installation, bio–art, generative art, social practice, public art, video; ii) the type of artistic strategy adopted, which is already a form in interpretation of the main act of enunciation proposed by the author (dramatization, visualization, inquiry, instruction, satire, perturbation, celebration, activation, etc.); iii) the type of environmental issues treated (waste, climate change, energy, resources, etc.) and finally iv) the type of ecologic approach that is involved, in a more or less explicit way (preservation, urban ecology, deep ecology, industrial ecology, human ecology, etc.). The interactions among these four sets go in every direction and the author, for each artist, enlightens the relationships that are activated, remaining inside a classic art critic approach that pretends not really to interpret each contribution but to give the coordinates to locate the work of an artist inside a whole frame.

In order to introduce the question about the relationships between artistic practices and technique, a first semiotic move is the placing side by side of the artistic genre classification with the proposals (both epistemological and methodological) of a semiotic of culture, whose main reference is the contribution of Jacques Fontanille (2008). Following that

theoretical frame, it is possible hence to switch from a genre classification to a problematization of the kind of semiotic object that is constituted by the artistic practices themselves. Briefly, the relevant point is the type of interpretative experience that specific artistic practices are promoting. The question is which immanence plans should each time be considered as optimal in order to interpret the meaning of an art artefact. Fontanille proposes a kind of onion model, layering several immanence plans, each one enlarging the perspective of the previous one in a movement of integration of semiotic features. From signs to texts, from objects to practices, from strategies to forms of life, a whole set of meaningful experiences are articulated in their respective relationships. This model is conceived as 'integrative', observing any kind of interaction among the levels, in both directions, ascendant or descendant. A given material object can host elements of inferior levels as textual forms (information about the product for instance) or signs (like labels), as well as integrating superior levels (the role of an interface is exactly that of anticipating the regulation of the practical relationships with the user).

This perspective represents a possible evolution of the state of art of a semiotic of practices as depicted in Mattozzi (2006), in order to discover possible meeting points between semiotics and STS studies about technical objects. One of the main critical aspects of STS research, as Mattozzi argued since the split structure of the collection of essays ('actants and webs' vs. 'practices and activities'), is the lack of continuity between the 'de–scription' of objects, mainly interested in innovation and the procedures of production, and other researches more interested in the actual users' interaction with concrete objects. The model of Fontanille potentially allows to record all the interactions among the levels, especially questioning the process itself of actantialization, i.d. the emergence and stabilization of instances, both material and immaterial, able to affect the course of the action.

From a methodological point of view, the website *Curating cities* (http://eco–publicart.org/), sponsored by the Australian Research Council, will represent a natural corpus for a semiotic research about the topic of eco–art, since it is a public database about eco–projects especially devoted to cities, also containing a lot of significant documentations.

Text–objects

Not surprisingly, the classic semiotics of art was mainly interested in painting, working on a semiotic object qualified in general as a text, where the text involves the experience of a tendentially closed configuration, showing internal relationships that had to be explored, first of all in terms of articulation between expressions and contents (the contents being mainly narrative or related to enunciation strategies). In that research context, moreover, the question of the technique was evident in the historical contribution of Greimas (1984), where he observed as Diderot, in his writing about the Salons, started to split his discourse and the analytical gaze, distinguishing an 'ideal' aspect (more iconographic, thematically oriented) from a more technical one, touching the type of pictorial execution and playing with categories that after became inside semiotics the plastic variables, like the formal oppositions concerning the shapes (eidetic categories), the distribution of the colours or the organization of the space (topological categories). A more recent version of the relationships between painting techniques (the different ways of using the brush), the visible results as trace of a creative process, and the emerging effects of meaning, is present in Basso Fossali (2013).

Among the artistic practices recognized as part of eco–art, a sub–set is clearly presenting outputs that assume the appearances of a text. The reference is to the wide galaxy of productions that go under the name of generative art, encompassing fractal art, swarm art and other analogous denominations. These arts are not interesting for the purposes of this research, since they generally are not addressed to ethical and environmental issues, working more on the aesthetic dimension. In generative art, the subject of enunciation delegates a big part of its initiative to a device of generation that simulates certain critical features of an ecosystem, mainly reproducing the fascination for a visual complexity engendered by a calculus where the stochastic component is emphasized (see Bornhofen, Gardeux, Machizaud, 2012). Here the technique depends on one side from the algorithmic properties of the automation introduced and on the other side, more semiotically, from this movement of delegation/substitution of the instance of enunciation of the text. Two examples are the series *Coded beauty*, by T. Kräftner or *SwarmArt* by C. Jacob, where the chaotic interlocking of linear stripes is redoubled by a chromatic huge variability, emphasizing an aesthetics of the tangle.

Another sub–set of textual art is represented by that forms of art (mainly paintings and photography) that contain a more or less explicit act of

denunciation about the relationships between humans and environment. Two authors working in this direction are Jeff Hong and Marina DeBris. The first is realizing a weblog work called *Unhappily Ever After* (started in 2014, still ongoing), where he inserts Disney characters inside photorealistic wasted landscapes, creating a classic clash or short circuit between alternative imageries. The innocent world of the globalized Disney characters, conceived for a pacified and irenic version of a conflict–free world, is dramatically reframed by the surroundings, recalling the severe conditions of the planet on different topics (from pollution to traffic, from animal extinction to global warming). The implausible presence of a fictional character, underlying its cartoon constitution in the appearances, questions the viewer about the relevancy of these environmental issues.

Marina DeBris, on the contrary, creates pieces of work of different genre (outfits, photography) recycling the real debris she founds in several places all around shores of Australia or California. Here is a photography recalling the codes of fashion photography in the posture (https://www.theguardian.com/artanddesign/gallery/2016/sep/13/trashion –designer–marina–debris–turns–ocean–rubbish–into–high–end–outfits–in– pictures#img–1), nevertheless displaying plastic reused materials that inevitably indicate the problematic origin of that abandoned stuff. The conflict between the aesthetic codes of beauty and the material presence of debris as major components of the picture, has to be interpreted as a subtle form of denunciation, having humans, again, as major addressee of this accusation of guiltiness. In this second sub–set of eco–art, the striking and evident presence of a recognizable act of enunciation (denunciation) makes this type of art very close to advertisement, reproducing exactly the same strategies of communication of social interest campaigns. WWF or Greenpeace, among the others, are using their campaigns to unleash a creativity that is exploring and sometimes reinventing the rhetorical possibilities of visual languages. Art and advertisement overlap, through a form of determination of meaning, the denunciation, that is also proposing a strong version of the divide between a subject of judgement (asymmetrical position of superiority) and an object of knowledge (actual causes of environmental suffering). It is sufficient to recall the sociological reconstruction of the implicit models behind denunciation (see Hennion 1993), to consider how art is losing here one constitutive trait of its modern history: the play with indetermination and the open character of the interpretation (consistent with the crisis of the subjectivity and of our power of knowledge).

Display–objects

The biggest part of eco–art projects, on the contrary, moves beyond a textual approach, as terms like performance, installation, social practice, suggest. Beyond the genres, a first set of artistic operations has to do with the visualization of a dynamic stream of information. It is an apparent form of installation, sometimes similar to sculpture, in other cases to architecture. Beyond textuality, it is required for these projects to consider the experience of a material corporeality as well as of the space that englobes the work and the viewer, both instituted by the work itself. A semiotics of objects and a semiotics of practices have hence to be involved.

This kind of projects, more than that, shares a similar feature, a projecting device that makes available to the viewer an actual display of visual changing properties. The data flow is made accessible to senses, thanks to the mediation of the artistic operation that works, technically, on a form of mapping, associating entry abstract data to other sensitive variable outputs. If we consider all the projects presented in the website *Curating Cities*, which is our primary corpus, six cases fall into this typology, three of whom we will discuss. As a first and clear example, observe *Nouage Vert*, by the duo HeHe, 2008 (http://eco–publicart.org/nuage–vert–green–cloud/). One of the author presents and comments the work in an essay written after the end of this first experiment: 'In Finland, every night from 22–29 February 2008, the vapor emissions from the Salmisaari coal burning power plant were illuminated with a high power green laser animation. The laser drew an outline of the moving cloud onto the cloud itself, colouring it green, turning it into a city scale neon sign, which grows bigger as local residents take control and consume less electricity.' (Evans, 2008).

In this case, a classic form of closed textuality is not present, since a luminous instable object is offered to the pedestrians, an object which is at the same time an interface in relation with the entry data and a display for the viewers. The association of the quantity of the electricity consumption with the size of the cloud, in term of reversed proportionality (the bigger the cloud, the less the consumption), is a form of transcoding that depends on an analogical structure: *a* is to *b* as *c* is to *d*. In classic semiotics, this association between a plastic category (size) and a category of content (electricity consumption) is called 'semi–symbolism', a form of micro–coding negotiated by the specific work (see, for instance, Calabrese, 1999). Semi–symbolism is a truly semiotic structure, since an articulation between a perceptible configuration (expression) and an invisible reference (content) is proposed. The same feature of an info display through transcoding is

recurrent in the six cases, with a striking similarity in the structural approach. *Particle falls* (by Andrea Polli and Chuck Varga, 2010) projects a laser fall on a wall of a building in San José, California, whose consistency depends on the content of PM2.5 in the local air, through a live analysis that engenders the data controlling the shape and the density of the fall. In this case, hence, it is a relevant information about air pollution that is selected (http://eco–publicart.org/particle–falls/). *Live Forever*, *the work of Infranatural* (by Jenna Didier and Oliver Hess, Los Angeles, 2011), is a network of custom laser–cut origami–like brass flowers affixed to the exterior wall of a Los Angeles fire station. 'Nested within the flowers is a series of LED lights connected through a controller programmed to run animations based on humidity and temperature data collected from sensors mounted on the roof of the building. Lighting is varied in intensity relative to the incoming data which gives the piece an evolving nature and enables it to indicate the current fire–risk in the County of Los Angeles' (quote from the website: http://eco–publicart.org/liveforever/). Like in the previous case, the information is concerning the environment and not immediately its relationship with the dwellers, like in the first example.

In all these cases, it is then possible to introduce the idea of an 'infoart', as an art that works exactly like infographics in contemporary journalistic publishing, facing the same problem of visualizing a data structure, substituting traditional bidimensional surfaces (the paper or the webpage) with variable material supports and projections. The semi–symbolic coding uses different variables: the chromatic hue (*Weather crone*, *Thunderbolt*), the light intensity (*Earth & Sky* and also *Live forever*), the dimensionality created by light (*Nouage vert*), the shape itself (*Particle falls*). The alliance between art and science is here evident: the techno–scientific web produces data through an exploration of the matter and transforms it into a visible matter. The syntax of the interactions between a device, the matter and the final visualization has been recognized, analysed and interpreted from a semiotic perspective by Dondero and Fontanille (2012). In the case of *Particle falls*, for instance, the artists used the new nephelometer measuring the quantity of PM2.5, a state–of–the–art technology. The metamorphosis of the data into something accessible to senses, it's about a form of plastic conversion or even 'in–figuration', a process of coming into an icon or, in the semiotic meaning, a figurative element, activating an acknowledgement of the image itself (the cloud, the fall, etc.). How this kind of solution is supposed to trigger a reaction in the viewer? The interaction with the audience is primarily at a cognitive level, since there is something to know

about that perceptible phenomena, with the possibility to estimate the values in their mutual relationships ('less' and 'more' is the expected outcome of a comparison for the audience, that cannot access the actual precise data, virtually present in the device). The live connection of the device with the environment is the other common and characterizing feature, giving a lively dimension to the work. Where is artistry in this kind of solutions? From one side, it is in the choice of the output shape that hosts the display, like the thunderbolt, the flower, the fall. Each iconic element opens up several iconographic paths and a symbolic dimension, creating a form of discourse about the overall meaning of the data. From another side, it is in the choice of the surface of inscription and the place of installation, like a dismissed crane, of the façade of a strategic building (in San José, *Particle falls* is located closed to a train station and a pedestrian path) or, above all, the column of vapor emissions by the power plant in *Nouage vert*. It is also possible to recognize an oscillation between a more sculptural approach (in *Thunderbolt* and *Live forever*) and an architectural one (in *Weather crane*). The rhetoric that accompanies that artistic interventions recalls always the sensitization, the attempt to improve the public awareness concerning environmental issues.

Tool–objects

A third group of eco–art projects encompasses apparently very different cases, sharing nevertheless a crucial feature: the appearance of an instrumental dimension, the use or fabrication of an object that does something, manipulating the environment and pretending to be something different from a display. Beyond the pure act of displaying, we move into the question of transforming the situation of implementation, treating practical objects and tools, objects that really operate inside a given scenario. The artistic objects start here to resemble to technical objects widely treated by STS research, at least since their agency is fully re–assumed by the object as a qualifying feature. In the two cases quickly discussed here, the statute of the artistry is what is actually at stake, mainly since the instrumental rationality seems to contradict one typical feature of art, not having any explicit utilitarian goal.

The main case to discuss here, it's about the initiative *Ikea loves Earth*, set in June 2016 (http://www.ikea.com/ms/it_IT/ikea–loves–earth/). Ikea asked 21 street renown artists to paint walls and surfaces in 19 cities all around Italy, on the topic of earth and sustainability, where sustainability is

more and more a core value in Ikea marketing strategy. The main point of this initiative is not in the street art itself, but more in the use of Airlite, a trade mark wall painting, patented in Bozen, which, as they say, purifies the air or reduces the pollutant agents (see: http://en.airlite.com/). Like in the previous case, we have the wall that is transformed, thanks to Airlite, into an active tool for the environment. The connection between a sociotechnical innovation, Airlite, a marketing strategy, both present for Airlite and Ikea, and street art, is part of a quite intriguing story, at least since the agency, finally, depends on one chemical compound, the dioxide of titanium, contained in a new formula inside Airlite. It is a photosensitive component and thanks to light becomes a catalyser of chemical reactions that decompose some pollutant or contaminant agents into inert minerals, salts, and a water film. The wall becomes a kind of killer of bacteria even if the rhetorical discourse of Ikea is more attracted by the metaphor of the breathing wall, comparing the action of Airlite to the action of trees, creating a measured equivalence that is mainly justifying the symbolic equivalence between oxygen production and the action of Airlite that, instead, is not producing any oxygen. It is also clear that Ikea can adopt this strategy since Airlite was already creating a marketing product as emerges from the website and the commercial video for launching and promoting that product. Technological innovation is not so clearly evident exploring the documents produced by Airlite, since the action of titanium was known since the 70ies, and the titanium, for its reflective power, is widely used in painting, also becoming an antonomasia term, the 'titanium white'. It seems that the specific innovation has to be related to the preservation of a non–degraded form of titanium that can work as a catalyst, inside a natural compound. Coming back to the initiative, it is possible to recognize a dramatic split between the instrumental action of Airlite and the pure urban decorative aspect assigned to that kind of art. Art becomes an ornamental commentary to the invisible action of titanium, a subjugated art that is controlled by science and marketing and not vice versa like in the previous examples. In this case, two different subjects of enunciation are present, the street artist and the titanium, where art is supposed to occupy its own representational place, being nothing more than 'just a picture' as opposed to the real and effective action of titanium. Moreover, the typical transgressive feature of street art is here rescued in an environmentally positive action. If the smog free tower cancelled the distance between art and design, in this last case art becomes a marketing tools, recovering a cosmetic and ornamental function. The rhetorical slipping from the Titanium

that causes some chemical local reactions to the mythical painting that makes the earth breath is transforming Airlite in a perfect example of 'factish' (Latour, 2009).

Environment–form of life

A final fourth group of projects should be an entire object of research, encompassing the several cases where the art project is no more related to an object but to the environment, becoming itself environment, a container of non–necessarily planned practices that can be activated in it. Without presenting a developed analysis of an historical case like *Nine Mile Run* (by STUDIO for Creative Inquiry, Carnegie Mellon University. Pittsburgh, USA, 1996–2000), it is worth suggesting that the semiotic concept of 'form of life' (Fontanille, 2015) can be effective, considering how the work of artists, who often plays as interface between several disciplines and the public, tries to transform a territory (Nine Mile Run is the actual name of a dismissed industrial site in Pittsburgh) into a full instance of enunciation and to nourish a modification of the relationships between humans and non–humans. According to Fontanille, the territory 'is a collective becoming, an ongoing transformation which is opposed (hence the recurrent negativity) to institutionalized and strictly determined spatial entities' (ivi, p. 225, our translation). The role of the artist was here to trigger changes that, in a way, aimed at promoting a geographical space into a form of life: art is here a form of reanimation. In the first phase of the project (Collins, 2001), the artistic team involved the locals through guided visits to the site, giving voice to them and designing a tool to combine the difference voices (politicians, experts and locals), redistributing their respective discursive force in favour of the locals, a classic case of empowerment. Every intervention was the occasion of a public debate, the statute of art also included. Several semiotic features became part of a social practice of construction, from the 'spatial' determination of the territory, drawing a limited space with a peculiar morphology, to the 'modal' and 'narrative' properties, involving the control of an actant on the space, here the emerging collective; from the 'figurative' and 'perceptible' properties, like the hidden tracks of a previous industrial site, to the 'enunciative' properties, since all the project was aimed at restoring the symbolic belonging of the site to the historical identity of the city; to conclude with the 'hermeneutic' features (Fontanille, 2015, pp. 226–227), where it is more patent that the territory becomes the outcome of a

collective work of meaning attribution, after relaunching a process that was previously interrupted.

Conclusion

A final schema will resume the crossings proposed here though different kind of eco–art projects, each one of them having a dominant semiotic consistency, each one assigning a role to technology and problematizing the statute of art.

Table 1   *Eco–art projects and semiotic features.*

Semiotic object	Eco–art projects	Genre	Relationship art/ technology	Statute of art
Text–object	– Coded Beauty, T. Kräftner – SwarmArt, C. Jacob	Generative art, fractal art, swarm art	Technology as instance of enunciation	Canonical, aesthetic orientation, art like advertisement
Display– object	– Nouage vert – Live forever – Thunderbolt – Particle falls – Weather crane – Earth vs. Sky	Installation, sculpture, architecture	Plastic conversion – transcoding	Infoart, art of connection of heterogeneous semantic spaces, (activism, journalism)
Tool–object	– Ikea Loves Earth – Smog free tower – Swing	Installation	Incorporation of technology as core device	Instable statute: art blurs limits with design, marketing and education
Environment– form of life	– Nine Mile Run	Social practice, performance	Matter of content / tool	Art as political (art of assembling)

The textual forms witness the oscillation between act of denunciations that are deeply recalling communicative strategies of social interest campaigns and a generative art that dismiss the role of the author in favour

of an eco–systemic logic of emersion of traces on a surface of inscription: the work is a piece of environment in all its complexity.

The group of artworks showing a display, on the contrary, tends toward an infoart, more similar to science and journalism, with the challenge of discovering new ways to connect alternative pieces of relevant but usually invisible information (energy local current consumption for instance). At that point, the individual gaze can start to problematize its own participation to a collective practice concerning the environment, recovering the theme of the sensitization.

Tool–objects are forms of installation where the instrumental dimension is dominant, granted by a dose of technology incorporated in the work. A wall whose painting is reducing the air pollutant contains artistic representations, whose meaning is subjugated by the agentive aspect of the wall. Again, art is showing its limits in losing its defining power, becoming itself, finally, a marketing tool.

A four group of project encompasses social performances aimed at redefining and renegotiating the identity of a piece of environment, within a collective activity, blending humans and non–humans, i.e. several instances whose productive interactions and reactions are largely finding in the artist the role of the catalyst making them possible. The environment begins a process of subjectification that involves several layers of meaning that recall the composition of a form of life.

It seems at the end that the meeting between art and ecology is an experimental laboratory where art is problematizing its own statute, accepting to blend with activism, journalism, marketing, design, politics, demonstrating how fragile or transversal is the art domain. Instead of a movement of unfolding on itself, typical on a more exposition–related form of art, here the movement outside of art arrives to undermine the autonomy of art, a risk accepted with no fear.

The irreplaceable ethnographic work generally promoted by STS could hopefully find inside semiotics conceptual tools to reframe the dynamics of meaning inside these complex phenomenon of eco–art.

References

Alfrey, N., Daniels, S. and Sleeman, J. (2012) To the Ends of the Earth: Art and Environment. *Tate Papers*, 17. [Online] Available from: http://www.tate.org.uk/research/publications/tate–papers/17/to–the–

ends–of–the–earth–art–and–environment [Accessed: November 15th, 2016].

Basso Fossali, P. (2013) *Il trittico 1976 di Francis Bacon. Con 'Note per una semiotica della pittura'*. Pisa: ETS.

Benshop, R. (2009) STS on Art and the Art of STS: An Introduction. *Krisis*, 1, 1–4.

Bornhofen, S., Gardeux, V. and Machizaud, A. (2012) From Swarm Art Toward Ecosystem Art. *International Journal of Swarm Intelligence Research*, 3 (3), 1–18.

Carruthers, B. (2008) *Mapping the Terrain of Contemporary Ecoart Practice and Collaboration: Art in Ecology: a Thinktank on Arts and Sustainability*. Vancouver: Canadian Commission for Unesco.

Calabrese, O. (1999) *Lezioni di semisimbolico*. Siena: Protagon.

Collins, T. (2001) Conversations in the Rust Belt. In Herzogenrat, B. (ed.), *From Virgin Land to Disney World. Nature and Its Discontents in the USA of Yesterday and Today*. Amsterdam/New York: Rodopi.

Demos, T.J. (2013) Contemporary Art and the Politics of Ecology. An Introduction. *Third text*, 27 (1), 1–9.

Demos, T.J. (2016) *Decolonizing Nature. Contemporary Art and the Politics of Ecology*. Berlin: Sternberg Press.

Dondero, M.G. and Fontanille, J. (2012) *Des images à problèmes. Le sens du visuel à l'épreuve de l'image scientifique*. Limoges: PuLim.

Evans, H. (2008) Nouage vert. *Cluster Magazine*, 7. [Online] Available from: http://hehe.org.free.fr/hehe/texte/nv/index.html [Accessed: June 30th, 2016].

Fontanille, J. (2008) *Pratiques sémiotiques*. Paris: PUF.

Fontanille, J. (2015) *Formes de vie*. Liège: Presses Universitaires de Liège.

Greimas, A.J. (1984) Sémiotiques figurative et sémiotique plastique. *Actés sémiotique*, 60.

Hennion, A. (1993) *La passion musicale*. Paris: Edition Métailié.

Latour, B. (2005) *Reassemblig the Social. An Introduction to Action–Network–Theory*. New York: Oxford University Press.

Latour, B. (2009) *Sur le culte moderne de dieux faitiches*. Paris: La Découverte.

Mattozzi, A. (ed.) (2006) *Il senso degli oggetti tecnici.* Roma: Meltemi.

Weintraub, L. (2012) *To Life! Eco art in Pursuit of a Sustainable Planet*. Berkeley: University of California Press.

Yaneva, A. (2003) When a Bus Met a Museum: Following Artists, Curators and Workers in Art Installation. *Museum And Society*, 1 (3), 116–131.

The Connexion between Digital Body and the Universe

Sana BOUKHRIS[*a] and Osman Miguel ALMIRON[†a]

[a] Université Paris–Est Marne–la–Vallée

Researches in Art, Science and Technology fields, existing in the artwork performances of Moon Ribas and Kitsou Dubois, promote the body ecology movement, looking for new relationships between the body and its environment.

Both artists are experimenting on their own bodies in order to rethink the limits. This approach raises the question of new digital technologies impact on the human body in contemporary society.

Cyborg artist Moon Ribas promotes endogenous relationship with nature. She feels every earthquake on the planet, by a sensor permanently grafted under her skin. Nature makes then the artist's body move and interact.

In the other hand, the French choreographer Kitsou Dubois establishes an exogenous relationship with nature. Indeed, in her performance, body is liberated from any gravity. Therefore, it is by overcoming nature that the body move and interact.

Our article aims to analyze the corporeal ecology in each artistic movement detailed above by considering the relation that the body entertain with the Universe enriched by technologies.

Keywords: *Universe; ecology; body; immersion; cyborg*

Introduction

The ecology, the environment, and the protection of nature have always been fields of artistic concern. These fields send us back to a series of process, fundamental interactions between the body and natural environments in which we live.

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[*] Corresponding author: **Sana Boukhris** | e–mail: **sana.boukhris@gmail.com**
[†] Corresponding author: **Miguel Almiron** | e–mail: **miguel.almiron@u–pem.fr**

In collaboration with the scientific field, artists take possession of ecology as a new means of thought, creation and action. They explore, expose and presume solutions and results to problems of ecological order.

Ecological problems, omnipresent in society, invest the whole of the artistic field and diverse approaches. Ecology has been defined and treated in different manners. The term comes from the Greek word 'oikos' (house, environment) and 'logos' (science): it's the house–science of the environment. It was invented in 1866 by Ernst Haeckel, a pro–darwinist German biologist.

A generally accepted definition, particularly used in human ecology, consists in defining ecology as being 'the triangular relationship between individuals of a species, the organized activity of this species and the environment of this activity' (Koninckx and Teneau, 2010).

Some contemporary artists put the accent on ecological problems of a certain reality, by creating ephemeral works of art or by integrating natural elements as Lucy and Jorge Orta do. Others open their work to the whole of the real world as a means of artistic experience, such as Tomás Saraceno or Olafur Eliasson. Others still get hold of environmental technology and science to start a process which will denounce a situation, arise awareness and thus favor a certain thought.

In this work, we have tried to realize an ecological approach which may question an awareness supporting previously unseen relationships between the body and its environment.

Cross–way research present in the artistic performances of Moon Ribas and Kitsou Dubois, engage them in the approach of a corporeal ecology in the search of new relationships between the body and its environment.

A research on the work of these two artists and a comparative observation, may give the possibility of questioning ourselves on the body's limits and redefine our relationship with nature.

A new relationship with the environment is being diffused re–questioning the place the body has in contemporary society, being aimed at by new technologies. How do different artists engage themselves on a creative transition in order to give birth to a corporeal ecology?

Context

A corporeal ecology is superposed to the environmental one, defined by Andrieu Bernard, as being all which happens to the living body at the moment of its immersion in the environment, without the subject being

necessarily conscious. 'Corporeal ecology is not a discourse, it's a corporeal practice of physical activity which engages our everyday responsibility: on a daily basis, by thinking about our gestures, it's consequences upon others, and nature' (Andrieu and Burel, 2014).

In order to ecologize in a deep manner, a gap installs between the body experience and what consciousness will be able to do. In these terms, we may refer to the concept of 'Deep Ecology' as noted by Arne Naess (Naess and Rothenberg, 2009) to designate the study of relationships between the human spirit and the natural world and the behaviors resulting from our attitudes, our beliefs and our perceptions. Our intention is not only to present this thought, but to make understand the mean of corporeal ecology in order to analyze the artworks cited in this essay.

It is appropriate to remain on Andrieu Bernard's works for a while, he develops the thought on the encounters between technology and cosmology at a time when the environment has been affected. In front of nature's degradation and technology's embodiment in practice, body finds itself at the center of the debate, in all its forms and situations.

Body's practice in relation to the sun, the air, water and the earth, arises the body in the cosmic entity (Le Breton, 1992). Integrating to nature is the desire of living an immersive experience. More than simply evading towards nature, a new body experience is being created and by consequence new sensorial dimensions are being established (Le Breton, 1999).

The living body's activity goes beyond the awareness of our body's experience and produces involuntary gestures. Those emergences that awaken unseen capabilities in the living, allow it to feel it's living body and bring about new self–consciousness, of others and of the environment (Berque, 2014).

Emersiology appeared following to the location of the body in vivifying situations which alternated the usual body pattern. Described, according to Anais Bernard, as a reflexive science coming from the sensibilities of our living body, in the consciousness of the body, experienced and defined by Andrieu Bernard as 'the involuntary movement in our body of the networks, humors and images; of which our conscience is aware only of the emerging part. The living body produces sensibilities by means of its 'ecologisation' in the world and among others' (Andrieu, 2015).

It's interesting to observe in the work of two contemporary artists, Moon Ribas and Kitsou Dubois, how a thought on the human body, in relation to the environment, is being brought to light. And also, how these two artists re–interpret the new relationship being transposed before ecology.

Moon Ribas undertakes this subject in her artistic experiences. Wither it's about attitudes, displacements or movements, it's all that is going to be in the artist's body that will favor it's 'ecologisation'. The immersion in nature is something that will bring about the living body's activities which will promote what we may call the 'ecologisation' of the body.

Our living body knows things in advance, and activates so many things in advance that we are rarely able to think those things. There is a kind of gap between what we call 'the living body' and our consciousness of the 'experienced body' (Andrieu, 2007).

What interests Moon Ribas is the activation, that is, what happens in the living body when we make him deal with an action.

From another angle and with the same principle of experimenting the body, Kitsou Dubois, artist, dancer and choreographer, works on the different states the body reveals in different environments where gravity has been modified. He works around the relationship between the body and weightlessness.

His work articulates the sensation of the experienced body in the awakening of new sensations arriving into conscience without her having voluntarily desired or deliberately searched for them.

In the experiment of Moon Ribas, the body is immerged in nature, in an opposite way, Kitsou Dubois' experience is that of an overhanging nature. The immersion of nature in the body implies a technical and material 'ecologisation' without mastering the elements, but with relational knowledge between them and our body, hence Andrieu Bernard's expressions 's'immonder' and 's'ammonder'. 'S'immonder is other than the transformation of our body in order to dominate nature by means of agility, force and adaptation'. 'S'ammonder consists in cutting ourselves from the natural, from Nature' (Andrieu, 2014, p. 24). For the philosopher Andrieu Bernard, the immersion in nature is 'a way for the subject of making new sensorial coordinates emerge in him' 'much more than an escaping towards nature and a corporeal adventure' (Andrieu, 2002).

We show that the artist or the spectator, produce involuntary effects and sensorial interactions when he introduces the experience. The deepness of the body is discovered by the emergence of new sensorial coordinates.

Nature's immersion becomes its immersion in the body's deepness. The body is immediately impregnated with the elements of the environment. We ecologies trying to feel in our own interior the effects of our encounter with the elements.

The endogenous experience

Moon Ribas is a choreographer and a cyborg artist who created 'Waiting for Earthquakes' in 2013. She had a chip implanted in her arm, permanently connected to an on–line seismograph which allowed her to feel earthquakes in real time by means of vibration. All around the world and independently of where she finds herself, she translates the vibrations of earthquakes into dance movements.

The more intense the earthquake is, most important the vibration in her body will be.

The objective of her artwork is to develop a sense that she calls the 'seismic sense'. She uses this new entry to create new experience with movement. Her relationship to cybernetics is a way to perceive the world in a new different way and consider technology as a tool to modify her own senses. 'Adding more senses, you have a different relation to the planet, a different experience of reality' she says. 'We have yet to learn how to live on our planet…' (Hopes and Fears, 2013).

Ribas noted that she is constantly interfered with the planet in her life. According to her, despite the produced gravity, she finds the feeling very pleasant. 'It's like a heartbeat–the Earth is constantly beating,' '…so I feel like now I have two heartbeats: my own heartbeat and the Earth's' (Hopes and Fears, 2013).

In our universe, we learn that there are many elements in movement: the earth, the stars, the clouds, the living things that move about. The universe represents people and tangible or abstract things as a whole, establishing the environment in which we live.

Planet Earth moves constantly, occasionally shaking every day. Ribas tried through his interpretations to translate the massive and natural movements of the planet in a different way.

Only her body feels those vibrations, no one else can enjoy them, the artist calls upon other artistic forms to express her feelings and share her experience with others.

Science taught us that many phenomenon, either visible or invisible, take place in nature, this is what makes up the basic elements of the universe. We have noticed that earthquakes have always existed and produce themselves constantly in a life span; they are a part of our planet's constitution. The earth keeps interrupting the life of the artist who on the other hand finds herself in permanent dialogue with the planet.

Her confidence in technology as a mean of extending the limits of the body allowed her to establish a close relationship with the planet and a

different experience of reality. The body thus finds itself at the center of the universe and it is the artwork that will reveal this engagement.

In a similar perspective, the Dutch artist Daan Roosegaarde, was interested by the relationship between the body and its environment. His idea was to update our senses connecting them to nature. His works varied, articulating from varied concepts related with nature and its constraints. He worked on space, light, water, air, planets…

In his artistic approach, he tried to render natural elements in order to bring as close as possible nature to the human.

Nature in collaboration with technology allows the creation of new senses among the human. Through the work of Moon Ribas, we are aware of new possible relationships with nature surrounding us. Natural phenomenon taking place in our universe may affect us and create within us a new will of redefining certain concepts of nature.

Moon Ribas commits herself in the path to a corporeal ecology, in quest of unknown relationships between her body and the environment. By the fact of ecologising her body, a new reading is established and new sensorial dimensions emerge. The artist draws with her body a border that will allow her to be more closely related to nature.

She undertakes an endogenous relationship with nature. She is in a direct and profound interaction with her universe. Her universe is not limited to physical or natural phenomenon interrupting her life, her body's interaction allowing her to establish an original and close relationship to her environment. Nature takes hold of the artist's body to make it move and be moved. Thus, new artistic perspectives emerge as invitations to re–think relationships and exchange with nature.

The exogenous experience

The reality of the body on earth is linked to gravity. It's an essential force of nature as powerful and necessary as it passes unnoticed, this is also the case for the earth's rotation. It has a great impact on the universe and most important on earthly existence. Gravity is the main ingredient of the force of heaviness.

Heaviness transforms our perception of the body, of our behaviors, and by doing so, of our existence. Taking the example of the artwork *Perspectives*, by Kitsou Dubois, a performance, where the body was liberated from earthly attraction and space came to be at the reach of a hand.

In order to analyze it, the artist's global approach, and some of her previous works of art will explore around the central question of knowing how the body interacts in front of a transformed environment. Space is at the same time a universe apprehended by technology, science and human sensibility. In this weightless universe, where movement is fluid and infinite, the body behaves differently and a new corporeal experience starts.

We have the impression of being sent into a universe that lacks points of reference. We don't weigh anymore, we have no body, and therefore we have no consciousness of limits.

Through her experimentation, Kitsou Dubois proposes to live the experience of a body that rests unmodified by the experienced situation. There is a paradoxal relationship between the bodily perception, in a state of weightlessness compared to that of being on earth, and the imaginary scenarios linked to those two, symbolically filled universes. In another artistic approach, Frank Pietronigro, with his artwork *Drift Paintings* experienced his body floating amidst a three–dimensional painting. His work can be directly experienced only under the circumstance of micro–gravity. His idea was to include his body in open–air paintings. Microgravity, an important factor for the environment's stability, has played a crucial role in the development of his paintings.

A study shows the way we feel our body in these mixed–reality spaces.

The relationship to nature is expressed differently. Opposed to Moon Ribas, Kitsou Dubois establishes an exogenous relationship with nature.

As a matter of fact, in her performances, the body evolves in the absence of gravity, it is so by freeing itself from gravity that the body can move and be moved.

Her work is not oriented on perceiving what microgravity is, but instead, it explores the incorporation of this natural element in the body's stability.

Nevertheless, the experience provides a living body that is not really modified by the experience. The weightless sensation, in this case, is limited to a weighting body, which means an ordinary one who imagines itself not being so.

We find, in a neighboring experience, different artistic an esthetic approach as in the work of Trisha Brown who experiments the horizontal walk, working on gravity, and mostly on the effects weight has on the body. Daniel Larrieu, on the other hand, sinks his dancers in a Waterproof swimming pool.

Kitsou Dubois tries to modify the relationship dancers have with gravity by making appear other relational and spatial forces which really exist but

are dissimulated by the usual relationship of the human body has in an earthly environment.

In the relationships of Kitsou Dubois, we notice that the dances interpreted by the artist remind us of a corporeal ecology, encountering an uncontrollable movement and a spontaneous reaction.

To abandon itself to living, which means abandon itself to its living and not being constantly under control. We may also pass self–activation by working the notion of presence in the world.

Taking into account the thoughts of the philosopher Gaston Bachelard in this sense, and seeing how with the earth, the air or the water; when we make people emerge in such environments, we then trigger ecologisation process which are not necessarily entirely representational ones (Paquot, 2016).

It's about triggering the emergence in the environment, letting the involuntary and the unconscious pass through, and delivering itself to a dance which is generally a controlled movement, rather than letting itself get into a situation of continual loss of control (Kitsou Dubois, 2000).

In a situation of weightlessness, the body floats in space up to a point where it loses all reference. The absence of gravity gives the sensation of a loss of weight. It seems also that the memory of the movement's gesture is partially lost. We find ourselves in such or such position, but we don't exactly know why, nor how. This process provokes a de–construction maybe a desincarnation, depriving the body of its usual anchorings (Stelarc, 1999).

Movement becomes fluid and infinite and the sense of limits is lost. The artist's experimentation modifies the visual and sensitive perceptions of the spectator, in order to take him into a deconstruction of his references, proposing him a new angle of observation.

A complete interior adventure is thus created in the quest of its own body's center, and to recreate its limits. In front to these improbable situations and these risk takings, the body tries to invent new ways of perceiving things and structure a new weightless movement in all the spaces' directions. Our perception of space and time is distorted, new sensations emerge, it's a way of putting our reality into perspective and reinvent it.

Discussion

The analysis of artist's creations who interact with natural forces makes it clear that there is a transformation in our society of multiple relationships with the 'non–human' environment.

Whether they are animals, molecules, objects, procedures or materials, these entities enable us to maintain relationships which allow the improvement of our languages, systems, signs and techniques. We are obsessive to review the relationship between individuals and the environment where they live. It is obvious to examine and highlight the relationship between 'human' and 'non–human'.

The experience of Moon Ribas with nature enabled her to forge a bond of complicity with the non–human world. This complicity invited her to seek new interactions and discover new sensorial dimensions. This extension of senses allowed the artist to expand her connection with animal species, who have also the ability to feel this natural phenomenon of earthquakes.

These moments of sharing with the world of animals allow us to understand their ability to solve problems. A continuity that makes it possible for us to distinguish and identify functions that account for the diversity of worlds, both in animals and in human's species.

In this sense, we can also refer to Neil Harbisson artist, who, embarks on the idea of extending his senses to improve his human experience. Through his 'Eyeborg' he can hear the colors. The system allows him to assign to each color a sound frequency and view colors differently. His perception of the world is thus modified and his apprehension of reality is improved. Applying cybernetics to his body, the artist consider himself as a non–human species. 'The Cyborg deliberately incorporates exogenous components extending the self–regulatory control function of the organism in order to adapt it to new environments' (Clynes and Kline, 1960).

Through the senses of other animals and species, we can get ideas for new abilities that we can adapt to humans by applying cybernetics to the body. If we could all perceive the reality of other animal species, we could say that we could learn and perceive the world differently.

Bruno Latour and Steve Woolgar (1979) appreciate the idea of introducing 'non– human' to 'human' network. Decomposing nature and society, he shows on which consist the composition of common world.

Kitsou Dbois joined Ribas in the idea of going beyond the limits of senses looking for new dimensions. On the other hand, her relationship with nature leads her to search her own humanity. Deprived of any sensation of human condition, the artist leads us towards a modified nature, a loss of meanings

and landmarks. New perspectives of action are created and new situations of improvisation of the gesture are born searching the human body itself. This confusion of sensation is explained by the fact that the human body, in certain situations, loses its human capacities. And this transition from the human to the non–human stage suggests a reconstituted subject who sets out to find new contexts different from the social practice.

Artists Fern Shaffer and Othello Anderson recognize that everything is the world is interconnected. They use energy, thought and movement in their rituals to strike a beautiful equilibrium and harmony between nature, science and spirit. Through their series of photography we find that they consider the earth as a living entity through which ritual and prayer are activated. Their idea is to bring the spirit back into the community and the world to achieve ecological and environmental goals.

As Gomart and Hennion (Gomart and Hennion, 1999) explain in their terms, all these 'new theories of action' are ultimately based on the same idea: to offer a more balanced and adapted view of the distribution of the capacities of action between the human actor and its physical environment.

The theoretical approach of the Actor–Network Theory (Latour and Woolgar, 1979) offers us an appropriate environment to analyze relationship between nature and society. This theory which inserts the actor in the fabric of relations between heterogeneous entities allowed us to redefine our interaction with nature.

Comparing to sociological theories, the originality of this approach is based on the awareness of its analysis system, classical human actors and non–human entities. Considering non–human entities are important because, due to their diversities and abilities, they influence the process of interaction between the human body and its environment. On the other hand, human and non–human actors interact with each other within a sociotechnical network and develop a connection looking for new readings of our links and attachments to the environment.

The results of this investigation argue that the causal link between humans and non–humans is reciprocal and reflexive. It couldn't be only defined by their external relations, but must incorporate their internal motivations. Here, the major attitude is to promote human and non–human ability to mutual understanding, because non–human is everywhere around us.

In this work, ecological values are used to understand the conception of human and non–human interaction's. The conceptor couldn't control

precisely these interactions, but could optimally reveal what the human and the non–human are able of living in interdependency.

The relationship between techno–scientific innovation and natural environment, turning our environmental and artistic practices looking for new sensorial aspects of the human body.

In this way, we think that we could talk about a 'corporeal artistic ecology', it's not a discipline or a new category of history of art but just attitudes of creations interested in conditions of human life.

Conclusion

Generally, in nature, our languages, our behaviors and our thoughts are linked to our brain. The body reacts to personal wills. It's the intention of those artworks to bare the body of its usual functions. We've discovered that our postures, our movements, our thoughts, may now be guided by technologies.

We could notice that both artists make experiences on their own body in order to rethink its limits, and enroll themselves in an ecological discipline of the body. Their approach interrogates us about the place that new numerical technologies give the body in the contemporary society, that is, a privileged place that magnifies our senses thanks to new devices.

Moon Ribas, cyborg artist, undertakes an endogenous relationship with nature, and makes out of her body, her interior, a stimulus receiving organ, not from the exterior but from the artist's own cybernetic body. In this way, nature takes possession of the artist's body, and turns itself into an organic presence, and as well as every vital organ of the human body, will confuse itself, make her move and be moved (Haraway, 1985).

On the other hand, Kitsou Dubois, establishes an exogenous relationship with nature; deconstructing the usual references in nature as well, and constructing a new incarnation, of a weightless body for example, but also one that is submitted to the possible environments that technologies may set us to live in, in the future. Kitsou Dubois goes beyond the law of gravity and presents us with a body capable of moving and be moved, no matter the natural environment where it finds itself.

This debate seems invaluable for us, because the non–human is everywhere around and between humans. This hypothesis allows us to open the question of the nature of our links and attachments to the environment around us.

References

Andrieu, B. (2002) *La nouvelle philosophie du corps*. Paris: Erès.

Andrieu, B. (2007) Entretien avec David Le Breton. *Corps*, 1 (2), 5–8.

Andrieu, B. (2014) Les fondateurs de l'écologie corporelle: immerseurs–naturiens– émerseurs. *Sociétés*, 125 (3), 23–34.

Andrieu, B. (2015*) Immersivité de l'art: interactions, imsertions, hybridations*. Paris: L'Harmattan.

Andrieu, B. and Burel, N. (2014) La communication directe du corps vivant. Une émersiologie en première personne. *Hermès*, 68 (1), 46–52.

Berque, A. (2014) *Poétique de la terre, histoire naturelle et histoire humaine: essai de mésologie*. Paris: Belin.

Clynes, M. and Kline, N. (1960), Cyborgs and space. *Astronautics*, 27 (7), 74–76.

Haraway, D. (1985) A Manifesto for Cyborgs, Science, Technology and Socialist Feminism in the 1980s. *Socialist Review*, 80, 65–108.

Hopes and Fears (2013) The woman who can feel every earthquake in the world [Online] Available from: http://hopesandfeers.com [Accessed: October 9th, 2016].

Kitsou Dubois (2000) Choregraphe de l'apesenteur [Online] Available from: http://www.kitsoudubois.com/wordpress/?page_id=2#anglais [Accessed: November 1st, 2016].

Koninckx, G. and Teneau, T. (2010) *Résilience organisationnelle, rebondir face aux turbulences*. Bruxelles: De Boeck.

Latour, B. and Woolgar, S. (1979) *Laboratory Life: The Social Construction of Scientific Facts*. Princeton: Princeton University Press.

Law, J. and Hassard, J. (1999) *Actor Network Theory and After*. Oxford and Keele: Blackwell and The Sociological Review.

Le Breton, D. (1992) *La sociologie du corps*. Paris: Presses Universitaires de France.

Le Breton, D. (1999) *L'adieu au corps*. Paris: Métailié.

Naess, A. and Rothenberg, D. (2009) *Vers l'écologie profonde*. Marseille: Wildproject Editions.

Paquot, T. (2016) *Géopoétique de l'eau: hommage à Gaston Bachelard*. Paris: Eterotopia France.

Stelarc, (1999) Vers le post–humain. In AA.VV., *Nouvelles de danse 40–41: Danse et nouvelles technologies*. Bruxelles: Contredanse.

Valerie Colette–Folliot (2006) La dance comme acte de langage [Online] Available from: http://www.dansez.com [Accessed: October 26th, 2016].

Smart City Selling? Business Models and Corporate Approaches on the Smart City Concept

Monika KUSTRA[a*], Jörg Rainer NOENNIG[b] and Dominika P. BRODOWICZ [c]

[a] Universitat Oberta de Catalunya; [b] TU Dresden, HafenCity University Hamburg; [c] Warsaw School of Economics

In the era of knowledge economy and rapid technological development related to ICT, open data and IoT, cities became living laboratories where new forms of urban operations are envisioned and introduced. In this regard, cities are markets offering numerous opportunities for the private sector to introduce smart products and services. So far, a considerable amount of literature has been published regarding the theoretical as well as technical aspect of smart city models. Still, there remains a research gap in terms of in–depth empirical studies related to the involvement of the private sector into creating frameworks for a smart city design and implementing business models in cooperation with the public sector. Based on two case studies – cities of Warsaw and Hamburg, the goal of this paper is to discuss the actual involvement of the private sector in establishing smart cities. Firstly, the relation between the smart city term and actions taken, as well as corresponding business models adapted by the private sector regarding this area are discussed. Secondly, empirical case studies' analysis based on semi–structured interviews, secondary data and desktop research was conducted. The results presented may facilitate improvements in strategic urban management and business development.

Keywords: *Smart city; private sector; urban business models; Warsaw; Hamburg*

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[*] Corresponding author: **Monika Kustra** | e–mail: **mkustra@uoc.edu**

Introduction

In the era of rapid technological development coupled with global economic crisis, cities became new markets for private industry in numerous fields including smart products and services. Smart city market is estimated to reach the value of 1.565 trillion USD by 2020 (Frost and Sullivan, 2014). In this context the article aims to stimulate discussion on the involvement of private sector in smart city models development and application of urban business models into urban environments. Therefore, two research questions were addressed: 1) How is the private sector involved in smart city initiatives creation? 2) What are the strategic urban operations, in which smart city solutions are applied most? To explore these questions the research was divided into two phases – theoretical and practical. Based on the literature review, the theoretical part is devoted to the examining the smart city paradigm in terms of the private sector's engagement and urban business models emergence. In the practical part two case studies were analysed, the cities of Warsaw and Hamburg. Both case studies have been built up by desktop research and secondary data analysis, additionally semi–structured interviews with private sector representatives served as the method of analysis in the case of Warsaw and open talks with expert were conducted in the case of Hamburg. These two European cities were chosen based on comparable sizes of area and population. The study was focused on identification of similarities and differences in approach to the issue of introducing private sector products and services in areas traditionally supported by public entities.

Smart city and the private sector

Smart city is a paradigm that has been defined for a number of years by representatives of academia (Albino, Berardi and Dangelico, 2015; Angelidou, 2014; Caragliu, Del Bo and Nijkamp, 2011), the private sector (Falconer and Mitchell, 2012; IBM Institute for Business Value, 2009; KPMG, 2015) as well as international institutions (European Commission, 2014). Nevertheless, one generally accepted definition is lacking. The concept is rather amorphous (Albino, Berardi and Dangelico, 2015) and in principle related to the application of technologies, in particular information and communications technologies (ICT) to solve particular urban problems related to transportation, energy, buildings, waste etc. (Batty et al., 2012; Nam and Pardo, 2011; Paroutis, Bennett and Heracleous, 2013). Therefore,

the relation between technology and cities, especially in terms of the private sector's engagement in smart cities discourse is crucial (Coutard and Guy, 2007). Even if big data and networked computing already form part of daily life (Pickren, 2016), a smart city paradigm is claimed to be a broader ecosystem linking together human, infrastructural, social and entrepreneurial capital (Scuotto, Ferraris and Brescian, 2016). This clearly relates to the STS (Science, Technology and Society) discourse, inter– and transdisciplinary approaches, in particular socio–technical networks (Sauer, 2012), as well as assemblage of human and non–human actors (Coutard and Guy, 2007). See fig. 1 for an exemplification of corresponding data sources between public and private sector and possible value creation. The conceptual linkage of technological and social development becomes particularly important since the broader trends of smart urbanism (Marvin, Luque–Ayala and McFarlane, 2015) would affect not only cities, but the entire built and social environment.
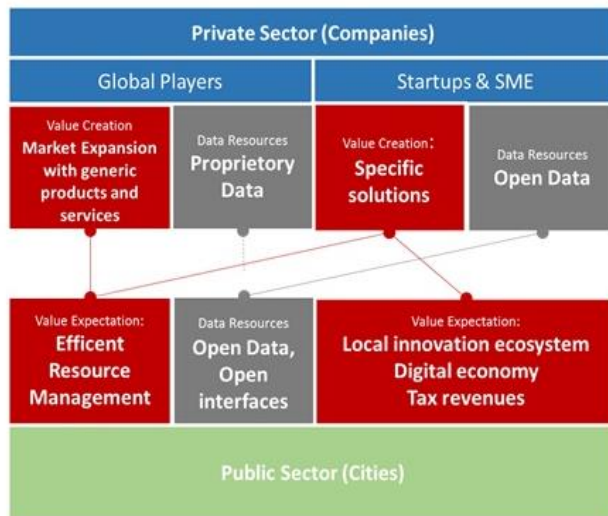
Figure 1   Matching and correspondence of data resource between public and private sector and possible value creation (Source: Authors).

Nonetheless, there is a growing number of critical research on smart city (Hollands 2015; March, 2016; Marvin, Luque–Ayala and McFarlane, 2015; Townsend, 2013). Hollands (2015) draws attention to the fact that currently the smart city model is driven by profits from global technology companies since urban areas are considered to be drivers for innovation (Scuotto,

Ferraris and Brescian, 2016). Firstly, smart city products and services may 'potentially provide ICT companies with alternative growth initiatives' (Paroutis, Bennett and Heracleous, 2013, p. 270). Secondly, the private sector creates demand for smart solutions contributing to the extensive smart city branding (Hollands, 2008). Therefore, the smart city concept is being referred to as a hegemonic corporate term (March, 2016), being described as a business–led, neo–liberal urban utopia (Hollands, 2015) or techno–utopia (Wiig, 2015).

Top vendors in smart city market such as IBM, Cisco, Siemens and Hitachi are all global corporations (Government Technology, 2014). When discussing the private sector, still a further differentiation into large global companies, SMEs and startup companies should be made. Multinational players, who promote themselves as heralds of smart technologies, seek added value mostly through market expansion and penetration. This applies especially to providers of IT infrastructures and services. IT infrastructure companies are now attempting to expand their increasing dominance in field like cloud computing, data storage and analytics. Companies like Google, IBM, and Cisco have discovered urban data business as a highly potential market. The creation of urban data platforms that synergize urban data from various resources is a key component in their market strategy (Hollands, 2015; Söderström, Paasche and Klauser, 2014). On the other hand, local start–up companies and SMEs pursue different models of value creation and business operations. Their smart city products and services usually depart from specific problems and are often based on context determinants such as skilled labour, technology ecosystem, and public funding. In other words, they are more dependent and responsive to local conditions and use open sources and interfaces for products or services development (Klein and Vega–Barachowitz, 2015). Still, local entrepreneurs may be limited in their creation of smart innovation as was the case in the Living Lab project examined by Sauer (Sauer, 2012)**.**

Urban business models

In order to analyse smart city strategies in the private sector, the authors suggest to scrutinise smart operations through a business models approach. Business modelling is used in the field of economics to secure and maintain operations of enterprises and organisations. Recently business modeling has been adopted in the urban context by interpreting key business

parameters from the urban planning and management perspective (Noennig et al., 2016).

Prominent business models applied in urban areas are based on the Open Innovation (OI) model and the Network Innovation Ecosystem model (NIE) (Scuotto, Ferraris and Brescian, 2016). The OI model contributes to innovation creation by exchanging knowledge and linking various stakeholders in a city's operations, i.e. local government, citizens, startups, SMEs, corporations, academia. According to Scuotto, Ferraris and Brescian (2016), the OI approach is beneficial as: 1) industry gets advantages from other stakeholders; 2) companies may not only exploit but also commercialise technologies and test new business models; 3) companies can enlarge the portfolio of their partners through acquiring strategic business partners (Scuotto, Ferraris and Brescian, 2016, p. 360). An example of the OI model are Living Labs, where new urban solutions are being introduced and tested. The NIE model, in turn, is based on exploiting external resources, sharing know–how and participating in co–creation of particular products. The focus is on investment in R&D through providing proactive role of both business and government. Eventually, strategic partnerships are built to 'share knowledge and innovation resources like ICT tools, technology platforms, and e–services application' (Scuotto, Ferraris and Brescian, 2016, p. 359).
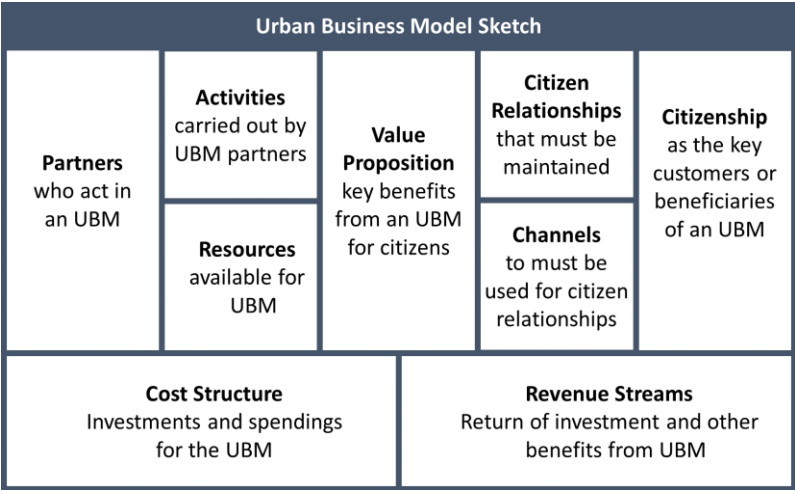
Figure 2   The structure of an Urban Business Model (Source: Knowledge Architecture Lab, TU Dresden).

Adopting the existing methodologies in the field of business modelling and strategic urban planning and management, the methodology called 'Urban Business Modeling' (UBM) was developed to support the systematic generation of new operations and business models in urban settings (fig. 2).

The UBM methodology, which models the cities in analogy to enterprises, supplies urban analysis, assessment of future projects and strategic urban visions. Specified into an urban business model with special focus on the urban data ('Urban Data Business Model', UDBM), the method helps to bring the different smart city models from private and public sectors into one conceptual framework (Noennig et al., 2016).

Warsaw

Smart city concept in Warsaw

Warsaw is one of the biggest cities in CEE region. Its population is estimated at 1,735,442 (Central Statistical Office, 2015). Current Development Strategy of the City of Warsaw towards the year 2020 (UM Warszawa, 2005) does not include references to the smart city model since at that time this concept was a novelty.

In late 2015 work on the revision of the strategy titled #Warsaw2030 began and is due to be finalised in 2017 (UM Warszawa, 2015). Teams working on strategy revise it in accordance to elements enlisted by the European Commission as key to develop a coherent strategy and smart city program (European Commission, 2013). So far the city hall gathered a broad group of experts as well as organized numerous public consultations to create a vision of Warsaw in 2030 as a city of active people, friendly and safe place, and open metropolis (UM Warszawa, 2016). Yet, again this vision does not directly address the concept of smart city, but the idea behind this approach is that smart solutions are supposed to be triggers for a better quality of living.

Smart city projects and applied business models

Warsaw attracts both international capital and domestic investment (Gorzelak and Smętkowski, 2012; Griffith, 2016). It is one of the largest markets for investments in ICT–based solutions not only in Poland, but also in CEE countries in areas like transport, energy and data analytics. In this regard, Warsaw is a market for most of global ICT firms, just to name a few: Microsoft, Google, IBM, HPE, Orange, T–Mobile (Gorzelak and Smętkowski, 2012).

On the basis of primary and secondary research it could be assumed that in terms of business models application, companies active in Warsaw do not offer tailor products or services. Those products, including IoT cloud platforms are already designed and if necessary may be slightly modified. Companies have not changed their business models but modified their products and services according to 'smart' trend to attract cities as new partners. All in all, the field of activity of private sector is generally related to the following connected with each other areas (Table 1):

- ICT and Big Data,
- Buildings,
- Energy.

Table 1   Smart urban operations in Warsaw.

IDENTIFIED AREAS OF SMART URBAN OPERATIONS	DESCRIPTION
ICT, big data	The market is monopolised by global (Microsoft) and domestic (Comarch) corporations offering smart city platforms for management of urban big data, more efficient contact with citizens and providing public safety.
Buildings	Smart technologies are usually implemented in the office building by big development firms. In this regard, an active entity is SKANSKA. Also SMEs and startups offer their services in this fields. This usually concerns tools for building energy management.
Energy	Private companies like Orange (smart meters), Atos (smart grids and meters) and Philips (energy efficient LED lightning) are active in this area.

Without further discussion if approach towards smart city concept in Warsaw is correct or not, it has to be emphasized that cases of smart projects already exist and often include ICT, buildings and energy solutions in one. Due to activity of international corporations including Microsoft and Orange and domestic enterprises like Comarch many smart city innovations applied in Warsaw regard ICT solutions. This includes eagerly awaited by many Varsovians smart parking systems which was commissioned by the Municipal Road Authority to Comarch (UM Warszawa, 2016). Moreover, global corporations sponsor and organize event related to big data and IoT, i.e. Hackathons and Living Labs. e.g. BIHAPI – Business Intelligence Hackathon API (Orange, 2015). In this case, smart city vendors use open innovation business model.

So far flagship projects include 19115 contact telephone number, website and mobile application and 'Virtual Warsaw' project financed by Bloomberg Philanthropies in 'Mayors Challenge' contest to apply beacons for creation of mobile application supporting people with visual impairment in moving around public spaces, buildings and transportation (Ifinity, 2014). Other area in which smart building solutions are applied is the existing building stock and particularly commercial offices. Smart solutions like meters and sensors are applied more frequently to support savings in consumption of energy, water and other resources, and enable effective waste management (e.g. reuse of grey water). To increase efficiency and security of buildings daily operations Building Management Systems (BMS) are being introduced and combined with ICT technologies (Brodowicz, Pospieszny and Grzymala, 2015).
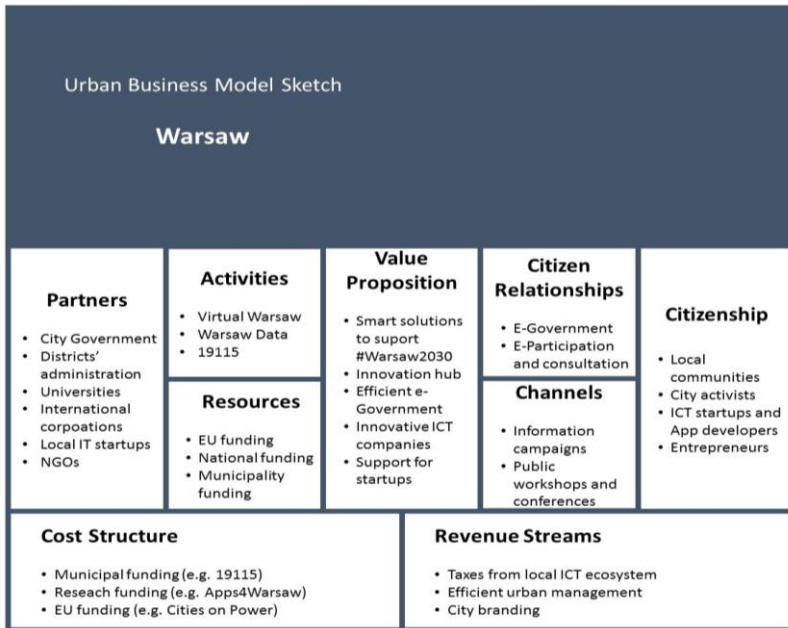
Figure 3   Warsaw Urban Business Model (Source: Authors).

Important city projects related to smart paradigm are also 'Open House' – benchmarking methodology for estimating sustainability of a building (Open House, 2016), 'Cities on Power' – project aiming at investments in renewable energy sources (Cities on Power, n.d.), 'Apps4Warsaw' – open

platform with urban Big Data (NCBiR, n.d.). Moreover, starting with Smart City Forum (Smart City Forum, 2016), City 2.0 – Smart City conference (Computerworld, 2016) and Smart City Warsaw blog (Dominiak, 2015), there is a growing number of networking platforms for cities and various industries (not only those related to Warsaw) to share information about existing and planned projects.

Smart city projects implemented in Warsaw are rather a result of numerous networking initiatives, projects and solutions provided in cooperation between private and public sector rather than solely public decisions. Above mentioned projects and investments are in the majority based on EU funding (Kustra and Brodowicz, 2016). Business models applied are in some cases based on public private partnership, but most of them have a form of cooperation based on public procurement law (fig. 3).

Current state of the research proves that potential areas for business activities that still remain underexplored in Warsaw are consultancy and urban labs. However, consultancy services are offered, there is a considerable gap in terms of smart city consultancy firms on the market. Regarding urban labs, this endeavour may offer concrete innovative advantages to the city and therefore should be subjected to significant investments.

Hamburg

Smart city concept in Hamburg – Hamburg Digital City

The Free and Hanseatic city Hamburg is one of the economic centres in Europe and the second largest city in Germany with 1,8 million inhabitants. Hamburg has clearly committed itself to becoming a Smart City, issuing a Digital City Roadmap ('Leitbild Digitale Stadt') in 2015 (City of Hamburg, 2015). Due to being a city–state without any superior authority on federal state level, public and private actors are closely networked. Institutional distances are short, thus communication processes are quick in politics as well as in the business sphere. This peculiar set–up allows for comparably quick and agile decision making in regards to urban policy and strategy making. Thus, the smart city agenda is strongly driven by the city government and authorities, yet involves a broad partnership of stakeholders, including research and education facilities, startup companies, SME as well large global companies, i.e. Cisco (Cisco, 2014; City of Hamburg, 2014).

As Hamburg is a growing city, various large–scale urban construction projects are going on. Most notable is the new Hafencity (Harbour City), Europe largest urban development project, which increases the inner city area by 40% by re–using former harbour areas (Bruns–Berentelg, 2010). The Hafencity, however, does not follow an explicit Smart City agenda, due to being schemed almost 20 years before. Nevertheless, currently the project is being referred to as a smart endeavour (Cisco, 2014).

Table 2   Smart urban operations in Hamburg.

IDENTIFIED AREAS OF SMART URBAN OPERATIONS	DESCRIPTION
ICT, Big Data	Small enterprises like Breeze work on sensor systems and data analytics. Cisco is an active stakeholder in providing ICT solutions.
Smart Port	SmartPORT initiative by Hamburg Port Authority (HPA) enhances port operations with networked logistics technology and seeks to establish the port as a smart city testbed/model for Hamburg city.
Transport	Research and Development partnership with Volkswagen (2016) was established to transform the city into a testbed for various intelligent transport systems (ITS).
Governance	"Digital First" is the institutional programme of Hamburg's city authorities to develop new effective formats of e-government/data-government, and of participatory exchange with the citizenship.

Smart city activities and applied business models

As a top–level governmental policy, Hamburg's Digital City Agenda is manifested by a number of projects that span across multiple levels of activity. A key activity is the long–term establishment of an urban data platform aiming at integrating all urban data resources, such as environmental, mobility or demographics data. The aim here is to stay independent from proprietary platform solutions as offered by large corporate vendors. In addition, Hamburg has issued a transparent data law, securing that urban data are being processed in a way that citizens can access and investigate them freely (Neuhüttler, 2015).

With key players of the Digital City Agenda, the authors have carried out expert talks, which were documented and analysed in regards to key strategic terms, actor networks, and development agenda. Experts included representatives of Digital City Steering Center of Hamburg, CityScience Lab at Hamburg Hafencity University, Hamburg Authority for Urban Development (including Data Office), Hamburg Port Authority, among

others. Based upon these investigations of smart city initiatives in Hamburg plus secondary data research, it may be affirmed that the field of activity of private sector in Hamburg is generally related to the following areas (Table 2):

- ICT and Big Data,
- Smart Port,
- Transport,
- E–government.

Figure 4   Hamburg Urban Business Model (Source: Noennig et al., 2016).

In the past years, Hamburg – which has an influential, committed, and well–organised citizenship – has established itself as a 'Public participation capital' in Germany, due to numerous urban and social development projects that broadly involved citizens (Petrin, 2012). Following citizen–driven smart city–concepts (Beinrott, 2015), these activities supports the vision of Hamburg as a smart city not only based on IT and CPS technologies (Caragliu, Del Bo and Nijkamp, 2011), but also on networked communities

and e–culture. This turn towards digital culture reflects in several on–going EU funded H2020 research projects, such as *My Smart Life* and *Smarticipate*, and also the *eCulture Agenda 2020* issued by the Cultural Department (Persberichten, 2015).

As upcoming large–scale development project after the Hafencity, urban districts like Rothenburgsort are designated testbeds for smart city solutions. Following Living–lab approaches (Cosgrave, Arbuthnot and Tryfonas, 2013), concepts are being developed to large extent in public–private partnerships both with local as well as with global companies. Focus is on issues such as urban health, urban ecology and sustainable urban development. In cooperation with Cisco, for instance, urban scale demonstrators have been created already for Smart Roads and Smart Lights in the port area. Another cooperation signed with Volkswagen in 2016intends to transform the urban area into a testbed for future urban mobility, supporting the city's application for hosting the eminent conference–fair ITS Intelligent Transportation Systems in 2021 (by this year autonomous vehicle system may be available in Hamburg). Figure 4 presents the complexity and variety of smart initiatives within the urban business model in Hamburg.

To supply on–going Smart City projects on a reliable scientific basis, the city of Hamburg has implemented and funded research initiatives dedicated to digital city research and computer science. A computer science taskforce across all universities in Hamburg is to identify urban key challenges from an informatics perspective, such as communication networks, algorithm design, sensor systems, and data analytics. With similar intention, the City Science Lab at Hamburg HafenCity University was established as a cooperation with the MIT Media Lab to investigate contemporary urban challenges related to digitization (City of Hamburg and Hafencity University Hamburg, n.d.). Other metropolitan research projects aim to clarify the role of citizens participation and interaction within smart community processes (Performing Citizenship, 2016).

Conclusions

One of the more significant findings to emerge from this study is that in light of the current global economic situation, technological advancements, and demographic growth cities remain receptive markets for smart solutions and products. Due to legal obligations, such as the responsibility to provide public transportation, cities are not only clients, but active partners of global

ICT corporations, SMEs and startups serving their smart solutions for everyday's urban life. However, the private sector not only offers products and services, but also creates demand for 'smart' solutions and contributes to the popularisation of the term for marketing and strategic reasons. Thus the collaboration between public and private bodies is ambivalent. Examples of positive outcomes are increased connectivity, information sharing and open data. From a more critical stance, there is a growing conviction that for corporations, cities are just another market to explore and exploit, and to potentially abandon again if economically feasible. Nonetheless the positive examples give proof that even profit driven partnerships between cities and private industry may offer substantial advantages to cities, e.g. value creation based on open innovation business models.

Table 3   Warsaw and Hamburg – concluding remarks.

	WARSAW	HAMBURG
Existing smart city strategy	No explicit smart city strategy	Existing Smart City Strategy, Roadmap "Digital City Vision".
Smart city main promoters	Private sector	Local government
Smart city operations	Big Data/ICT, energy, buildings	Big Data/ICT, Smart Port, Mobility and Transportation, governance.
Selected gaps	Consulting, Urban Labs, transport	Large scale demonstrators, science-to-business cooperation.
Global corporations	Participate actively.	Strong push into selected application areas (e.g. Smart Port), excluded from the urban data platform development.
SMEs and start-ups	Small ecosystem	Small ecosystem

Hamburg follows a smart city initiative actively prepared and promoted top–down by the city authorities, with major companies like Cisco being involved. Still precaution is taken in regards to critical data infrastructures (e.g. urban data platforms), where a vendor–lock–in with private supplies is seen as critical. Here policy–makers advocate open and non–proprietary smart services. The city's digital urban business model (as drawn up by the authors) focuses on digitization and innovation, which is based on OI and NIE business models balancing the private sector engagement with a high public commitment. Warsaw provides another approach, in which companies are triggers for implementation of smart solutions. In terms of Warsaw's smart city approach, no explicit public strategy exists. Nevertheless, qualitative analysis has identified that there is a significant

'smart' technology push both from global as well as domestic companies. Business models applied to this urban environment are based on the OI model.

Regarding targeting of strategic areas for private investments, in both case studies, projects related to Big Data and ICT–based solutions are the most frequent. Moreover, technology–based solutions are the most profitable to be offered by corporations which already own the infrastructure and know–how, previously offered to industrial clients. It may prove the fact that even if products or services are branded as city–tailored, in fact they are not. In addition, the focus on urban operations contributes to the assumption that it is a technology that constitutes the core of a smart city even though both private and public sector may take strong activities to prove the opposite (see e.g. Hamburg's digital participation or e–governance projects). Final remarks regarding the analysis of two case studies are provided in Table 3.

These findings have significant implications for the understanding how the smart city paradigm is evolving and being created, which is essential from the strategic urban planning and management point of view. The scope of this study was limited in terms of case studies. Thus, more detailed research based on empirical case study analysis from a larger number of urban environments is suggested. Further research in this field might also investigate how private sectors business models and public sector urban models – potentially going beyond smart city models – can be brought into one unified framework. To frame the highly dynamic yet divergent developments in 'smart' urban technologies on the one hand, and their implications for urban society, public engagement, social development and cohesion on the other, STS discourses such as technology impact, technology politics and regulation may serve as a reference in further research.

References

Albino, V., Berardi, U. and Dangelico, R.M. (2015) Smart Cities: Definitions, Dimensions, Performance, and Initiatives. *Journal of Urban Technology*, 22 (1), 3–21.

Angelidou, M. (2014) Smart city policies: A spatial approach. *Cities*, 41, S3–S11.

Batty, M., Axhausen, K.W., Giannotti, F., Pozdnoukhov, A., Bazzani, A., Wachowicz, M., Ouzounis, G. and Portugali, Y. (2012) Smart Cities of the Future. *European Physical Journal: Special Topics*, 214 (1), 481–518.

Beinrott, V. (2015) *Bürgerorientierte Smart City: Potentiale Und Herausforderungen*. TOGI–Der Zeppelin–Universität. [Online] Available at: https://www.zu.de/institute/togi/assets/pdf/TOGI–150302– [Accessed: November 16th, 2016].

Brodowicz, D.P., Pospieszny, P. and Grzymala, Z. (2015) *Eco Cities*. Warszawa: CeDeWu.

Bruns–Berentelg, J. (2010) *HafenCity Hamburg: Neue Urbane Begegnungsorte Zwischen Metropole Und Nachbarschaft/Places of Urban Encounter between Metropolis and Neighborhood*. Vienna: Springer.

Caragliu, A., Del Bo, C. and Nijkamp, P. (2011) Smart Cities in Europe. *Journal of Urban Technology*, 18 (2), 65–82.

Central Statistical Office (2015) *Statistical Yearbook of Warsaw*. [Online] Available at: http://warszawa.stat.gov.pl/publikacje–i–foldery/roczniki–statystyczne/rocznik–statystyczny–warszawy–2015,6,12.html [Accessed: November 10th, 2016].

Cisco (2014) *City of Hamburg and Cisco Launch Plans for Smart City of the Future and Lay Foundation for a Partner Ecosystem*. [Online] Available at: https://newsroom.cisco.com/press–release–content?articleId=1414144 [Accessed: November 16th, 2016].

Cities on Power (n.d.) *Cities on Power*. [Online] Available at: http://www.citiesonpower.eu/ [Accessed: September 10th, 2016].

City of Hamburg (2014) *Hamburg and Cisco agree on Cooperation*. [Online] Available at: http://www.hamburg.de/smart–city/4311574/cisco–english/ [Accessed: November 14th, 2016].

City of Hamburg (2015) *Hamburg Smart City*. [Online] Available at: www.hamburgsmartcity.com [Accessed: November 14th, 2016].

City of Hamburg and Hafencity University Hamburg (n.d.) *Finding Places Hamburg*. [Online] Available at: http://www.findingplaces.hamburg [Accessed: November 14th, 2016].

Computerworld (2016) *Miasto 2.0 – Smart City*. [Online] Available at: http://www.computerworld.pl/konferencja/SmartCity2016 [Accessed: November 10th, 2016].

Cosgrave, E., Arbuthnot, K. and Tryfonas, T. (2013) Living Labs, Innovation Districts and Information Marketplaces: A Systems Approach for Smart Cities. *Procedia Computer Science*, 16 (13), 668–677.

Coutard, O. and Guy, S. (2007) STS and the City: Politics and Practices of Hope. *Science, Technology & Human Values*, 32 (6), 713–734.

Dominiak, B. (2015) *Warsaw Smart City Blog*. [Online] Available at: http://www.warsawsmartcity.pl/ [Accessed: November 12th, 2016].

European Commission (2013) *Smart Cities Stakeholder Platform Using EU Funding Mechanism for Smart Cities*. [Online] Available at: https://eu–smartcities.eu/sites/all/files/Guideline–Using EU fundings mechanism for smart cities.pdf [Accessed: November 28th, 2016].

European Commission (2014) *Digital Agenda for Europe: About Smart Cities*. [Online] Available at: http://ec.europa.eu/digital–agenda/en/about–smart–cities [Accessed: November 28th, 2016].

Falconer, G. and Mitchell, S. (2012) *Smart City Framework. A Systematic Process for Enabling Smart+Connected Communities*. Available at: http://www.cisco.com/c/dam/en_us/about/ac79/docs/ps/motm/Smart–City–Framework.pdf. [Accessed: November 28th, 2016].

Frost & Sullivan (2014) *Smart City Market Anticipated to Create Huge Business Opportunities with a Total Market Value of $1.5 Trillion by 2020, states Frost and Sullivan*. [Online] Available at: http://www.frost.com/sublib/display–press–release.do?searchQuery=1.565+trillion&ctxixpLink=FcmCtx3&ctxixpLabel=FcmCtx4&id=289282032&bdata=aHR0cDovL3d3dy5mcm9zdC5jb20vc3JjaC9jYXRhbG9nLXNlYXJjaC5kbz9zZWFyY2hUeXBlPXN1YiZzb3J0Qnk9UiZxdWVyeVRleHQ9MS41NjUrdHJpb [Accessed: October 15th, 2016].

Gorzelak, G. and Smętkowski, M. (2012) Warsaw as a Metropolis: Successes and Missed Opportunities. *Regional Science Policy & Practice*, 4 (1), 25–45.

Government Technology (2014) *Top 10 Smart City Tech Suppliers*. [Online] Available at: http://www.govtech.com/local/Top–10–Smart–City–Suppliers.html [Accessed: October 15th, 2016].

Griffith, J.C. (2016) Metropolitan–wide Governance and an Innovation District: Smart Growth Reforms to Increase Economic Competitiveness in Warsaw, Poland. *Legal Studies Research Paper*, 16 (4), 1–27.

Hollands, R.G. (2008) Will the Real Smart City Please Stand Up? Intelligent, Progressive or Entrepreneurial?. *City*, 12 (3), 303–320.

Hollands, R.G. (2015) Critical Interventions into the Corporate Smart City. *Cambridge Journal of Regions Economy and Society*, 8 (1), 61–77.

IBM Institute for Business Value. (2009) *A Vision of Smarter Cities: How Cities Can Lead the Way into a Prosperous and Sustainable Future*. [Online] Available at: http://www–

03.ibm.com/press/attachments/IBV_Smarter_Cities_–_Final.pdf. [Accessed: September 10th, 2016].

Ifinity (2014) *Milion euro na beacony w Warszawie*. [Online] Available at: http://getifinity.com/milion–euro–na–beacony–w–warszawie/ [Accessed: October 15th, 2016].

Klein, G. and Vega–Barachowitz, D. (2015) *Start–Up City: Inspiring Private and Public Entrepreneurship, Getting Projects Done, and Having Fun*. Washington: Island Press.

KPMG (2015) *Smarter Thinking for Smart Cities*. [Online] Available at: https://assets.kpmg.com/content/dam/kpmg/pdf/2015/10/foresight–34.pdf [Accessed: November 14th, 2016].

Kustra, M. and Brodowicz, D.P. (2016) Implementing Smart City Concept in the Strategic Urban Operations: The Case of Warsaw. In *Proceedings of the 11th Forum on Knowledge Asset Dynamics: Towards a New Architecture of Knowledge: Big Data, Culture and Creativity*. Dresden: IFKAD.

March, H. (2016) The Smart City and Other ICT–led Techno–imaginaries: Any Room for Dialogue with Degrowth? *Journal of Cleaner Production*, 20, 1–10.

March, H. and Ribera–Fumaz, R. (2014) Smart Contradictions: The Politics of Making Barcelona a Self–sufficient City. *European Urban and Regional Studies*, 23 (4), 1–15.

Marvin, S., Luque–Ayala, A. and McFarlane, C. (2015) *Smart Urbanism: Utopian Vision Or False Dawn?*. Abingdon–New York: Routledge.

Nam, T. and Pardo, T.A. (2011) Conceptualizing Smart City with Dimensions of Technology, People, and Institutions. In *12th Annual International Conference on Digital Government Research*. College Park: dg.o.

NCBiR (n.d.) *Dane po Warszawsku*. [Online] Available at: http://www.danepowarszawsku.pl/ [Accessed: October 10th, 2016].

Neuhüttler, J. (2015) *Urban Services. Studie Zu Geschäftsmodellen Für Innovative Stadtdienstleistungen*. Stuttgart: Fraunhofer IAO–IAT der Universität Stuttgart. [Online] Available at: http://www.smart–urban–services.de/wp–content/uploads/2015/04/Urban_Services_2015_Langversion.pdf [Accessed: November 20th, 2016].

Noennig, J.R., Jannack, A., Schmiedgen, P. and Sägebrecht, F. (2016) Urban Business Models (UBM): A New Perspective On City Management and Operations. In *IFKAD, Towards a New Architecture of Knowledge: Big Data, Culture and Creativity*. Dresden: IFKAD.

Open House (2016) *Open House*. [Online] Available at: http://www.openhouse–fp7.eu/ [Accessed: October 10th, 2016].

Orange (2015) *BIHAPI – Business Intelligence Hackathon API*. [Online] Available at: http://www.bihapi.pl/ [Accessed: October 10th, 2016].

Paroutis, S., Bennett, M. and Heracleous, L. (2013) A Strategic View on Smart City Technology: The Case of IBM Smarter Cities during a Recession. *Technological Forecasting and Social Change*, 89, 262–272.

Performing Citizenship (2016) *Graduate School Performing Citizenship*. [Online] Available at: http://performingcitizenship.de. [Accessed: November 10th, 2016].

Persberichten (2015) *SMARTICIPATE – Smart Open Data Services for Open Governance*. [Online] Available at: http://www.nlpersberichten.nl/welovethecity/smarticipate–smart–open–data–services–for–open–governance [Accessed: November 10th, 2016].

Petrin, J. (2012) *Nexthamburg, Bürgervisionen Für Eine Neue Stadt*. Hamburg: Körber–Stiftung.

Pickren, G. (2016) The Global Assemblage of Digital Flow: Critical Data Studies and the Infrastructures of Computing. *Progress in Human Geography*, 1–19.

Sauer, S. (2012) Do Smart Cities Produce Smart Entrepreneurs? *Journal of Theoretical and Applied Electronic Commerce Research*, 7 (3), 63–73.

Scuotto, V., Ferraris, A. and Brescian, S. (2016) Internet of Things: Applications and Challenges in Smart Cities: A Case Study of IBM Smart City Projects. *Business Process Management Journal*, 22 (2), 357–367.

Smart City Forum (2016) *Smart City Forum*. [Online] Available at: http://en.smartcityforum.pl/ [Accessed: October 10th, 2016].

Söderström, O., Paasche, T. and Klauser, F. (2014) Smart Cities as Corporate Storytelling. *City*, 18 (3), 307–320.

Townsend, A.M. (2013) *Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia*. New York: W.W. Norton & Company.

UM Warszawa (2005) *Strategy for the Development of the Capital City of Warsaw up T the Year 2020*. [Online] Available at: http://bip.warszawa.pl/NR/exeres/35BA3E76–B8DF–4B16–928A–E82B76CA4980,frameless.htm [Accessed: September 14th, 2016].

UM Warszawa (2015) *Warszawa aktualizuje strategię rozwoju miasta*. [Online] Available at: http://www.um.warszawa.pl/aktualnosci/warszawa–aktualizuje–strategi–rozwoju–miasta?page=0 [Accessed: October 10th, 2016].

UM Warszawa (2016) *Zaczynamy testy systemu informacji parkingowej*. [Online] Available at: https://zdm.waw.pl/aktualnosci/zaczynamy–testy–systemu–informacji–parkingowej [Accessed: October 10th, 2016].

Wiig, A. (2015) IBM's Smart City as Techno–utopian Policy Mobility. *City*, 19 (2–3), 258–273.

Open innovation e tutela giuridica dell'ambiente. Il caso dell'Open Source Seed Initiative

Roberto Franco GRECO[*][a]

[a] Università del Salento

L'Open Source Seed Inititative è un'iniziativa nata negli Stati Uniti nel 2014 che consiste nell'applicazione della logica open source ai semi. Con l'espressione 'sementi open source' si intendono le sementi non brevettate e riseminabili a cui può accedere chiunque ne faccia richiesta, a patto che si impegni contrattualmente a non trasformare il prodotto e i suoi derivati in beni su cui vantare diritti commerciali esclusivi. La logica è quella tipica dei software open source, fondati sulla gratuità, condivisione e co–creazione dei contenuti. Questi principi hanno da sempre caratterizzato l'attività agricola, facendo dell'agricoltore quel custode della biodiversità da ultimo riconosciuto, in Italia, dalla legge 194/2015. L'iniziativa si colloca in una dimensione giuridica parallela al sistema closed shop dei diritti di proprietà intellettuale sulle risorse biologiche, nel quale l'agricoltore è spesso il passivo acquirente delle risorse biologiche e biotecnologiche di proprietà delle multinazionali. Nel contributo si evidenzia il valore socio–ecologico degli strumenti di open innovation e si esamina l'iniziativa dalla prospettiva della tutela giuridica dell'ambiente, interpretandone i contenuti alla luce dei principi dello sviluppo sostenibile e dell'uguaglianza sostanziale e indagandone le relazioni con i diritti alla diversità e sovranità alimentare dei popoli.

Keywords: Open source; commons; agrobiodiversità; proprietà intellettuale

Introduzione

Questo scritto muove dalla convinzione della necessità di mettere in rilievo, sul piano giuridico, il valore socio–ecologico degli strumenti di 'open innovation' e si propone di partecipare al più generale dibattito sulla

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[*] Corresponding author: **Roberto Franco Greco** | e–mail: **robertofrancogreco@gmail.com**

funzionalizzazione dei sistemi open source come pratiche di 'empowerment' della collettività. Esso ha ad oggetto l'analisi dell'*Open Source Seed Initiative* (da qui in avanti in acronimo OSSI), che sarà osservata dal punto di vista della tutela giuridica dell'ambiente.

L'OSSI è un'iniziativa nata nel 2014 da un'idea di Jack Kloppenburg and Irwin Goldman (University of Winsconsin–Madison) che consiste nell'applicazione della logica open source ai semi. Nell'ambito di numerosi incontri tra centri di ricerca, associazioni di agricoltori, ONG, e rappresentanti delle comunità locali, è stata creata una piattaforma composta da 29 varietà vegetali di 14 colture differenti di 'sementi open source'. Con l'espressione 'sementi open source' si può intendere quelle sementi non brevettate e riseminabili a cui può accedere chiunque ne faccia richiesta, purché si impegni contrattualmente a non trasformare il prodotto e i suoi derivati in beni su cui vantare diritti commerciali esclusivi (clausola *copyleft*). Questa clausola assume rilevanza centrale nel contratto che regola l'accesso ai semi, perché garantisce che qualsiasi pianta derivata dalla selezione di sementi open source resti liberamente accessibile alla collettività e che su di essa non possa essere vantato alcun diritto di privativa industriale. Così si intende assicurare l'efficacia, nel tempo, degli effetti tipici del 'free access approach'. Le varietà dei semi open source devono essere registrate presso il *Center for Food Security*, che ne vaglia la compatibilità con i criteri di sicurezza per l'alimentazione umana (Butruille et al., 2015; Carolan, 2016; Vernooy, Sthapit e Shrestha, 2015; si veda anche http://osseeds.org).

La logica che sta alla base della creazione della piattaforma in questione è quindi analoga a quella dei software open source, governati dai principi della gratuità, condivisione e co–creazione dei contenuti. Questi principi rimandano chiaramente ad un approccio etico–solidaristico all'iniziativa; essi appaiono giuridicamente sintonici ai 'doveri inderogabili di solidarietà politica, economica e sociale' cui fa riferimento l'art. 2 della Costituzione italiana. I citati principi non sono nuovi all'agricoltura, anzi hanno da sempre ispirato le più antiche culture contadine facendo dell'agricoltore quel custode di biodiversità da ultimo riconosciuto, in Italia, dalla legge 194/2015 sulla tutela e valorizzazione della biodiversità di interesse agricolo e alimentare. In particolare, l'art. 3 definisce ''agricoltori custodi' gli agricoltori che si impegnano nella conservazione, nell'ambito dell'azienda agricola ovvero in situ, delle risorse genetiche di interesse alimentare ed agrario locali soggette a rischio di estinzione o di erosione genetica'. La disposizione sembra riflettere l'esistenza di una dimensione solidaristica congenita alla

cultura rurale e al mondo contadino, plasmata nel tempo dalla figura dell'agricoltore che 'custodisce'. Infatti l'agricoltore custode è un agricoltore solidale che esercita l'attività agricola non semplicemente al fine di soddisfare interessi privati di profitto e/o sussistenziali, ma che, attraverso l'attività medesima, fornisce servizi agroecosistemici di utilità pubblica come la conservazione della biodiversità. È dunque riconosciuto all'agricoltore un ruolo di responsabilità nella tutela dei sistemi ambientali, tanto più se si considera che oggi sono le stesse attività agrosilvopastorali a figurare spesso tra i fattori maggiormente impattanti per l'ambiente. La tutela ambientale non può quindi prescindere dalla sostenibilità delle attività agricole (Monteduro, 2013; Monteduro et al., 2015). Ciò è dimostrato tra l'altro dalla relazione tra tutela della biodiversità e cambiamenti climatici, riconosciuta *ex plurimis* dalle Convenzioni sulla diversità biologica e sui cambiamenti climatici del 1992 e oggetto della seconda area tematica della Strategia nazionale per la biodiversità del 2010. Le citate Convenzioni e la Strategia hanno rilevato l'incidenza negativa sulla resilienza dei sistemi ambientali della perdita di biodiversità e della riduzione dei servizi ecosistemici ad essa connessi.

Queste riflessioni introduttive sembrano già sufficienti a giustificare l'interesse che iniziative come l'OSSI possono rivestire in una prospettiva d'analisi giuridico–ambientale. Inoltre la considerazione della dimensione solidaristica come componente consustanziale all'agricoltura permette di creare un parallelo tra presente e passato, che probabilmente trova proprio nella tematica dei semi una delle sue rappresentazioni più nitide: l'antica pratica della condivisione dei semi sembra trovare nell'open source applicato all'agricoltura una sua rivisitazione contemporanea. Per queste ragioni pare corretto leggere l'OSSI come una retro–innovazione, una declinazione dell'intellettualità di massa in grado di agire nell'ambito di una dimensione giuridica alternativa a quella del sistema 'closed shop' dei diritti di proprietà intellettuale sulle risorse biologiche; il sistema che ha favorito l'alienazione sociale delle produzioni e trasformato spesso l'agricoltore da 'custode' in passivo acquirente delle risorse biologiche e biotecnologiche di proprietà delle multinazionali: secondo un documento dell'ETC Group, il mercato mondiale dei semi appartiene oggi, per il 50%, esclusivamente a tre grandi corporation (Then e Tippe, 2014).

Questi dati impongono una riflessione critica sulla disciplina dei diritti di proprietà intellettuale in parola e sulla dimensione politica di tali scelte normative, che sembrano per certi versi esprimere le correnti contraddizioni di quello che è stato definito, nell'ambito dei Critical Legal Studies, come

'legalismo liberale' (Binder, 1987; Boyle, 1985; Kennedy, 1993; Pupolizio, 2009). Le marginalizzazioni e discriminazioni da esso prodotte richiedono soluzioni di giustizia sociale attraverso cui perequare i rapporti di forza nel mercato e riformare i paradigmi classici di proprietà in maniera sostenibile. In questo scenario, un importante ruolo può essere svolto dall'attività di produzione e scambio di informazioni in ambienti non commerciali e non proprietari, come sono tipicamente quelli dei software open source, da parte della c.d. società in rete. In tali contesti, è data agli individui la possibilità di diffondere orizzontalmente informazioni e conoscenze e di autorappresentarsi in progetti cooperativi (Benkler, 2007; Castells, 2008). L'OSSI rappresenta solo una delle tante iniziative (sui semi) fondate sulla condivisione e partecipazione che, anche in ambito nazionale, si stanno diffondendo. Osservando il panorama italiano, con la precisazione che gli esempi citati non esauriscono il novero dei numerosi operatori cc.dd. 'seed saver', sono sicuramente degne di nota la Rete Semi Rurali, l'Associazione Civiltà Contadina e il Gruppo Coltivare Condividendo, che da tempo si impegnano nella tutela dell'agrobiodiversità.

Alcune riflessioni sulla ricostruzione teorica dell'OSSI nel dibattito sui beni comuni

È possibile associare all'OSSI un macro obiettivo di carattere sostanziale forse in grado di rappresentarne il senso nelle sue molteplici declinazioni: la creazione di una categoria di 'Protected Commons'. La categoria presenta delle caratteristiche tipiche che potrebbero essere così riassunte:

(i) l'OSSI è il risultato di un percorso decisionale democratico e partecipato che ha coinvolto le diverse formazioni sociali operanti sul territorio (approccio *bottom up*);

(ii) la piattaforma si compone di beni materiali (i semi) ad accesso libero (componente open source) che vengono contrattualmente protetti dai diritti di privativa industriale tipici della tutela della proprietà intellettuale;

(iii) essa viene alimentata al suo interno dagli agricoltori fruitori del servizio, che condividono le sementi open source con una platea potenzialmente sempre più numerosa di operatori (funzione autopoietica);

(iv) concorrendo alla preservazione ed incremento del livello di differenziazione genetica presente nella piattaforma, gli agricoltori forniscono un servizio agroecosistemico di utilità collettiva.

Questo tentativo di ricognizione esemplificativa delle caratteristiche dell'OSSI, a giudizio di chi scrive, consente di sostenere la peculiarità del

genus di 'protected commons' in questione e di inquadrarne l'analisi nel dibattito sui beni comuni. In questo senso, si può anzitutto notare che le matrici politiche e sociali sottese all'iniziativa sono assimilabili alle generali istanze che hanno portato alla centralità del dibattito sui *commons* nel panorama internazionale contemporaneo. Esse sono riassumibili nella collettiva consapevolezza dell'esistenza di una serie di beni fondamentali per le comunità, che non possono essere mercificati e sottratti alla condivisione perché ascrivibili ad un patrimonio ritenuto comune. Trattasi di beni connessi alla possibilità dei *cives* di avere delle condizioni di vita dignitose perché orientati ad una funzione sociale ed ecologica (Dani, 2014).

Se è facilmente identificabile il *milieu* culturale in cui il fenomeno si radica, lo stesso non può dirsi rispetto alla definizione di bene comune. Infatti, allo stato dell'arte, non sembra possibile individuare una nozione univoca ed esaustiva del concetto, che si presenta 'incerto, fluido, sfuggente, polisemico' (Dani, 2014). I tentativi di ricostruzione dogmatica della categoria si sono tradotti frequentemente nella sua comparazione con istituti ed esperienze del passato. Tra questi vengono spesso richiamati i beni comuni del periodo medievale come i pascoli, le foreste e i corsi d'acqua. Allora, la locuzione 'bene comune' indicava quei beni vincolati da destinazioni d'uso comunitarie che ne garantivano la fruizione ad una specifica collettività ed escludevano coloro i quali di essa non facevano parte (Barnes, 2013; Curtis, 2016; Dani, 2014; Levine, 2001; Richardson, 1946). L'esigenza era quella di evitare che l'eccessivo sfruttamento provocasse il depauperamento della risorsa, determinando, in una delle sue declinazioni, la nota 'tragedia dei beni comuni' prospettata da Hardin (Hardin, 1968).

Nel medioevo siffatto sistema rappresentava sicuramente un modello di welfare virtuoso: i beni comuni erano di vitale importanza per il benessere di ogni singola comunità locale. Oggi, in un contesto in cui le risorse comuni sono più scarse rispetto al passato e i potenziali fruitori sono aumentati, la sua adozione forse rischierebbe di acuire le disparità sociali e le ingiustizie tra i consociati. È opinione di chi scrive che lo stesso rischio possa ripresentarsi ogni qual volta si riflette sulla sostenibilità attuale dei beni comuni secondo approcci ricostruttivi della categoria fondati sull'esclusiva relazione tra l'attributo 'comune' e la *res*. Diversamente si propone di riflettere sull'opportunità di un'inversione di tendenza che, da quello sui beni, conduca al dibattito sui 'servizi comuni', anche alla luce della discussione sui servizi ecosistemici (Costanza et al., 1997). Questa operazione richiederebbe l'aggiornamento delle categorie già esistenti da realizzare mediante il condizionamento sociale ed ecologico dell'esercizio

dei diritti sui beni, qualunque natura essi abbiano. In questo scenario, l'OSSI potrebbe rappresentare un archetipo: privati diventano i semi una volta acquistati dalla piattaforma e verosimilmente tali sono i fondi su cui vengono coltivati; comune, perché rivolto alle generazioni attuali e future, è il servizio di preservazione e tutela della biodiversità agrogenetica erogato. Un processo di questo tipo esigerebbe dalla collettività – da intendersi come centro di imputazione di interessi condivisi tra consociati socialmente ed ecologicamente responsabili – uno sforzo nel verso della sostenibilità. Questa ricostruzione potrebbe trovare un'ancora dogmatica importante nell'aggiornamento di quella formulazione di bene comune di matrice giusromanistica, sussunta, in letteratura, nel c.d. principio del 'tutto–parte'; nel cui ambito il 'tutto', la comunità politica, ingloba le parti, territorio e collettività. Tale rapporto implica la relazione sia tra collettività e cittadino, che tra collettività e territorio (Maddalena, 2012). Questo principio definisce, dunque, un modello di relazioni, che si ritiene possa essere tuttora valido se si realizza l'attualizzazione dei significati di 'tutto' e 'parte'.

Sicuramente, il criterio dell'appartenenza del bene è stato il primo ad emergere ed è quello sulla cui base anche il principio in analisi è stato edificato: la fondazione della comunità politica romana (tutto) dipese dall'impossessamento, ad opera dei Quiriti (collettività/parte), di territori (parte), occupati per la fondazione della città, il cui uso rimase a lungo comune (Maddalena, 2012).

Oggi, il 'tutto' è cambiato diventando parte di un se stesso più grande. Esso è dato dalla complessa realtà multipolare in cui viviamo, che pur conservando i necessari localismi, mostra le interdipendenze e le ambizioni di organicità che condizionano le singole entità politiche che la compongono. Così le decisioni prese in una specifica comunità politica, soprattutto rispetto a particolari materie, devono essere parametrate sulla base degli interessi di una collettività più estesa di quella tradizionale e producono effetti difficilmente localizzabili entro precisi spazi territoriali. Questo concetto di comunità politica 'allargata' trova certamente nell'Unione Europea uno dei suoi esempi più rappresentativi.

In uno scenario di questo tipo, abitato da collettività sovra–territoriali, sembra poco plausibile l'implementazione di un sistema di fruizione comune, e allo stesso tempo equa, dei beni. In definitiva, si ritiene che il principio del tutto–parte, attualizzato di senso, possa configurare, da un lato, uno strumento per giustificare teoricamente l'insostenibilità odierna di politiche sui beni fondate sulla loro fruizione comune e, dall'altro, rappresentare, data la complementarietà dei rapporti tra politica, collettività

e territorio di cui esso è portavoce, un valido paradigma per un auspicato processo di comunizzazione dei servizi che coinvolga orizzontalmente il 'tutto'.

Le principali regole della disciplina dei diritti di proprietà intellettuale sui semi

Le creazioni intellettuali, così come i beni materiali, possono essere soggette a proprietà: la c.d. proprietà intellettuale. Uno degli strumenti attraverso cui essa viene tutelata è il brevetto. I semi, quando vengono brevettati, diventano proprietà intellettuale. È quindi necessario il consenso del titolare del brevetto per il loro utilizzo ed è tendenzialmente vietato ripiantare gli eventuali semi dell'annata precedente. Al titolare del brevetto viene riconosciuto un diritto esclusivo e limitato nel tempo. La normativa comunitaria di riferimento è contenuta nella direttiva 44/1998/CE 'sulla protezione giuridica delle invenzioni biotecnologiche', che in Italia è stata recepita dal D.L. 3/2006 e convertita nella L. 78/2006. La direttiva è figlia degli impegni assunti dalla allora Comunità europea a Marrakech nel 1994, dove venne ufficializzato il c.d. accordo TRIPs sugli aspetti commerciali dei diritti di proprietà intellettuale (Autieri et al., 2016; Fonte, 2005; Scuffi, 2009).

Per quanto riguarda il tema dei semi, qui basti considerare il combinato disposto degli artt. 3 e 4 della direttiva citata. L'art. 4 comma 1 prevede che 'non sono brevettabili: a) le varietà vegetali e le razze animali, b) i procedimenti essenzialmente biologici di produzione di vegetali o di animali'. Il comma 2 dell'art. 3 dispone che 'un materiale biologico che viene isolato dal suo ambiente naturale o viene prodotto tramite un procedimento tecnico può essere oggetto di invenzione, anche se preesisteva allo stato naturale'. Il comma 1 dell'art. 3 chiarisce che 'sono brevettabili le invenzioni nuove che comportino un'attività inventiva e siano suscettibili di applicazione industriale, anche se hanno ad oggetto un prodotto consistente in materiale biologico o che lo contiene, o un procedimento attraverso il quale viene prodotto, lavorato o impiegato materiale biologico'.

Le disposizioni menzionate indicano che ad essere tutelata mediante brevetto è l'invenzione, che rappresenta l'attività intellettuale di intervento biotecnologico sul seme dalla quale deriva la selezione di una varietà vegetale. La protezione del seme è quindi indiretta, in quanto il seme è materiale biologico che contiene l'invenzione. Per materiale biologico 'si intende un materiale contenente informazioni genetiche' (art. 2).

ROBERTO FRANCO GRECO

Effetti ecologici e socio–culturali delle politiche di controllo industriale sui semi

Il quadro normativo sopra accennato è il risultato di un percorso giuridico che, dagli anni novanta, si è consolidato in politiche di controllo industriale sui semi avallate dalla progressiva corporativizzazione del diritto (Mattei, 2011). Per comprenderne la portata storica, bisogna considerare che gli agricoltori, dalla rivoluzione agricola del neolitico, sono sempre stati proprietari dei semi. Diversamente, nello scenario corrente, il brevetto delle sementi risolve tale rapporto di proprietà. Le sementi brevettate non vengono vendute a chi le utilizza, ma piuttosto concesse in uso temporaneo per specifici cicli agricoli. All'agricoltore viene quindi riconosciuto il godimento a tempo determinato della proprietà intellettuale altrui. Così le sementi eventualmente accantonate al termine del ciclo produttivo non appartengono all'agricoltore che le detiene, ma restano di proprietà del detentore del brevetto e non possono essere utilizzate, senza il suo consenso, nel ciclo produttivo successivo. Costituisce reato l'utilizzo per più di un ciclo produttivo delle sementi brevettate. Non a caso si è verificato un incremento vertiginoso dei contenziosi tra multinazionali e agricoltori per violazione della normativa sui brevetti (Vesto, 2014) .

Si è così assistito al ridimensionamento degli spazi di autonomia dei contadini e alla crescita della loro soggezione giuridica ed economica alle multinazionali. Parafrasando Bauman, questa condizione potrebbe essere suggestivamente descritta come 'solitudine dell'agricoltore globale' (Bauman, 2000). È emblematico il caso del *Round–Up–Ready Gene Agreement*, accordo sulla base del quale la Monsanto ha vietato agli agricoltori di vendere, cedere in qualsiasi forma e conservare le sementi presenti al termine del ciclo produttivo, a pena del pagamento di una sanzione pecuniaria pari a cento volte il danno provocato all'azienda dal comportamento illecito (Shiva, 2003).

Nel tempo le multinazionali del sementiero hanno ingegnerizzato un numero sempre più elevato di nuove varietà, create per essere implementate in modelli agricoli ad alto input. Circa l'85% delle principali colture mondiali sono state transgenizzate e rese resistenti a diversi erbicidi, spesso prodotti e commercializzati dalle stesse multinazionali che detengono i brevetti dei semi. Le criticità ambientali di questo modus operandi sono paragonabili a quelle già sperimentate con la 'rivoluzione verde' (Giovannetti, 2009).

Gli effetti della rivoluzione genetica non sono solo prettamente ecologici, ma anche di carattere socio–culturale. I semi sono infatti espressione di

conoscenze e tecniche plurisecolari tramandate da generazione in generazione. Conservare i semi significa anche difendere le diversità culturali (Shiva, 2003), tutelate dall'art. 9 della Costituzione oltre che a livello comunitario e internazionale, e preservare l'humus storico e sociale delle comunità che li custodiscono.

Una lettura dell'OSSI dal punto di vista della tutela giuridica dell'ambiente

La multidimensionalità degli aspetti coinvolti dall'analisi finora effettuata, sul piano giuridico, può essere correlata alla nozione di 'ambiente' contenuta nell'art. 5, comma 1, lett. c) del Dlgs. 152/2006. Ivi si stabilisce che per ambiente deve intendersi il '(…) sistema di relazioni fra i fattori antropici, naturalistici, chimico–fisici, climatici, paesaggistici, architettonici, culturali, agricoli ed economici'.

La disposizione, già solo testualmente, consente di concludere che l' 'ambiente in senso giuridico' si compone, più che dei singoli fattori, delle relazioni fra i fattori in tanto in quanto esse formano un 'sistema' (Monteduro, 2015). Non è dalla mera sommatoria dei fattori che si coglie l'ambiente in senso giuridico, ma dai loro rapporti dinamici all'interno del sistema che li ricomprende. La variazione di un singolo fattore produce effetti su tutti gli altri generando nuovi equilibri e definendo nuove relazioni.

La definizione giuridica di ambiente come sistema di relazioni appare preziosa per un'interpretazione dell'OSSI in chiave giuridico–ambientale. Sulla sua base è possibile anzitutto chiedersi in che misura la disciplina del controllo industriale dei semi, da una parte, e l'OSSI, dall'altra, incidono sugli equilibri del 'sistema ambiente': la selezione biotecnologica dei semi ha portato all'invenzione di varietà vegetali ad alta resa con caratteristiche uniformi e regolari nel tempo. Ciò, di fatto, sta provocando una progressiva omologazione delle colture con conseguente perdita della biodiversità agrogenetica. Dal canto dell'OSSI, la creazione di un sistema di 'Protected commons' del tipo indicato sembra configurarsi quale strumento per il recupero, ove possibile, la tutela e la valorizzazione della biodiversità agraria contrastando la tendenza all'omologazione. Pertanto rileva l'esistenza di una dicotomia tra i due modelli posti a confronto, che riflette le problematiche del più generale rapporto tra sviluppo e ambiente e chiama in causa il principio dello sviluppo sostenibile (art. 3 quater del Codice dell'ambiente italiano, D.lgs 152/2006). Esso è garante di una dimensione giuridica centrata sui doveri, imputabili tanto ai privati cittadini quanto alle

pubbliche amministrazioni (art. 3 quater, cit., comma secondo), che impone ad ogni attività umana giuridicamente rilevante di conformarvisi, di svolgersi in modo tale da garantire che il soddisfacimento dei bisogni delle generazioni attuali non comprometta la qualità della vita e le possibilità delle generazioni future (Fracchia, 2015). Ciò si traduce nel dovere giuridico di preservare la biodiversità agraria di cui oggi godiamo e di contrastarne la perdita.

La lettura costituzionalmente orientata di questo approccio doveristico pone il fine della tutela ambientale in relazione diretta con il mezzo dell'adempimento dei già citati 'doveri inderogabili di solidarietà politica, economica e sociale', nei confronti delle generazioni presenti e future. La declinazione tridimensionale della solidarietà costituzionale può essere sintetizzata nel concetto di solidarietà ambientale. L'interpretazione che si propone si completa mediante la lettura combinata degli artt. 2 e 3 della Costituzione italiana. Perciò l'adempimento dei doveri inderogabili di solidarietà ambientale diviene strumentale al 'pieno sviluppo della persona umana' (comma 2), che non può verificarsi se anzitutto non si garantisce la sopravvivenza della specie attraverso la salvaguardia, tra le altre cose, della biodiversità: questa sarebbe il fine effettivo della tutela tipicamente antropocentrica del diritto ambientale (Fracchia, 2015). Esiste dunque un legame diretto tra sostenibilità ambientale e solidarietà costituzionale, che forse segna il verificarsi di un'evoluzione interpretativa di quest'ultima nel senso della tutela giuridica dell'ambiente.

Riflettendo ancora sugli effetti culturali della perdita di biodiversità agraria, bisogna peraltro considerare l'esistenza di un rapporto di stretta connessione tra coltura e cultura che trova la sua sintesi giuridica nel concetto di diversità alimentare. Non a caso, osservando il panorama italiano, il Decreto del MIPAAF del 9 aprile del 2008 si intitola 'Individuazione dei prodotti agroalimentari italiani come espressione del patrimonio culturale italiano'. Questa relazione tra coltura e cultura esprime la dimensione territoriale/identitaria del cibo, che è ancorata giuridicamente a principi costituzionali di rilievo primario come il principio autonomistico (artt. 5 e 114 Cost) e il principio di differenziazione (art. 118 Cost.) (Monteduro, 2015). In ragione di tale componente identitaria, sono sempre più i popoli che reclamano il diritto alla propria sovranità alimentare e autodeterminazione. Molti moti di protesta popolare contro modelli produttivi globalizzati, dalla 'piazza' sono poi confluiti in iniziative a più ampio raggio. Tra queste pare ragionevole annoverare anche l'OSSI,

considerato che quest'ultima è in controtendenza con l'assetto tradizionale del sistema di tutela della proprietà intellettuale.

A questo punto sembra possibile rendere maggiormente esplicita la funzione ambientale dell'OSSI ricorrendo alla lettera del Codice dell'ambiente (D.lgs. 152/2006). In questo senso:

(i) l'OSSI partecipa alla preservazione della biodiversità agraria, contribuisce alla promozione '(…) dei livelli di qualità della vita umana, da realizzare attraverso la salvaguardia ed il miglioramento delle condizioni dell'ambiente e l'utilizzazione accorta e razionale delle risorse naturali' (art. 2, comma 1 D.lgs.152/2006) e, dunque, concorre a 'salvaguardare il corretto funzionamento e l'evoluzione degli ecosistemi naturali dalle modificazioni negative che possono essere prodotte dalle attività umane' (art. 3 quater, comma 4 D.lgs. 152/2006);

(ii) data la logica open source che promuove la dimensione solidaristica agricola, l'OSSI favorisce l'inserimento del principio di solidarietà '(…) nell'ambito delle dinamiche della produzione e del consumo (..) per salvaguardare e per migliorare la qualità dell'ambiente anche futuro' (art. 3 quater, comma 3 D.lgs.152/2006).

Conclusioni

Ferma la possibilità di identificare nell'OSSI un vettore di tutela ambientale, è necessario tuttavia evitare di trarre l'erronea conclusione secondo cui la fonte del problema della globalizzazione agrogenetica, e delle diverse criticità ambientali che a questa si accompagnano, sarebbe rappresentata dalle biotecnologie in quanto tali. Occorre sgombrare il campo da questo eventuale equivoco, in quanto in diversi ambiti la tecnologia svolge un ruolo di primaria importanza nella tutela ambientale e non solo. La matrice delle conflittualità emerse risiede, piuttosto, altrove: nell'assenza di efficaci meccanismi di regolazione giuridica del mercato quale *locus artificialis*. Infatti, a giudizio di scrive, è la mancanza di contrappesi normativi alle logiche puramente economiche/finanziarie a causare i rischi di 'oligopolio agrogenetico' ed a determinare la difficoltà di tutelare, all'interno del mercato e per suo tramite, diritti fondamentali e interessi costituzionalmente protetti. Ciò accade anche perché la volontà collettiva espressa dalle singole dimensioni normative statali, nell'era della globalizzazione, finisce spesso per essere ridotta alla marginalità. Il rischio è però quello, in assenza di regole adeguate nella dimensione transnazionale, dell'accentuarsi dell'incompatibilità tra le esigenze di sfruttamento

economico delle innovazioni tecnologiche, da un lato, e quelle di tutela ambientale, dall'altro. Per questi motivi si ritiene che il problema debba essere ricercato nel c.d. ordine giuridico del mercato: il mercato è connotato da artificialità, giuridicità e storicità; non è dunque luogo governato naturalisticamente da leggi economiche immutabili e perenni, ma il suo equilibrio deriva da precise tecniche del diritto che danno forma all'economia ed è condizionato dalla mutevolezza storica delle decisioni politiche (Irti, 2004).

In ambito europeo, la guida giuridica al 'condizionamento ambientale' delle politiche, anche di quelle economiche, è rappresentata dal principio di integrazione. Esso rappresenta uno dei principi fondamentali delle politiche ambientali dell'Unione ed esprime il carattere trasversale del diritto dell'ambiente. La sua applicazione comporta che l'adozione di ogni politica, in qualsiasi materia e settore di attività, debba essere condizionata dalla tutela ambientale. La così estesa operatività del principio dipende dalla circostanza che ogni attività umana giuridicamente rilevante possa potenzialmente cagionare danno all'ambiente. Il dovere del legislatore, europeo e nazionale, di parametrare in qualsiasi settore i propri interventi sulla base della tutela ambientale indica che quest'ultima rappresenta parte integrante dei processi di sviluppo e non separabile da essi (Renna, 2012). La reciproca integrazione tra ambiente e sviluppo consente alla tutela ambientale di perdere 'i suoi vetusti caratteri antagonistici rispetto alle logiche dello sviluppo, per divenire, piuttosto, il volano con cui garantire i diritti delle generazioni future'(Renna, 2012) e attraverso il quale ripristinare, nei limiti del possibile, l'infranto 'equilibrio tra il fatto creativo e il fatto distruttivo dell'uomo' (Giannini, 1973).

Sembra dunque necessaria la piena integrazione della tutela ambientale nelle politiche di settore per invertire il trend che attualmente conduce verso la conflittualità tra ambiente e sviluppo.

In definitiva è possibile ritenere che solo condizionando socialmente ed ecologicamente il mercato, e conferendo ad esso una dimensione più 'umana', lo sviluppo tecnologico potrà esprimere le proprie potenzialità in maniera sinergica con l'imperativo della sostenibilità. L'OSSI, in questo scenario, si candida a rappresentare un valido strumento per il perseguimento, con la piena garanzia della tutela ambientale, del 'razionale sfruttamento del suolo' e dell' 'equità dei rapporti sociali' come stabilisce icasticamente l'art. 44 della Costituzione italiana.

Bibliografia

Autieri, P., Floridia, G., Mangini, V., Olivieri, G., Ricolfi, M., Romano, R. e Spada, P. (a cura di) (2016) *Diritto industriale. Proprietà intellettuale e concorrenza*. Torino: Giappichelli.

Barnes, P. (2013) *Capitalismo 3.0. Il pianeta patrimonio di tutti*. Milano: Egea.

Bauman, Z. (2000) *La solitudine del cittadino globale*. Milano: Feltrinelli.

Benkler, Y. (2007) *La ricchezza della rete. La produzione sociale trasforma il mercato e aumenta le libertà*. Milano: Università Bocconi.

Binder, G. (1987) On Critical Legal Studies and Guerrilla Warfare. *The Georgetown Law Journal*, 76 (1). [Online]. Disponibile sul sito: https://ssrn.com/abstract=2567401 [ultimo accesso: 20 febbraio 2017].

Boyle, J. (1985) The Politics of Reason: Critical Legal Theory and Local Social Thought. *University of Pennsylvania Law Review*, 133 (4), 685–778.

Butruille, D.V., Birru, F.H., Boerboom, M.L., Cargill, E.J., Davis, D.A., Dhungana, P., Dill, G.M., Dong, F., Fonseca, A.E., Gardunia, B.W., Holland, G.J., Hong, N., Linnen, P., Nickson, T.E., Polavarapu, N., Pataky, J.K., Popi, J. and Stark, S.B. (2015) Maize Breeding in the United States: Views from within Monsanto. In Janick, J. (a cura di), *Plant Breeding Reviews: Volume 39*. New Jersey: Wiley–Blackwell.

Carolan, M. (a cura di) (2016) *The Sociology of Food and Agriculture*. New York: Routledge.

Castells, M. (2008) *La nascita della società in rete*. Milano: Università Bocconi.

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P. and van den Belt, M. (1997) The Value of The World's Ecosystem Services and Natural Capital. *Nature*, 387, 253–260.

Curtis, R.D. (2016) Did the Commons Make Medieval and Early Modern Rural Societies More Equitable? A Survey of Evidence from across Western Europe, 1300–1800. *Journal of Agrarian Change*, 16 (4), 646–664.

Dani, A. (2014) Il concetto giuridico di 'beni comuni' tra passato e presente. *Historia et Ius*, 6, 1–48.

Fonte, M.C. (2005) Diritti di proprietà intellettuale ed erosione del dominio pubblico nel futuro della produzione alimentare. *Agriregionieuropa*, 3. [Online] Disponibile sul sito: http://agriregionieuropa.univpm.it [ultimo accesso: 20 febbraio 2017].

Fracchia, F. (2015) Il principio dello sviluppo sostenibile. In Rossi, G. (a cura di), *Diritto dell'ambiente*. Torino: Giappichelli.

Giannini, M.S. (1973) Ambiente: saggio sui suoi diversi aspetti giuridici. *Rivista trimestrale di diritto pubblico*, 1, 15–53.

Giovannetti, M. (2009) Agrobiodiversità e Beni Comuni. In Modonesi, C. e Tamino, G. (a cura di), *Biodiversità e Beni Comuni*. Milano: Jaca Book.

Hardin, G. (1968) The Tragedy of the Commons. *Science*, 162, 1243–1248.

Irti, N. (2004) *L'ordine giuridico del mercato*. Roma: Laterza.

Kennedy, D. (1993) *Breve storia dei critical legal studies negli Stati Uniti*. In Arnaud, A. J. (a cura di), *Dictionnaire Encyclopediques de Theorie e Sociologie du droit*. Parigi: Librairie Générale de Droit et de Jurisprudence.

Levine, P. (2001) Civic Renewal and the Commons of Cyberspace. *National Civic Review*, 90, 205–212.

Maddalena, P. (2012) I beni comuni nel diritto romano: qualche valida idea per gli studiosi odierni. *Federalismi.it*, 14, 1–40.

Mattei, U. (2011) *Beni Comuni. Un Manifesto*. Roma: Laterza.

Monteduro, M. (2013) Environmental Law and Agroecology. Transdisciplinary Approach to Public Ecosystem Services as a New Challenge for Environmental Legal Doctrine. *European Energy and Environmental Law Review*, 22, 2–11.

Monteduro, M., Buongiorno, P., Di Benedetto, S. e Isoni, A. (a cura di) (2015) *Law and Agroecology: A Transdisciplinary Dialogue*. Berlino: Springer.

Monteduro, M. (2015) Diritto dell'ambiente e diversità alimentare. *Rivista quadrimestrale di Diritto dell'ambiente*, 1, 88–131.

Pupolizio, I. (2009) I Critical Legal Studies: le contraddizioni del 'legalismo liberale'. In Campesi, G., Pupolizio, I. e Riva, N. (a cura di), *Diritto e teoria sociale. Introduzione al pensiero socio–giuridico contemporaneo*. Roma: Carocci.

Renna, M. (2012) I principi in materia di tutela dell'ambiente. *Rivista quadrimestrale di diritto dell'ambiente*, 1–2, 62–84.

Richardson, H.G. (1946) The Commons and Medieval Politics. *Transactions of the Royal Historical Society*, 28, 21–45.

Scuffi, M. (2009) *Diritto processuale della proprietà industriale ed intellettuale*. Milano: Giuffrè.

Shiva, V. (2003) *Il mondo sotto brevetto*. Milano: Feltrinelli.

Then, C. e Tippe, R. (2014) *Brevetti europei su piante e animali. L'industria dei brevetti sta prendendo il controllo sul nostro cibo? Monaco, No patents on seeds.* [Online] Disponibile sul sito: www.semirurali.net [ultimo accesso: 20 novembre 2017].

Vernooy, R., Shtapit, B. e Shrestha, P. (2015) Epilogue: Vision of the Future. In Vernooy, R., Shtapit, B. e Shrestha, P., *Community Seed Banks. Origins, Evolutions and Prospects*. New York: Routledge.

Vesto, A. (2014) I beni dall'appartenenza egoistica alla fruizione solidale. In Autorino, G. e Stanzione, P. (a cura di), *Comparazione e diritto civile*. Torino: Giappichelli.

SECTION II

Gender, Bodies and Health in Sociotechnical Environments

'The Hard Hat Problem': Women Traveling the World of Computing

Mariacristina SCIANNAMBLO[*][a]

[a] Madeira Interactive Technologies Institute

Gender and feminist STS studies have shown the benefits of using gender as an analytical category in order to problematize not only formal discriminations of women in technoscientific fields, but also gender biases encoded in technical knowledge and professional cultures. According to this view, gender and technoscience are mutually shaped, so that just as gendered beliefs and practices affect the construction of scientific knowledge, so too technoscientific organizations shape the relations between men and women. In the field of computing these processes have been scrutinized by recent studies that put under scrutiny those 'unspoken ideas' on gender that have shaped computing. Against this backdrop, this paper problematizes the experience of Italian women who travel the world of computing as practitioners and academics. The analysis is based on a set of in–depth interviews which aim at addressing the gender gap in computing by questioning the gender assumptions that shape the construction of disciplines, practices, and knowledge surrounding computer technologies. Therefore, rather than emphasizing those mechanisms that keep women outside or at the margins of computing, the paper examines the experience of those women who inhabit the computer world in order to question the alleged gender neutrality of the field.

Keywords*: Gender; women; computing; feminist STS*

Introduction

During the last three decades, feminist theory in Science and Technology Studies (STS) has largely explored the relation between gender, science, and technology. If early STS remind us that scientific and technical worlds are the outcome of collective and material processes (Latour and Woolgar, 1986;

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[*] Corresponding author: **Mariacristina Sciannamblo** | e–mail: **cristina.sciannamblo@m–iti.org**

Pinch and Bijker, 1984), feminist STS problematize such processes by uncovering power differentials, marginal and invisible positions, multiplicities and layers of silence that technoscientific phenomena inevitably produce (Haraway, 1997; Star, 1991). Far from being a homogeneous body of knowledge, the feminist critique of technology has come to terms with the various approaches and issues raised by feminist critical theory. In this respect, we recognize three streams of research by which feminist analysis has articulated its reflections about the gendered character of technology (Cozza, 2008; Faulkner, 2001). A first research path can be phrased as 'women in technology', and addresses the key question 'why are there so few women in technical fields? This approach shapes many institutional and corporate campaigns that aim to recruit women in technical paths.

A second analytical perspective examines the relationship between 'women and technology' by focusing on specific technologies with which women interact, for example, in domestic and work places. This stream develops a reflection on the experience of women as users of technology. As Faulkner (2001) points out, this line of thought tends to hold a dichotomous understanding of technology, seen either as a masculine instrument of control or as an opportunity for the emancipation of women. Both these approaches view technological artifacts as black boxes, disregarding their inner articulation and ambivalence.

In contrast to the perspectives described so far, feminist contributions to STS have framed their analysis in terms of 'gender and technology' (Cockburn and Omrod, 1993; Wajcman, 1991), questioning the mutual shaping of gender relations and technical practices. A key tenet of this approach is the relevant critical stance towards the nature of technology, its use, users, and design processes, which challenges both technological determinism and any assumption about the neutrality of technology.

Against this backdrop, recent studies have come to employ feminist critiques in science and technology in order to investigate the relationship between gender and computer technologies (Abbate, 2012; Balka and Smith, 2000; Misa, 2010). This is a body of research that, starting with the acknowledgment of the gender divide in computing, has developed an interesting set of historical, sociological, and cultural analyses about the interplay between computing and gender in different countries (Corneliussen, 2014; Hicks, 2010; Lagesen, 2007, 2008). The assessment of the imbalance between men and women in computing is the first step required to develop reflections that go beyond the mere assessment of

numbers. As a matter of fact, the scant presence of women in computer science training programs and jobs is a phenomenon that has been well–documented over the last years (Hill, Corbett and Rose, 2010; She Figures, 2015). Besides monitoring the gender equity in technoscientific studies and careers, this line of research suggests the claim that computing is regarded as male territory and, by the same token, that girls show disinterest and disaffection towards computer science. Margolis and Fisher (2002) point out that such feelings are neither genetic nor accidental, but rely upon multiple external factors such as the encounter with a technical culture that women perceive as distant from them, and a variety of discouraging experiences with teachers, peers and school programs.

Following this line of inquiry, this paper problematizes the experience of Italian women who travel the world of computing as practitioners and academics. More specifically, the study has involved women who participate in Italian and international networks, initiatives, and campaigns that confront the problem of the gender divide in computing. The analysis is based on a set of in–depth interviews which aim at questioning the gender assumptions that shape the construction of disciplines, practices, and knowledge surrounding computer technologies. Therefore, rather than emphasizing the mechanisms that keep women outside or at the margins of computing (glass ceiling, leaky pipeline), the paper examines the experience of those women who inhabit the world of computing in order to question the alleged gender neutrality of the field.

The research

This paper provides the results of my doctoral research in which I interviewed Italian women within the field of computing as students, professionals, and academics between the ages of 23 and 71, and involved in networks and initiatives committed to promoting greater female presence and gender awareness in computing. I have conducted nineteen semi–structured interviews and carried out direct observations of six events dedicated to attracting young female students to computer science and IT professions. In doing so, I have tried to detect arguments and rhetoric deployed when recruiting young female students to computer science and computer engineering academic departments, the discursive practices around gender issues in computing and the relationship between women and computing.

Six networks were involved in the study:

- Girls Geek Dinners
- Project NERD? – Sapienza University
- Microsoft Pink Cloud
- Ubuntu Women
- Girls in Tech
- Wister – Women for Intelligent and Smart TERritories

These networks can be defined as such inasmuch over the course of my research I verified that several women involved in the interviews belong to more than one organization, that some of them participate in activities promoted by other groups, therefore most of them know one another. Accordingly, besides promoting networking events to foster the relationships between women and the IT industry, they themselves practice networking (Cozza, 2011) in order to promote and reinforce their goals.

However, despite being connected to one another, these networks present differences in the practices, targets, and goals characterizing their approach. For example, some of them belong to corporate initiatives (Microsoft Pink Cloud), others are developed by open source communities (Ubuntu Women). Some of them are distinctively national initiatives (the Project NERD? at Sapienza University, Wister) while others are international organizations with local branches (Girls in Tech and Girls Geek Dinners).

The interviews I conducted were structured according to three macro–themes: educational paths, gender issues in computing, viewpoints on and experience in informatics. These themes revolve around two main research questions I wish to investigate:

- What is the relationship between women IT professionals and IT technologies?
- How do women problematize gender issues in their technical field?

In addressing these inquiries, the excerpts of interviews presented in the following sections problematize the popular rhetoric that describes computing as an unwelcoming place for women, thus challenging the assumption by which computer science is inherently a masculine domain. According to Keith Grint and Rosalind Gill, the association between technology and masculinity is a cultural and ideological one, but it also seems to be an academic assumption as some writings on the gender–technology relation start their reflections with the understanding that technology is inherently masculine (Grint and Gill, 1995). As a matter of fact, several studies have remarked that women are not alienated from technology as they invented early computing technologies (Light, 1999;

Sciannamblo, 2016) and they continue to have relations with technology which are marked by pleasure and enjoyment (Corneliussen, 2014). Along these lines, women students and professionals I met throughout my research find computing as an empowering, interesting and funny world while, at the same time, they do not disregard the gender issues in the field. In the following sections, I thematize three main issues that emerged from the interviews: the importance of numbers, the dynamic of pinkwashing, and gender troubles women experience in traveling the sociotechnical world of computing. The analysis of the narrative collected has shaped these three analytic dimensions that allow us to see how women travel through and problematize a technical territory that is marked out as predominantly male (Gherardi, 1996). Moreover, the engagement with computer technologies will show how women fashion themselves as critical subjects *of* and *in* male gendered technical culture (Dorrestijn, 2012).

'We are very few': numbers matter

Although computing has been greatly populated by women in the early days of digital computing (Light, 1999; Sciannamblo, 2016), nowadays it represents a typical example of a technoscience that has excluded women (Lagesen, 2007). Indeed, since the early 1980s, various narratives have focused on the exclusion of women, developing an understanding that describes computer fields as technical worlds 'where women and femininity appear as matter out of place' (Sørensen, Faulkner and Rommes, 2011, p. 45). The acknowledgement of the low number of female students in computer science and engineering is also one of the first issues that has come up during interviews with women of different ages. Here is the reflection of Maria, who started studying electronic engineering in 1984:

'When I started engineering at university, there were 10 girls out of 250 students. My group of female students attended throughout the 5 years, so everyday was like this. Then I accompanied my brother to the law department, I took a look around in Crociera Room at University of Milan and I said 'oh, this is a different world'. I studied electronic engineering, actually it was computer science but back then it was all electronic. We were counted according to our surname and the percentage of women was of 4%. But today it has not changed.' (Maria, engineer, member of Girls Geek Dinner)

As Maria points out, the number of female students when she studied electronic engineering at Politecnico in Milan was rather low. Such disparity

was more evident when she got the opportunity to visit the law department where her brother studied, an entirely 'different world' in her words, looking at the differences between the number of men and women.

The scant presence of women in computing is not just an issue affecting educational paths as it becomes more evident in volunteering activities such as those required by open source communities. Here is the reflection of Eva, who recalls the time she has joined the Ubuntu Women community:

'When I arrived, there were very few women. There were no women on the board, no women among the moderators of the forum, there were very few women. It was just a fact of presence, there was no presence, there were very few.' (Eva, communication manager, co–founder of Ubuntu Women Italy)

Here Eva remarks on the first issue that emerges when it comes to the discussion about gender issues in science and technology, namely the actual absence of women. This is not a matter of (in)visibility, namely to make visible the contribution or the presence of women that has been concealed by historical records as Rossiter points out (1993), but it has to do with the very lack of women in this field. While recognizing the shortage of women in computer science can appear an obvious issue, this is anything but trivial insofar as no further inquiries – such as the supposed symbolic and material construction of computing as a masculine realm – would have been posed without the acknowledgement of the absence of women. As several studies have pointed out (Lagesen, 2007; Margolis and Fisher, 2002), the analysis of numbers is crucial in order to even think about gender issues in computing and, then, to explore further readings and approaches to the problem. Additionally, the recognition of a neat disparity in the number of men and women is important inasmuch as it is the basis for the emergence of the women's networks I have examined as well as the first concern that motivates female professionals in computing to join and create these networks in order to promote the presence of women in the field.

Pinkwashing: problematizing the access of women to computing

The fundamental goal driving campaigns toward the promotion of women in computing is to reduce the distance between men and women. In this regard, the women students and professionals I interviewed tended to dispute not only the alleged gender neutrality of the field, but also two commonplaces at the heart of recruitment campaigns and discourses

surrounding computing: that women are particularly good with people and at developing communication skills (Corneliussen, 2014; Lagesen, 2007; Lagesen and Sørensen, 2009), and, by the same token, that they do not particularly like technical and scientific subjects which are often depicted as adverse masculine mastery. However, if the majority of the women I met attributes the choice made to undertake a career in computer science to passion and interest in mathematics and technical tinkering, there also are slightly different experiences, as in the case of Viola, who recounts the time before applying to the computer engineering program as below:

> 'It's a dumb thing, but it went by exclusion. You know, at the beginning I wanted to study communication. I liked the idea of communication, I saw the computer and computer science as a means of communication, able to connect people in order to communicate. However, the educational offer did not convince me because I wondered 'what can I do next?'. I wanted something more technical, more... I do not know how to say, I liked studying, but it [communication] seemed to me little concrete actually, I liked writing but I also liked scientific subjects. Therefore, I eventually landed up in computer engineering because the aspect of communication related to information technology as a computer system, as a way to connect people stood, and it was engineering on the other hand, which had the scientific part I was interested in.' (Viola, engineer, member of Ubuntu Women Italy)

Viola did not consider studying computer engineering as her first choice, but rather it seemed to be a good link between her primary interests (communication) and the need to envision a clear path after university which, in her words, 'something more technical and concrete' like a degree in engineering could offer. In Viola's words, computer engineering as educational path emerges as a crossroad where different motivations converge.

This experience is somewhat at odds with the rhetoric that aims at recruiting women in IT by outlining a supposed model of femininity that sees women as more inclined to communication and social skills. The so–called representation dilemma (SSL Nagbot, 2016), which aims precisely at recognizing the lack of diversity in technoscience along with attempting to push the boundaries of the heteronormative masculine culture of computing, is problematized by Neda, a computer scientist working in the public administration and committed to promoting open source software:

'This issue [shortage of women in computing] is becoming popular to the point that, I dare to say, I have had enough of those initiatives that are also commercially exploited and that always associate the term 'pink' with technologies, which is a really absurd way of trying to fight a stereotype using another stereotype that is pink. This is deadly annoying because the fact of associating the pink to technology gives a wrong message to girls, that is that technology is the candy, the cute thing, it is a simplification of technology that women themselves actually do not hold. So, I don't understand the reason why they are told, like babies, 'do get closer to technologies because they are cute, they are pink'. Rather, we have to explain the real benefits of technology, because there are. Moreover, I am a computer scientist so I speak from personal experience, when women get access to informatics they don't do that superficially, I think the worst nerds that I know are women, so we are not necessarily fascinated by the pink aspect if we want to use the pink term in this way. We are often fascinated by what is behind, the challenge that lies behind informatics, not at all because it is an easy job. They pass on an absolutely distorted message and it's a shame, it is really a shame.' (Neda, computer scientist, open source advocate)

Here Neda exemplifies some crucial issues that define the complexity of the gender–technology relation. Wendy Faulkner considers such relation as lying in the symmetry by which 'just as one cannot understand technology without reference to gender, so one cannot understand gender without reference to technology' (Faulkner, 2001, p. 90). Neda's words problematize precisely this assumption by challenging two opposite material–semiotic associations that regard technology as a traditional masculine domain on the one hand, and the opposite construction of female, thus pink–colored, technologies.

Additionally, in challenging the dichotomous terms whereby technology is gendered, Neda also points to the heteronormative assumptions behind such dualistic understanding of informatics insofar as heteronormativity refers to the relationship between gendered opposites – a male and a female. On the contrary, the claim 'the worst nerds that I know are women' shows how stereotyped gender identities constructed through a likewise stereotyped image of technology come undone in practice.

'The hard hat problem': women traveling through the world of computing

As figures and numbers certify, educational paths and careers in the world of computers are domains quantitatively dominated by men. Nevertheless, there is no lack of women mentors and historical inspiring examples – such as Ada Lovelace to Anita Borg, and Grace Hopper – which are popularized to a great extent by networks aimed at bridging the gender gap in computing. Such availability of references is an important aspect to be taken into account especially when it comes to addressing the age of women involved in the field. This issue has emerged from the field research when I met Frida. She is full professor in Artificial Intelligence (AI). She received her degree in mathematics in 1968, after which she started researching Informatics with a permanent contract in an Italian public research center. When she started working in computer science, there were neither academic programs in informatics in Italy nor the recognition of computer science as an academic subject area.

To borrow a poignant expression from Silvia Gherardi, Frida can be regarded as a woman who has traveled in a male world throughout her career (Gherardi, 1996). Frida is a pioneer, namely someone who paved the way for AI in Italy, a woman in a world totally populated by men. In recalling her career, she claims that she has experienced an overall fair environment in terms of gender dynamics, aside from one particular case, when she moved from introductory courses to the 'real engineering':

> 'When the graduate program in computer engineering set out, I moved to the course of AI. Previously, I taught in a course of the biennium, that is an introductory course, then I moved to a course in the triennium, namely an advanced engineering course: I felt some hostility in the faculty. Because back then a woman teaching in a course of biennium...why not? There are several women that teach mathematics and physics in the biennium, but in the triennium of engineering… engineers are male, a and woman is perceived, or was perceived in 1990…' (Frida, full professor in computer engineering)

Here Frida outlines a division of subjects areas – introductory courses and advanced courses – which are informed by gender asymmetries and presumptions. According to her experience, introductory courses such as mathematics and physics are likely to be taught by women, but when it comes to advanced engineering courses, like AI, a woman is perceived as an intruder (Gherardi, 1996). Therefore, I asked Frida what is it that makes

introductory courses a likely female domain, whereas advanced courses look like a male clubhouse:

'Because in the triennium you have advanced engineering subjects like civil engineering. So in the first two years you learn the tools of the trade, right?! Mathematical tools, physic tools and so on. Then you learn the proper techniques of your engineering, these are what I call engineers with capital 'i'. So I felt some mistrust among faculty colleagues when I had the courage to leave the world of service subjects and enter the world of actual engineers. There are few women who are actual engineers.'

This excerpt shows the extent to which Frida has experienced the gendered division of knowledge within the engineering field. In her view, the more it comes to specialized and technical subjects the more the field is male–dominated. A gendered division of sub–fields emerges, with 'service subjects' taught by more women in the biennium and advanced engineering subjects which were configured as a male domain.

When I asked Frida to explain this supposed distinction between 'harder' and 'softer' engineering, she claimed:

'Well, also in engineering there is the engineer who goes with his hard hat to construction sites and the engineer who goes to offices and sits at the table. […] In the field of information, the graduate program that attracts more women is management engineering because it is without the hard hat.'

The figure of the 'hard hat' is a powerful one, therefore I asked Frida what this object represents for her:

'It means hard life, life you live on construction sites, life in an environment where there are only men, in which you have to lead or control a group of men, so you have to be accepted as chief by a group of men, so it is a working condition not that easy, honestly. Let's say, to be a forerunner or be alone in certain positions, without models for you and for others around you, without previous examples for those around you, this is not easy.'

The hard hat is both a symbolic reference and a material artifact through which Frida describes the prevalent masculine environment that construction sites embody. These are environments commonly associated with manual work, physical strength, risk, danger, noise, dust, elements

that, in turn, are usually associated with a gender identity that corresponds to the heterosexual, able, working–class male. It is this gendered field with the 'hard hat' that Frida describes as hostile in seeing a woman teaching advanced engineering subjects rather than 'service subjects'.

Conclusion

The interplay between gender and technology can be analyzed under a variety of approaches (Cozza, 2008; Faulkner 2011). In this paper I put these approaches to work in order to explore the field of computing, a relatively young technoscientific area that registers one of the lowest percentages of women (She Figures, 2015).

However, notwithstanding the gender imbalance in terms of number that female computer professionals themselves recognize as a pivotal issue, the narratives of women who travel through a technical territory that is marked out as male problematize precisely the alleged neutral character of computing as well as those initiatives that call for 'more women in tech' by reproducing those very gender stereotypes they are supposed to fight. From this point of view, a critical reflexive approach emerges with respect to rhetoric and marketing campaigns aimed at recruiting young women to computer science. In this respect, the term 'pinkwashing' has been employed to describe the exploitation of social and political causes – such as the struggle against breast cancer – by companies to appeal to consumers and sell their products (Lubitow and Davis, 2011). In the case of the interviews presented here, this critique has been moved by women who operate within open source communities towards corporate initiatives that use the color pink – and metaphor – to mark out the company's commitment to promoting more women and gender awareness in technology. This is an important issue inasmuch as it points to the heteronormative, binary character with which the image of computing is associated. Indeed, the marketing strategy of linking computer technology with the color pink reflects the traditional gendered division of labor by which women take up care duties such as housework and childcare, while men play the role of breadwinners focused on career and professional advancement (Rubin, 1975). The critical stance of several women practitioners towards pinkwashing interestingly resonates with Christina Dunbar–Hester's analysis of gendered selfhoods within American radio activists (Dunbar–Hester, 2014). Her account of the good intentions of many radio activists committed to contrasting a hierarchy of technical

participation based on gender roles unveils the reluctance of some women to overcome a traditional feminine domain marked by domestic duties. In her view, such 'reinscription of neotraditional gender roles' operated by female members of radio communities emphasized the complex and nuanced relationships between gendered selfhoods and technical practice, and the thorny challenge of decoupling the hegemonic masculine identity from technical mastery.

Finally, the case of women pioneers who enter male worlds as in the accounts of Frida brings into play elements of reflexivity that deserve attention. Indeed, Frida's experience unveils the contribution of women to the construction of computer science as a new technical field and scientific discipline in Italy. In this regard, 'the hard hat problem' points precisely to the gendered character of technoscientific knowledge inasmuch it is possible to detect a hierarchical order of disciplines such that introductory subjects (mathematics, physics) to the field of computer science are regarded as a female domain, whereas advanced engineering subjects are to be considered as a male domain. This remark calls into question the mutual shaping of political orders and the construction of science (Shapin and Schaffer, 1985), but it mainly identifies the invisible or marginal role of women, thus an asymmetrical order of gender relations behind the advancement of Western knowledge (Haraway, 1997).

References

Abbate, J. (2012) *Recoding Gender: Women's Changing Participation in Computing*. Cambridge: MIT Press.

Balka, E. and Smith, R. (eds.) (2000) *Women, Work and Computerization*. New York: Springer US.

Cockburn, C. and Ormrod, S. (1993) *Gender and Technology in the Making*. London: Sage.

Corneliussen, H.G. (2014) Making the Invisible Become Visible: Recognizing Women's Relationship with Technology. *International Journal of Gender, Science and Technology*, 6 (2), 209–222.

Cozza, M. (2008) Fare e disfare il genere. Studiare la tecnologia in un'ottica di genere. Paper presented at II Convegno nazionale STS Italia: *Catturare Proteo. Tecnoscienza e società della conoscenza in Europa*, Università di Genova, 19–21 June. [Online] Available from: www.stsitalia.org/papers2008. [Accessed: December 8th, 2016].

Cozza, M. (2011) Bridging Gender Gaps, Networking in Computer Science. *Gender, Technology and Development*, 15 (2), 319–337.

Dorrestijn, S. (2012) Technical Mediation and Subjectivation: Tracing and Extending Foucault's Philosophy of Technology. *Philosophy & Technology*, 25 (2), 221–241.

Dunbar–Hester, C. (2014) *Low Power to the People: Pirates, Protest, and Politics in FM Radio Activism*. Cambridge: MIT Press.

Faulkner, W. (2001) The Technology Question in Feminism: A View from Feminist Technology Studies. *Women's Studies International Forum*, 24 (1), 79–95.

Gherardi, S. (1996) Gendered Organizational Cultures: Narratives of Women Travellers in a Male World. *Gender, Work & Organization*, 3 (4), 187–201.

Grint, K. and Gill, R. (eds.) (1995) *The Gender–Technology Relation: Contemporary Theory and Research*. London and Bristol: Taylor & Francis.

Haraway, D.J. (1997) *Modest−Witness@Second−Millennium.FemaleMan−Meets− OncoMouse: Feminism and Technoscience*. New York: Routledge.

Hicks, M. (2010) Meritocracy and Feminization in Conflict. Computerization in the British Government. In Misa, T.J. (ed.), *Gender Codes. Why Women are Leaving Computing*. Los Alamitos, CA: Wiley–IEEE Computer Society.

Hill, C., Corbett, C., and Rose, A. (2010). *Why so Few? Women in Science, Technology, Engineering, and Mathematics*. American Association of University Women.

Lagesen, V.A. (2007) The Strength of Numbers Strategies to Include Women into Computer Science. *Social Studies of Science*, 37 (1), 67–92.

Lagesen, V.A. (2008) A Cyberfeminist Utopia? Perceptions of Gender and Computer Science among Malaysian Women Computer Science Students and Faculty. *Science, Technology & Human Values*, 33 (1), 5–27.

Lagesen, V.A. and Sørensen, K.H. (2009) Walking the Line? The Enactment of the Social/Technical Binary in Software Engineering. *Engineering Studies*, 1 (2), 129–149.

Latour, B. and Woolgar, S. (1986). *Laboratory Life: The Social Construction of Scientific Facts*. 2nd Ed. Princeton: Princeton University Press.

Light, J.S. (1999) When Computers Were Women. *Technology and Culture*, 40 (3), 455–483.

Lubitow, A. and Davis, M. (2011) Pastel Injustice: The Corporate Use of Pinkwashing for Profit. *Environmental Justice*, 4 (2), 139–144.

Margolis, J. and Fisher, A. (2002) *Unlocking the Clubhouse. Women in Computing*. Cambridge: MIT Press.

Misa, T.J. (ed.) (2010) *Gender Codes. Why Women Are Leaving Computing*. Wiley–IEEE Computer Society.

Pinch, T.J. and Bijker, W.E. (1984) The Social Construction of Facts and Artifacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other. *Social Studies of Science*, 14 (3), 399–441.

Rossiter, M.W. (1993) The Matthew Matilda Effect in Science. *Social Studies of Science*, 23 (2), 325–341.

Rubin, G. (1975) The Traffic in Women: Notes on the 'Political Economy' of Sex. In Reiter, R. (ed.), *Toward an Anthropology of Women*. New York: Monthly Review Press.

Sciannamblo, M. (2016) Binary Codes. A Gender–informed Discussion on Professionalism in Nascent Digital Computing. *AG About Gender–Rivista internazionale di studi di genere*, 5 (9), 103–122.

Shapin, S. and Schaffer, S. (1985) *Leviathan and the Air Pump: Hobbes, Boyle and the Experimental Life*. Princeton: Princeton University Press.

She Figures (2015) *She Figures 2015. Women and Science. Statistics and Indicators*. European Community. [Online] Available from: https://ec.europa.eu/research/swafs/pdf/pub_gender_equality/she_figures_2015–final.pdf. [Accessed: December 5th, 2016].

Sørensen, K.H., Faulkner, W. and Rommes, E.W.M. (2011). *Technologies of Inclusion: Gender in the Information Society*. Trondheim: Tapir Akademisk Forlag.

SSL Nagbot, (2016) Feminist Hacking/Making: Exploring New Gender Horizons of Possibility. *Journal of Peer Production*, 8. [Online] Available from: http://peerproduction.net/issues/issue–8–feminism–and–unhacking/feminist–hackingmaking–exploring–new–gender–horizons–of–possibility/. [Accessed: November 9th, 2016].

Star, S.L. (1991) Power, Technologies and the Phenomenology of Conventions: On Being Allergic to Onions. In Law, J. (ed.), *A Sociology of Monsters: Essays on Power, Technology and Domination*. London and New York: Routledge.

Wajcman, J. (1991) *Feminism Confronts Technology*. University Park, Pennsylvania: Penn State Press.

La (in)differenza di genere nella sociomaterialità della scuola steineriana: un'esperienza di ricerca

Camilla BARBANTI*a e Alessandro FERRANTEa

a Università di Milano–Bicocca

La scuola primaria è un luogo tecnologicamente denso, costituito da materiali di uso comune e da materiali specifici per l'apprendimento. Inoltre, nello spazio scolastico attori umani e non–umani si combinano articolando e disarticolando i confini tra i generi.

Il contributo sviluppa la questione della costruzione sociomateriale del genere a partire dai risultati di una ricerca etnografica svolta in una scuola steineriana italiana. In particolare, in esso si intende mostrare le peculiari modalità attraverso cui gli oggetti e le pratiche quotidiane danno vita a dei processi educativi che configurano materialmente il genere. Ciò che emerge dalla ricerca è che la materialità agente nella scuola steineriana non sembra strutturare rigidamente le identità di genere, ma le mette in scena in modo fluido e nomadico.

Keywords: Scuola; apprendimento; genere; actor–network theory; materialità

1. Studi di genere e svolta sociomateriale nella ricerca educativa

La questione del genere è stata posta con forza in ambito pedagogico durante il corso del Novecento, in particolare dal dopoguerra, grazie soprattutto all'apporto dei movimenti femministi (Cambi, 2003; Mapelli e Seveso, 2003). Negli ultimi decenni gli studi sul rapporto tra apprendimento e genere si sono intensificati, mettendo a tema in special modo l'educazione al femminile (Brambilla, 2016; Ulivieri, 2007).

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* Corresponding author: **Camilla Barbanti** | e–mail: **camilla.barbanti@gmail.com**

L'attenzione teorica e politico–educativa al genere è stata sviluppata in senso lato entro la vasta cornice delle pedagogie critiche. Queste hanno avanzato delle proposte formative e hanno progettato degli interventi emancipativi (Hooks, 1994) volti a sfidare i modelli dominanti di genere (Gamberi et al., 2010) e a sollecitare l'emersione negli educandi e negli stessi educatori di nuove competenze e di inedite consapevolezze rispetto alle problematiche connesse al genere. Ciò ha permesso di indagare criticamente e di mettere in discussione abitudini socio–culturali consolidate e pratiche tradizionali di definizione delle identità di genere sia negli spazi intenzionalmente educativi (scolastici e non), sia nei più ampi contesti di apprendimento informale (Brambilla, 2016). Educare a una cittadinanza di genere, alla promozione di una cultura di non discriminazione, al rispetto e alla valorizzazione nei confronti delle differenze si profila come un'operazione quanto mai indispensabile (Padoan e Sangiuliano, 2008), se si considera che le pratiche sociali diffuse e le istituzioni educative, quelle scolastiche *in primis*, hanno contribuito e ancora oggi contribuiscono spesso inconsapevolmente a trasmettere delle rappresentazioni stereotipate di maschile e femminile, concorrendo a riprodurre il binarismo di genere che pervade ideologicamente la società occidentale (Butler, 2004). Ad esempio, è stato rilevato che le pratiche di lettura e di scrittura incidono nella strutturazione delle identità di genere dei bambini (Davies, 1993) e che in alcuni casi i libri di testo delle scuole primarie favoriscono implicitamente un'educazione sessista (Biemmi, 2011).

Gli studi di genere in campo pedagogico, però, hanno sovente trascurato il ruolo attivo della materialità nella costituzione dei soggetti. Nelle scienze sociali, del resto, spazi, arredi, tecnologie, artefatti, oggetti, sono stati considerati a lungo argomenti di interesse minore (Landri e Viteritti, 2016; Sørensen, 2009).

Tuttavia, secondo alcuni studiosi, da circa due decenni è in atto una significativa svolta sociomateriale nella ricerca educativa, resa possibile dall'affermazione nel dibattito internazionale di diverse prospettive che hanno posto al centro delle proprie indagini gli elementi materiali, senza disgiungerli da quelli sociali (Fenwick, Edwards and Sawchuk, 2011). Questi approcci descrivono l'apprendimento, la conoscenza, l'azione didattico–educativa decentrandosi dall'individuo che apprende, conosce, agisce. L'educazione, cioè, non è più pensata come se fosse soltanto una prerogativa umana, un fenomeno meramente culturale, sociale e personale, frutto di relazioni e di comunicazioni intersoggettive tra docenti e studenti, ma è concepita come una performance radicata nella prassi (Edwards,

2012). Essa è l'effetto di assemblaggi immanenti, che includono l'umano e il non–umano (Fenwick e Edwards, 2010). In tal senso, la conoscenza e l'apprendimento non avvengono nelle menti di individui disincarnati che si muovono in un vuoto immateriale, ma sono degli eventi collettivi, ibridi, distribuiti in reti sociomateriali (Viteritti, 2012). Il rinnovato interesse verso la materialità dell'educazione invita pertanto a 'considerare gli oggetti, le tecnologie, i dispositivi, gli spazi quali attori non secondari e in alcuni casi come veri e propri 'protagonisti' delle pratiche e delle politiche educative' (Landri e Viteritti, 2016, p. 7). In questo campo di ricerca la teoria formativa e quella sociale tendono di conseguenza a riorganizzarsi sotto il profilo epistemologico e metodologico per dare rilievo teorico al contributo del non–umano (Ferrante, 2014). In riferimento alle questioni del genere, gli approcci sociomateriali in educazione – e tra questi l'Actor–Network Theory (ANT) (Fenwick e Edwards, 2010; 2012; Sørensen, 2009; Waltz, 2006) – permettono di mettere a tema come, nello spazio scolastico, attori umani e non–umani si combinino articolando e disarticolando i confini tra i generi (Fenwick, Edwards and Sawchuk, 2011).

Il saggio intende contribuire al dibattito sulla costruzione sociomateriale del genere negli ambienti educativi, rifacendosi a tal fine a una ricerca etnografica compiuta in una scuola steineriana italiana. In essa, attraverso l'approccio teorico–metodologico dell'ANT, si sono tracciate le interazioni tra gli elementi eterogenei che nella quotidianità danno forma alle reti scolastiche.

Di seguito si procederà a chiarire brevemente come l'ANT consenta di ripensare l'educazione e la scuola e successivamente si discuteranno alcuni dati emersi dalla ricerca per mostrare come si performino le identità di genere nel contesto esaminato.

2. L'Actor–Network Theory in educazione

La maggior parte degli studi ANT traccia il modo in cui umani e non–umani (piante, animali, microbi, testi, tecnologie, oggetti, ecc.) si connettono, seppur in modo transitorio e imprevedibile, formando delle reti attraverso dei processi di traslazione e delle continue negoziazioni e mediazioni (Latour, 2005).

Dagli anni novanta l'ANT ha cominciato progressivamente a penetrare negli *educational studies*, producendo una consistente mole di ricerche in svariati ambiti (Fenwick e Edwards, 2010, 2012; Landri e Viteritti, 2016). Al di là dello specifico oggetto di volta in volta indagato, la centratura è sempre

posta sui rapporti tra umano e non–umano e sulle dinamiche minute che avvengono in ogni nodo del network. L'intento che orienta le differenti ricerche è di descrivere nel dettaglio i processi sociomateriali tramite cui prendono forma le azioni educative, concentrandosi su ciò che le cose fanno insieme, piuttosto che isolare i singoli agenti.

In linea generale, utilizzare l'ANT negli *educational studies* permette di pensare l'educazione come una pratica agita che comporta una concatenazione di elementi molteplici. L'attività educativa si struttura infatti grazie a traslazioni, negoziazioni, mediazioni tra discorsi, saperi, oggetti, arredi, desideri, emozioni, corpi, documenti, standard, tecnologie, artefatti, spazi. Educare e insegnare sono allora delle azioni incorporate in una materialità irriducibile ai soli umani (Barone, 2014; Ferrante e Sartori, 2016). La classe, in quest'ottica, può essere letta come un reticolo di pratiche più o meno ordinate, stabili e durevoli, sostenute da una pluralità di relazioni tra persone, spazi, oggetti, tecnologie, attività (McGregor, 2004). L'ANT, quindi, guarda ai modi in cui l'apprendimento concretamente si radica nell'azione, porta in primo piano i materiali e la materialità, esplora il mutuo implicarsi di energie umane e non–umane in contesti situati, evitando di separare rigidamente individui e cose. Essa rende visibile l'eterogeneità degli attori che partecipano all'accadimento formativo e si focalizza sulle relazioni tra le entità attraverso cui avviene l'azione, piuttosto che sulle entità in sé stesse come fonte primaria dell'azione.

Secondo l'ANT il materiale non è inerte, ma riveste un ruolo attivo di natura performativa (Fenwick e Edwards, 2013). Le cose agiscono su e con i soggetti e viceversa. La sorgente dell'agire si situa entro dei pattern che producono l'azione formativa in senso ecologico (Viteritti, 2012). L'azione, cioè, è distribuita tra i vari agenti (umani e non) e si costruisce nella relazione tra mondo sociale e materiale. Ciò consente di focalizzarsi su un'*agency* dislocata, trasversale, dispersa in una complessa rete di elementi di diversa natura in connessione tra loro, che sorreggono e modificano la pratica. Il concetto di 'materialità agente' afferisce pertanto a un campo di forze collettivo, ibrido, relazionale e in divenire, che di volta in volta genera conoscenze e apprendimenti (Ferrante, 2016; Sørensen, 2009).

Per quanto concerne la ricerca nella scuola steineriana, l'ANT ha permesso di descrivere la scuola come un 'laboratorio pedagogico' e come un 'ambiente tecnologicamente denso' (Bruni et al., 2013; Crabu, 2014; Landriscina e Viteritti, 2016), costituito da materiali di uso comune e da materiali specifici per l'apprendimento. La scuola rappresenta l'esito emergente dalle complesse interazioni fra soggetti umani e oggetti

tecnologici (Barbanti, 2016). A differenza di altre prospettive pedagogiche più incentrate sulla comprensione delle intenzioni soggettive e sull'analisi delle relazioni interpersonali, dunque, l'ANT ha reso possibile nel corso della ricerca dare spazio alla materialità, lasciando emergere il reticolo di pratiche che coinvolge allo stesso tempo ambienti, persone e oggetti.

Riteniamo infine che l'ANT possa offrire un valido apporto teorico–metodologico ai *gender studies*. L'ANT si contrappone a ogni tipo di essenzialismo e rifiuta qualsiasi assunto fondativo circa la natura umana, sia questa intesa in termini biologici o metafisici. L'identità – quindi anche l'identità di genere – è descritta come un prodotto storico e culturale, che viene costantemente performato nelle interazioni sociali. L'ANT, in tal senso, si connota come un'ontologia performativa (Fenwick e Edwards, 2013) e incoraggia ad abbandonare definitivamente l'idea di un individuo autonomo e separato, altro dal contesto che lo ospita e lo forgia (Landri e Viteritti, 2016). Nello specifico, rispetto ad altre prospettive che caratterizzano gli studi di genere, l'ANT consente di condurre delle ricerche concentrandosi non solo sulle pratiche discorsive e sulle dimensioni di ordine simbolico che incidono nella costruzione del genere, ma anche e soprattutto sul ruolo attivo della materialità nel configurare i processi di soggettivazione. La materialità non viene più concepita come una presenza anonima, inerte e quasi 'invisibile', un dato di fatto, ma diviene un oggetto di interesse e di discussione. L'identità di genere, in ottica ANT, non preesiste alle relazioni sociali e materiali che la pongono in essere ed è il frutto dell'assemblaggio di agenti umani e non–umani. Secondo questo approccio è il network nel suo insieme ad agire e ad avere effetti di potere (Fenwick e Edwards, 2010). Di conseguenza, per analizzare la costruzione sociomateriale del genere l'ANT invita a tracciare e a problematizzare il reticolo di elementi che presiede alla formazione delle identità e al contempo sottolinea il carattere situato, instabile e contingente di ogni processo di definizione identitaria. Ciò apre lo spazio a un ripensamento delle pratiche e delle politiche di genere e sollecita i ricercatori a tenere pienamente conto dell'articolazione dinamica del sociale e del materiale.

3. La ricerca nella scuola steineriana

La ricerca si è svolta tra il 2015 e il 2016 in una scuola steineriana del nord Italia. Le scuole che si ispirano alla pedagogia di Rudolf Steiner sono diffuse in tutto il mondo, specialmente in Europa. In Italia, a oggi, sono trentuno, come riporta la Waldorf World List del 2016. La prima scuola

steineriana, la Libera Scuola Waldorf, fu fondata nel 1919 a Stoccarda dall'industriale Emil Molt e dallo stesso Steiner per permettere di studiare ai figli degli operai della fabbrica di sigarette Waldorf–Astoria.

Da un punto di vista pedagogico, la scuola steineriana è interessante non solamente per l'approccio 'antroposofico' e didattico–educativo che la caratterizza, ispirato appunto alla vasta ed eclettica opera teorica di Steiner, ma soprattutto per la particolare cura posta nei confronti dell'ambiente e dei materiali. La scuola steineriana è concepita da coloro che la abitano come un 'organismo vivente' (Balduino, 1999), gli edifici sono costruiti sia all'interno che all'esterno secondo specifiche architetture, i muri delle aule sono dipinti con colori e tecniche di tinteggiatura particolari, gli artefatti (mobili, corredo scolastico, ecc.) sono anch'essi scelti in modo non casuale. Vi è dunque un'esplicita attenzione ai materiali eterogenei implicati ogni giorno nel fare scuola. L'estrema cura degli spazi, dei materiali e delle relazioni tra adulti e bambini che è osservabile nella scuola steineriana è giustificata dal corpo docente ricorrendo alla struttura concettuale espressa da Steiner rispetto ai presupposti antropologici e formativi che devono sostenere la crescita dei soggetti. Non sorprende quindi che gli/le insegnanti per conoscere e applicare correttamente il metodo steineriano debbano frequentare un lungo e oneroso corso di formazione, che incide significativamente sulle rappresentazioni che hanno del proprio ruolo e dei bambini, ossia di chi sia, possa e debba essere un bambino e di come poterlo e doverlo educare.

Nella ricerca, rifacendosi all'ANT, si è indagata la materialità agente nella scuola steineriana. Si sono studiati quei reticoli di pratiche che coinvolgono allo stesso tempo persone e cose (Bruni e Gherardi, 2007). Ancorandosi ad alcuni artefatti (ad esempio quaderni, flauti, documenti, scaldavivande) si sono esplorate le reti sociomateriali che danno forma alla scuola steineriana e alle pratiche educative che quotidianamente in essa accadono. Gli oggetti, al di là di come vengono di volta in volta definiti – da semplici strumenti inerti a complessi artefatti semiotici – abitano e al contempo costituiscono il mondo (Caronia e Mortari, 2015) e la scuola. Elementi non–umani di ogni tipo (testi, artefatti, regole, banchi, quaderni, ecc.), infatti, articolano il senso (Mattozzi, 2006) e hanno una propria *agency* (Latour, 1996). Grazie a questo approccio nella ricerca si sono tracciate le interazioni tra gli umani e alcuni artefatti presenti nella scuola steineriana, esaminando come si associano, si traducono, esercitano una forza gli uni sugli altri (Fenwick e Edwards, 2010).

Dal punto di vista metodologico la ricerca si è avvalsa di un'osservazione etnografica di circa due mesi continuativi, realizzata seguendo la modalità goffmaniana della 'osservazione asistematica' (Goffman, 1971; Leone, 2009). In seguito a una prima analisi delle osservazioni e delle *field notes* si è proceduto con un secondo accesso al campo, dove si è raccolto del materiale fotografico e sono state condotte delle interviste in profondità, rivolte ad alcune insegnanti dell'istituto.

La ricerca non è stata esplicitamente finalizzata a un'analisi di genere. Nonostante ciò, nel corso dell'osservazione sul campo sono emersi alcuni dati che risultano interessanti se riletti alla luce delle questioni legate al genere. È stato dunque possibile ricostruire come nella scuola steineriana gli oggetti e le pratiche quotidiane (discorsive e non) articolino e disarticolino il genere (Waltz, 2006), dando vita a dei processi di apprendimento che lo configurano materialmente. A tal fine, si è indagato lo specifico sistema di relazioni che coinvolge una molteplicità variabile di elementi: insegnanti, famiglie, bambini, spazi, regole, oggetti, attività, miti, idee, discorsi. Si è così potuto notare che la rete sociomateriale agente nella scuola steineriana non performa una rigida e marcata distinzione tra il maschile e il femminile, ma mobilita delle identità di genere fluide, sebbene ciò non sia privo di aspetti critici, come si vedrà a breve.

4. Genere e scuola steineriana

La scuola steineriana presenta un modello pedagogico peculiare, in larga misura ispirato all'idea propria del suo fondatore che le pratiche formative debbano essere incentrate sulla necessità di individuare e coltivare la personalità autentica dei bambini e delle bambine, incentivando l'emersione spontanea del loro naturale 'temperamento'. In altri termini, il modello educativo steineriano si fonda sull'assunto metafisico che gli alunni possiedano in sé una propria essenza spirituale, la quale è presupposta come un dato di partenza di cui qualsiasi progetto educativo deve tenere conto. Il compito primario della scuola, in questo senso, non consiste nel 'riempire la testa' degli allievi con astratte nozioni, ma nel sollecitare in tutti i modi possibili il bambino a divenire sé stesso, a scoprire chi è, quali sono le sue inclinazioni, le sue tendenze.

L'intero apparato metodologico, didattico e relazionale della scuola steineriana è pensato per realizzare questa finalità educativa e antropologica ed è organizzato in modo da esaltare l'individualità degli alunni. Ad esempio, quando le insegnanti comunicano con il gruppo–classe

nella sua interezza, anziché rivolgersi a un generico 'voi', interpellano una singolarità, un 'tu'. Non dicono 'fate i compiti, prendete il quaderno, non disturbate', ma 'fai i compiti, prendi il quaderno, non disturbare'. La comunicazione non assume come interlocutore un insieme indifferenziato – la classe – ma ogni singolo soggetto presente sulla scena. È sempre l'individuo nella sua unicità a essere chiamato in causa, anche quando la situazione presuppone una collettività. Da quanto si è avuto modo di osservare, ad assumere rilievo nelle pratiche discorsive e nei rapporti interpersonali che connotano la scuola steineriana è la personalità irripetibile dell'alunno, ciò che viene definito come l''essere spirituale' di ciascuno. Nei discorsi che circolano nella scuola il genere è pressoché ignorato, come se non fosse una componente ineludibile dell'identità dei soggetti. La distinzione tra maschile e femminile desta scarso interesse: gli sforzi delle insegnanti sono decisamente più orientati a cercare di comprendere che tipo di temperamenti caratterizzino i bambini e le bambine.

La marcata attenzione all'individualità e l''indifferenza' al genere sono sostenute anche dall'allestimento della struttura materiale della scuola. Gli spazi, gli oggetti, i materiali scolastici sono infatti progettati con l'intento di favorire la scoperta e l'armonico sviluppo delle 'naturali' predisposizioni degli studenti. Ogni alunno è sollecitato a costruire degli oggetti e scegliere il colore delle divise scolastiche secondo i suoi gusti personali, senza che sia incentivato a compiere le sue scelte e le sue azioni seguendo logiche relative al binarismo di genere. Per esempio, entrando nella scuola si può osservare che bambini e bambine, dalla prima alla quinta elementare, indossano delle divise scolastiche che pur avendo una forma alquanto simile (maniche lunghe, strette sul polso da un semplice elastico, girocollo circolare, bordo inferiore lungo fin sopra alle ginocchia, tasche anteriori quadrate) variano di colore. C'è chi indossa un grembiule blu, chi verde chiaro, chi arancione, chi viola, chi rosa, chi azzurro, chi giallo, ecc. A differenza di quanto può accadere ancora oggi in alcune scuole 'tradizionali', in quella esaminata l'azzurro e il rosa non sono associati in modo convenzionale al maschile e al femminile. Vi sono così bambine che vestono grembiuli blu, azzurri, verdi e bambini che ne indossano di gialli, rosa salmone, indaco. Le rappresentazioni sociali più diffuse, che presuppongono una combinazione stereotipata tra determinate cromie e il genere, nel contesto della scuola steineriana non incidono particolarmente nella scelta del colore, al di là di ogni consapevolezza che studenti e insegnanti possono avere in merito al significato 'politico' e culturale del loro comportamento. Inoltre, dato che il

grembiule è a maniche lunghe e arriva poco sopra alle ginocchia, copre quasi per intero gli abiti indossati dai bambini. A livello visivo, ciò attenua ulteriormente le differenze di genere che l'abbigliamento spesso porta con sé. Quello che emerge dall'osservazione, quindi, è che la divisa sfuma le differenze che abitualmente si inscrivono nel vestiario. La decisione da parte della scuola di non imporre una divisa in base al genere e l'assemblaggio sociomateriale 'alunno–grembiule' non evocano in sostanza una netta differenziazione tra maschile e femminile.

Accanto ai grembiuli, nella scuola steineriana vi sono altri oggetti che con la loro presenza performano il genere ed esaltano l'individualità degli alunni. Astucci, quaderni, porta flauto sono confezionati dai bambini stessi insieme all'insegnante di lavoro manuale. Essi hanno per tutti la stessa forma e, ancora una volta, è il bambino a scegliere i colori, le stoffe e il modo di decorarli, personalizzandoli. Ciò fa sì che non entri fisicamente a scuola un corredo scolastico che incorpora le logiche commerciali e consumistiche dominanti, le quali di frequente veicolano e inscrivono anche nello spazio scolastico un forte binarismo di genere. Si pensi a titolo esemplificativo alle copertine dei quaderni raffiguranti i personaggi dei cartoni animati, sia italiani sia stranieri, che spessissimo prevedono e si rivolgono a un pubblico differenziato proprio in base al genere (ad esempio 'Winx' e 'Naruto'). La rete sociomateriale della scuola steineriana, dunque, include determinati attori umani e non–umani e al contempo ne esclude altri.

Nelle lezioni di lavoro manuale e di falegnameria a cui si è assistito durante la ricerca, inoltre, bambini e bambine partecipavano insieme e indistintamente a diverse attività – lavoro a maglia, tessitura, ricamo, intaglio, raspatura, segatura del legno – senza che fosse messa in atto una ripartizione differenziale delle stesse in base al genere. Ciò fa sì che il sistema scolastico non riproduca la tradizionale associazione di certe pratiche con un genere specifico.

Per quanto visto, la scuola steineriana tende a essere autoreferenziale, nel senso che si costituisce come una sorta di 'mondo nel mondo', una parentesi spazio–temporale distinta dalla vita diffusa e per certi versi contrapposta a essa, un ambiente esclusivo ed escludente, in cui vigono regole, discorsi, abitudini, idee, prassi spesso distanti da quanto avviene in altri ambienti sociali o in istituzioni scolastiche che adottano approcci differenti. La separatezza tra la scuola steineriana e gli altri contesti è istituita e mantenuta attraverso un insieme eterogeneo di fattori: discorsi 'esoterici' che richiamano alcuni elementi dell'antroposofia steineriana, rituali di accoglienza e di chiusura che segnano materialmente e

simbolicamente l'ingresso e l'uscita dei soggetti dai percorsi formativi, la presenza di arredi, di materiali e di oggetti – perlopiù di origine naturale (legno, ecc.) – appositamente predisposti per costruire un ambiente *ad hoc* rispettando quanto più possibile i dettami di Steiner, l'obbligo per gli alunni di indossare un grembiule colorato che ricopre quasi interamente i loro abiti e che dunque riveste un valore iniziatico, il divieto assoluto di usare artefatti, specialmente tecnologici (cellulari, computer, videogiochi, ecc.) all'interno dell'edificio scolastico, il fatto che la maggior parte del corredo scolastico è realizzato dai bambini stessi. Tutto ciò concorre a produrre un regime materiale–discorsivo con proprie logiche, propri criteri, proprie procedure interne, che lascia volutamente sullo sfondo e in buona misura ignora pratiche e abitudini apprese dai bambini in altri *milieu* socio–culturali. Di conseguenza, se da un lato la scuola steineriana in effetti non promuove discriminazioni basate su un rigido binarismo di genere, dall'altro non permette neppure che gli apprendimenti di genere acquisiti dai bambini (in famiglia, tramite la fruizione dei media, nel gruppo dei pari, ecc.) trovino nella scuola uno spazio di espressione e di rielaborazione sociale, cognitiva e affettiva. Dal punto di vista educativo, l'impostazione steineriana trascura il genere come dimensione rilevante dell'esistenza e incorre nel rischio che l'esperienza che gli alunni fanno a scuola sia in qualche modo scissa da quella che avviene in altri contesti. L'attenzione al temperamento individuale dei soggetti conduce le insegnanti a disinteressarsi di un'educazione scolastica al genere e in definitiva lascia che siano solo i processi di socializzazione informale a determinare il modo concreto con cui ciascun alunno fa esperienza del genere, a scuola e al di fuori di essa.

Inoltre, la scuola steineriana è alimentata dal mito di un bambino libero di divenire ciò che è, che non deve fare altro che scoprire il proprio temperamento 'naturale', la propria essenza spirituale. L'osservazione delle pratiche sociomateriali in atto nella scuola consente tuttavia di affermare che l'individualità dei soggetti è attivamente costruita grazie alla concatenazione di elementi umani e non–umani. Essa perciò non è affatto un *a priori*, qualcosa che esiste al di fuori del network in cui si realizza. La scuola fabbrica l'individualità e la singolarità dei soggetti. L'intento di svelare il temperamento naturale, ad esempio, induce a effettuare persistenti richieste agli studenti di esprimere le proprie preferenze, creare artefatti, e così via, come se questo complesso di attività potesse aiutare i bambini e le insegnanti a decifrare la vera indole di ciascuno. In questo modo, però, la scuola non opera maieuticamente su individui dati, non trae fuori dai soggetti qualcosa che già c'è, ma li modella attivamente, li costituisce. Gli

esempi che abbiamo riportato in precedenza non indicano di conseguenza che il bambino sia del tutto libero e non subisca condizionamenti di nessuna natura, quanto piuttosto che nel contesto della scuola è ideologicamente e pragmaticamente presupposto come soggetto–di–scelta. Egli è invitato a scegliere, anzi *deve* scegliere, è costretto dal dispositivo scolastico a indicare le sue preferenze, a esplicitare i suoi gusti, a manifestare la propria creatività. Tale vincolo normativo porta alla formazione di un network costituito dagli alunni, dai docenti, dai genitori, dalle regole del contesto, dalla materialità in atto, che provoca come effetto l'attribuzione a ogni individuo della capacità di essere un soggetto–di–scelta. Sebbene la scuola faccia corrispondere tale soggetto alla figura singolare di un bambino o di una bambina, nella nostra analisi risulta essere un aggregato di umano e non–umano, un collettivo ibrido: una qualsiasi decisione, infatti, può essere presa dai bambini solo nella misura in cui fanno parte di un reticolo sociomateriale che li esorta continuamente a percepirsi ed essere percepiti dagli altri come titolari di una possibile scelta. L'analisi condotta, in sintesi, mostra che le identità che si configurano nella scuola steineriana non preesistono alle pratiche, ma sono il prodotto di incessanti processi di costruzione, che presuppongono interazioni dinamiche e complesse tra agenti umani e non–umani. In ultima istanza, quindi, la retorica essenzialista ostacola la comprensione critica da parte delle insegnanti dei meccanismi di potere agenti nel contesto scolastico.

5. Conclusioni

L'analisi delle osservazioni a cui si è sinteticamente accennato tramite gli esempi riportati induce a sostenere che nella scuola steineriana esaminata sia ravvisabile una sorta di 'indifferenza' di genere a livello istituzionale. Questo non significa che siano del tutto assenti delle norme legate al genere, né che gli alunni vengano desessualizzati, o che non esista alcuna distinzione fra maschi e femmine, quanto piuttosto che la materialità in atto non produce assi sistematici di differenziazione di genere.

La differenza fra i soggetti viene spostata prevalentemente da un piano di accentuata caratterizzazione culturale di genere a un piano di 'tipi individuali' in via di formazione e di sviluppo. Ad acquisire rilevanza, cioè, non sono le differenze di genere in quanto tali, ma le pratiche di differenziazione tra individui. Queste non passano da un'unica linea di demarcazione che separa nettamente e in modo dualistico il maschile dal femminile, ma si inscrivono entro una pluralità di processi che mettono in

scena in modo fluido e nomadico le identità dei singoli soggetti (Braidotti, 1994). Di conseguenza, nella scuola steineriana avviene una riconfigurazione dei parametri di intelligibilità grazie a cui diviene possibile leggere in situazione il quotidiano 'farsi e disfarsi del genere' (Butler, 2004).

Ciò tuttavia riveste un significato ambivalente. Da una parte, infatti, consente di evitare che l'istituzione scolastica legittimi e consolidi al proprio interno delle logiche legate al dualismo tra maschile e femminile, dall'altra però rende difficoltoso rielaborare pedagogicamente nel contesto protetto della scuola gli apprendimenti informali di genere con cui, volenti o nolenti, i bambini e le bambine si confrontano quotidianamente dentro e al di fuori delle mura scolastiche.

Attribuzione dei paragrafi

Il presente lavoro deriva dalla collegiale condivisione degli autori. I paragrafi 1–2–5 sono a cura di Alessandro Ferrante, i paragrafi 3–4 sono a cura di Camilla Barbanti.

Bibliografia

Balduino, L. (1999) La scuola, un organismo vivente. Il ruolo dei genitori nella scuola steineriana. *Mercurio il notiziario della scuola di Torino di via Giordano Bruno 3*, 18–21.

Barbanti, C. (2016) La scuola: una miriade di assemblaggi sociomateriali. Nuovi quesiti, processi e oggetti nella ricerca in ambito educativo attraverso l'approccio dell'Actor–Network Theory. *Scuola Democratica. Learning for Democracy,* 7 (1), 183–198.

Barone, P. (2014) Embodiment, formazione e post–umanesimo. In Barone, P., Ferrante, A. e Sartori, D. (a cura di), *Formazione e post–umanesimo. Sentieri pedagogici nell'età della tecnica*. Milano: Raffaello Cortina.

Biemmi, I. (2011) *Educazione sessista. Stereotipi di genere nei libri delle elementari*. Torino: Rosenberg & Sellier.

Braidotti, R. (1994) *Nomadic Subjects: Embodiment e Sexual Difference in Contemporary Feminist Theory*. New York: Columbia University Press.

Brambilla, L. (2016) *Divenir donne. L'educazione sociale di genere*. Pisa: ETS.

Bruni, A. e Gherardi, S. (2007) *Studiare le pratiche lavorative*. Bologna: Il Mulino.

Bruni, A., Pinch, T. e Schubert, C. (2013) Technologically Dense Environments: What For? What Next?. *Tecnoscienza: Italian Journal of Science & Technology Studies*, 4 (2), 51–72.

Butler, J. (2004) *Undoing Gender*. New York–London: Routledge.

Cambi, F. (2003) *Manuale di storia della pedagogia*. Roma–Bari: Laterza.

Caronia, L. e Mortari, L. (2015) The Agency of Things: How Spaces and Artefacts Organize the Moral Order of an Intensive Care Unit. *Social Semiotics*, 25 (4), 401–422.

Crabu, S. (2014) Allineare umani, tecnologie e saperi: il lavoro infrastrutturante negli ambienti tecnologicamente densi. *Studi Organizzativi*, 16 (1), 50–72.

Davies, B. (1993) *Shards of Glass. Children Reading and Writing Beyond Gendered Identities*. Sydney: Allen & Unwin.

Edwards, R. (2012) Theory Matters: Representation and Experimentation in Education. *Educational Philosophy and Theory,* 44 (5), 522–534.

Fenwick, T. e Edwards, R. (2010) *Actor–Network Theory in Education.* London: Routledge.

Fenwick, T. e Edwards, R. (a cura di) (2012) *Researching Education Through Actor–Network Theory*. London: Wiley–Blackwell.

Fenwick, T. e Edwards, R. (2013) Performative Ontologies. Sociomaterial Approaches to Researching Adult Education and Lifelong Learning. *European Journal for Research on the Education and Learning of Adults*, 4 (1), 49–63.

Fenwick, T., Edwards, R. e Sawchuk, P. (2011) *Emerging Approaches to Educational Research: Tracing the Socio–material*. London: Routledge.

Ferrante, A. (2014) *Pedagogia e orizzonte post–umanista*. Milano: LED.

Ferrante, A. (2016) *Materialità e azione educativa*. Milano: FrancoAngeli.

Ferrante, A. e Sartori, D. (2016) From Anthropocentrism to Posthumanism in the Educational Debate. *Relations. Beyond Anthropocentrism*, 4 (2), 175–194.

Gamberi, C., Maio, M.A. e Selmi, G. (a cura di) (2010) *Educare al genere. Riflessioni e strumenti per articolare la complessità*. Roma: Carocci.

Goffman, E. (1971) *Relations in Public: Microstudies of the Social Order*. London: Allen Lane.

Hooks, B. (1994) *Teaching to Transgress: Education as the Practice of Freedom*. New York: Routledge.

Landri, P. e Viteritti, A. (2016) Introduzione. Le masse mancanti in educazione. *Scuola Democratica. Learning for Democracy*, 7 (1), 7–22.

Landriscina, R. e Viteritti, A. (2016) Sociomaterialità in classe. Pratiche di innovazione didattica. *Scuola Democratica. Learning for Democracy*, 7 (1), 93–115.

Latour, B. (1996) On Actor–Network Theory: A Few Clarifications. *Soziale Welt*, 47, 369–381.

Latour, B. (2005) *Reassembling the Social. An Introduction to Actor–Network Theory*. New York: Oxford University Press.

Leone, S. (2009) *Erving Goffman: formazione e percorsi di ricerca*. Milano: FrancoAngeli.

Mapelli, B. e Seveso, G. (2003) *Una storia imprevista. Femminismi del Novecento e educazione*. Milano: Guerini.

Mattozzi, A. (a cura di) (2006) *Il senso degli oggetti tecnici*. Roma: Meltemi.

McGregor, J. (2004) Spatiality and the Place of the Material in Schools. *Pedagogy, Culture & Society*, 12 (3), 347–372.

Padoan, I. e Sangiuliano, M. (a cura di) (2008) *Educare con differenza. Modelli educativi e pratiche formative*. Torino: Rosenberg & Sellier.

Sørensen, E. (2009) *The Materiality of Learning. Technology and Knowledge in Educational Practice*. New York: Cambridge University Press.

Ulivieri, S. (a cura di) (2007) *Educazione al femminile. Una storia da scoprire*. Milano: Guerini.

Viteritti, A. (2012) *Scienza in formazione. Corpi, materialità e scrittura in laboratorio*. Milano: Guerini.

Waltz, S. (2006) Nonhuman Unbound: Actor–Network Theory and the Reconsideration of 'Things' in Educational Foundations. *Journal of Educational Foundations*, 20 (3–4), 51–68.

La sicurezza come pratica materiale di coordinamento. Il caso dell'introduzione di un sistema per la gestione della terapia oncologica

Silvia FORNASINI [*a], Enrico Maria PIRAS[a] e Francesco MIELE [a]

[a] Fondazione Bruno Kessler

I benefici che le tecnologie dell'informazione possono apportare alla somministrazione sicura di farmaci sono stati ampiamente esplorati in letteratura. Esiste tuttavia un vasto consenso sulla necessità di considerare sia i protocolli formali sia le pratiche di lavoro informali nella progettazione di sistemi informatici che possano efficacemente supportare processi di coordinamento complessi come quelli necessari per la gestione farmacologica. Attraverso il presente contributo indagheremo il processo di introduzione di un nuovo sistema di somministrazione sicura della terapia illustrando i risultati di una ricerca qualitativa svolta in due reparti di oncologia medica del Nord Italia. La ricerca ha messo in luce come la sicurezza del sistema, che dovrebbe essere garantita da protocolli formali standardizzati, venga supportata da pratiche informali, conoscenza situata e lavoro di articolazione, che permettono il coordinamento tra i diversi attori. La ricerca ha inoltre svelato come, nonostante le micro–politiche che l'introduzione del nuovo sistema vorrebbe imporre attraverso il controllo dei superiori sullo staff, la sicurezza del processo venga garantita dal lavoro di articolazione e dal mutuo controllo tra le diverse figure professionali.

Keywords: Gestione farmacologica; oncologia; sicurezza; coordinamento; lavoro di articolazione

Introduzione

Una delle maggiori sfide all'interno dei sistemi sanitari è la somministrazione efficace e sicura delle terapie, questione che si fa

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[*] Corresponding author: **Silvia Fornasini**| e–mail: **s.fornasini@fbk.eu**

particolarmente rilevante nel campo dell'oncologia medica, visto l'alto grado di tossicità dei farmaci chemioterapici (Phillips et al., 2001). Il processo di prescrizione, preparazione e somministrazione dei trattamenti chemioterapici è complesso e gli errori possono avere conseguenze significative sulla salute dei pazienti. Le tecnologie dell'informazione (IT) pensate per favorire il coordinamento all'interno e tra reparti ospedalieri, sono una delle risposte alla avvertita necessità di semplificare il flusso di lavoro, ridurre gli errori e aumentare la qualità, l'efficienza e la sicurezza del sistema sanitario (Bubalo et al., 2013; Kohn, Corrigan e Donaldson, 2000).

Attraverso il presente contributo indagheremo il processo di introduzione di un nuovo sistema di somministrazione sicura della terapia illustrando i risultati di una ricerca qualitativa svolta in due reparti di oncologia medica del Nord Italia. Ci si focalizzerà sul processo di introduzione del nuovo sistema, mostrando come esso abbia dovuto essere integrato con i sistemi esistenti, e come abbia richiesto una modifica delle pratiche lavorative ed implicato nuove complesse pratiche sociomateriali e specifici know–how. Mostreremo quindi, da una parte, come la somministrazione sicura dei farmaci sia accompagnata da un rimodellamento delle pratiche di coordinamento; dall'altra, ci concentreremo su come questo possa comportare una ridefinizione della divisione delle responsabilità tra i lavoratori, rafforzando – formalmente, ma non nella pratica – il controllo dei responsabili sullo staff.

Fondamenti teorici

Negli ultimi decenni il coordinamento tra gli attori della cura è stato affidato anche a tecnologie dell'informazione e della comunicazione. La specializzazione crescente ha condotto al design e all'implementazione di sistemi dedicati per ogni esigenza, dalla raccolta longitudinale di informazioni alla gestione di immagini diagnostiche. Con il nome di Computerized Physician Order Entry (CPOE) ci si riferisce a quei sistemi ideati per facilitare la gestione delle terapie migliorando la sicurezza e la precisione della somministrazione e l'efficienza complessiva del processo.

Analogamente a quanto accade con altre IT sanitarie, questi sistemi si propongono due macro obiettivi connessi ma distinti: il coordinamento e la suddivisione delle responsabilità (Dourish, 2001). Tuttavia, in contrasto con le aspettative, studi sempre più numerosi (Cohen e McGee, 2004; Lu et al., 2005) riportano come i benefici apportati da sistemi di supporto al coordinamento siano limitati, e come non sia scontato che queste

tecnologie favoriscano il coordinamento, l'efficienza e un'equa suddivisione delle responsabilità nella cura clinica (Vikkelsø, 2005). Allo scopo di approfondire tali studi attraverso il caso preso in esame, si prenderanno come riferimenti teorici principali i contributi inerenti a pratiche di lavoro informali, lavoro di articolazione e tecnologia come pratica situata (Bruni e Gherardi, 2007; Corbin e Strauss, 1993; Gherardi, 2004) spesso trascurate durante la progettazione delle IT in sanità, poiché risultano invisibili ai modelli razionali di lavoro (Star e Strauss, 1999). Per progettare sistemi informativi che facilitino il coordinamento è tuttavia fondamentale prestare attenzione ai protocolli formali così come alle pratiche di lavoro informali ed al lavoro di articolazione che servono a stabilire, mantenere e cambiare gli accordi necessari per lavorare sia all'interno della propria unità organizzativa, sia tra diverse unità (Bruni e Gherardi, 2007). Andremo quindi ad indagare l'introduzione della tecnologia secondo la prospettiva delle pratiche situate, identificandone le potenzialità nel momento del suo utilizzo effettivo da parte della comunità di utilizzatori, nonché in relazione ad altri strumenti, tecniche e pratiche che ad essa si accompagnano (Gherardi, 2004).

In questo lavoro intendiamo coniugare gli studi su pratiche situate e lavoro di articolazione con il contributo della comunità CSCW (Computer Supported Cooperative Work), che ha riconosciuto da tempo l'impossibilità di cogliere la ricchezza delle organizzazioni semplicemente applicando regole e protocolli razionali: il lavoro include infatti pratiche tacite e situate invisibili alle rappresentazioni formali del lavoro (Ellingsen e Monteiro, 2003; Grimson, Grimson e Hasselbring, 2000; Hartswood et al., 2003; Robinson, 1991; Schmidt e Bannon, 1992; Suchman, 1987). Un concetto chiave utilizzato dai contributi CSCW per descrivere il lavoro di coordinamento e cooperazione è la nozione di Common Information Spaces (CIS), che definisce i contesti in cui le informazioni vengono condivise tra gli attori che collaborano tra loro. Il concetto, proposto da Schmidt e Bannon (1992), muove dal presupposto che il supporto al lavoro cooperativo richieda non solamente strumenti tecnici ma un processo continuo di negoziazione sul senso dell'agire:

> 'Il lavoro di cooperazione non è facilitato semplicemente fornendo un database condiviso, ma richiede la costruzione attiva da parte dei partecipanti di un common information space dove il significato degli oggetti condivisi è discusso e risolto, almeno localmente e temporaneamente' (Schmidt e Bannon, 1992, p. 27, trad. nostra).

Questa prospettiva invita a soffermarsi sulle modalità attraverso cui gli artefatti supportano la coordinazione e il lavoro di articolazione negli ambienti cooperativi, con una particolare attenzione per i luoghi in cui le relazioni tra attori, artefatti e informazioni vanno ad incontrarsi (Bannon e Bødker, 1997; Bossen, 2002; Randall, 2000; Schmidt e Bannon, 1992).

Il nostro lavoro si inserisce dunque nella parte del dibattito che vede gli obiettivi di coordinamento e divisione delle responsabilità garantiti non solo dall'utilizzo dei protocolli formali che i sistemi di gestione sicura della terapia presuppongono, ma anche dalle pratiche situate e dal lavoro di articolazione che si svolgono all'interno dei common information space; ci concentreremo quindi su come la somministrazione sicura dei farmaci avvenga soprattutto grazie a queste pratiche, che permettono al lavoro di coordinamento di svolgersi anche in situazioni non previste da protocolli standardizzati.

Contesto e metodo della ricerca

Il presente contributo illustra i risultati di una ricerca effettuata tra il 2015 e il 2016 all'interno dei reparti di farmacia e oncologia clinica di due ospedali del Nord Italia in seguito all'introduzione di un sistema IT volto a migliorare la somministrazione sicura dei farmaci chemioterapici. I due reparti oncologici hanno un unico responsabile clinico: l'implementazione pilota del sistema è stata compiuta dapprima nel reparto con un minore numero di casi trattati giornalmente, e successivamente replicata e adattata al centro più grande. I dati qui presentati sono stati raccolti in due occasioni differenti e in corrispondenza di due momenti significativi. Il primo periodo di osservazione è stato condotto nella fase di design del sistema nell'ospedale pilota; il secondo periodo di osservazione si è svolto in seguito all'implementazione e alla messa a regime del sistema nei due centri ospedalieri. Alla luce delle finalità di questo lavoro, la valutazione comparativa tra i due centri verrà omessa.

Precedentemente all'introduzione del nuovo sistema, la somministrazione dei farmaci avveniva attraverso l'utilizzo di una cartella clinica elettronica, un sistema interno di prescrizione online, e una serie di strumenti digitali al letto del paziente (ad es. la pompa di infusione).

Il nuovo sistema è stato disegnato e sviluppato per permettere una 'gestione sicura della somministrazione dei farmaci', supportando e monitorando l'intero processo, dalla prescrizione alla somministrazione. Uno dei suoi componenti base è una cartella clinica informatizzata, che include una libreria di tutti i regimi chemioterapici attualmente in uso,

utilizzata dai farmacisti. Tra gli altri componenti figurano un lettore barcode, le etichette col barcode per i farmaci, dei braccialetti con barcode per i pazienti, e un tablet. Il tablet comunica via bluetooth con il lettore barcode e via wi–fi con il server della cartella clinica informatizzata. Il sistema permette la verifica automatica delle procedure (lo scanning dei barcode e l'identificazione RFID) per facilitare l'abbinamento sicuro di paziente e terapia, e comporta l'utilizzo di un tablet che supporti le infermiere durante la somministrazione dei farmaci al letto del paziente. Per una descrizione del sistema e una valutazione da parte del personale infermieristico si veda il lavoro di Enzo Galligioni e colleghi (2015).

I dati qui presentati sono stati raccolti secondo la logica dell'etnografia organizzativa: si sono osservati gli spazi della farmacia, del Day Hospital oncologico e del laboratorio chemioterapico di entrambi gli ospedali, prestando particolare attenzione a se e come l'introduzione del nuovo sistema abbia modificato le pratiche di coordinamento dei diversi attori organizzativi all'interno dei reparti. Seguire il processo di introduzione del nuovo sistema ha richiesto l'adozione di diverse tecniche di rilevazione:

- osservazione etnografica della farmacia, del Day Hospital oncologico e del laboratorio chemioterapico;
- shadowing: sono stati affiancati quattro infermiere, tre tecnici e una farmacista, dalla preparazione delle etichette nell'ufficio dei farmacisti, all'allestimento dei farmaci in laboratorio, sino alla somministrazione al letto del paziente;
- sei interviste a due tecnici di laboratorio, due medici e due farmacisti, finalizzate a completare il quadro e reperire informazioni più dettagliate.

Riconfigurare spazi e pratiche di coordinamento

Per entrare a far parte delle pratiche proprie di un contesto organizzativo, il processo di *mise–en–contexte* (Latour, 1992, p. 89) di un nuovo sistema comporta il coinvolgimento dell'intero network di attori, sia umani che non umani. La sua introduzione implica infatti una relazione tra tecnologie, attori umani e contesto e può mettere in luce elementi come routine consolidate, pratiche lavorative situate e relazioni di potere. Nei prossimi paragrafi descriveremo il contesto in cui il nuovo sistema è andato ad inserirsi, e come ciò abbia comportato una modifica delle pratiche lavorative redistribuendo i compiti e le responsabilità tra i diversi attori coinvolti nel processo.

La sicurezza come lavoro di articolazione

I dati veicolati dal nuovo sistema passano attraverso differenti medium e professionalità: dalla composizione dei farmaci alla somministrazione, il processo di infrastrutturazione richiede infatti l'integrazione e l'uso coordinato di una grande quantità di artefatti informativi. Un luogo caratterizzato da una particolare densità tecnologica, e che permette l'interazione tra diversi attori eterogenei, è un piccolo corridoio (fig. 1) che funge da punto di raccordo tra la farmacia, il laboratorio e il resto dell'ospedale:

'Tra l'ufficio dei farmacisti e il laboratorio c'è un piccolo corridoio con due passa–farmaci (una sorte di passa vivande da una stanza all'altra). Il primo viene usato per passare dall'ufficio al laboratorio alcuni oggetti necessari per la preparazione dei farmaci: i documenti con le terapie, le etichette dei farmaci e un diario cartaceo utilizzato dai tecnici e dai farmacisti per comunicare tra loro. Il secondo è usato per passare dal laboratorio al corridoio i farmaci pronti per la somministrazione. Due o tre volte durante la mattina un'operatrice addetta entra nel corridoio e controlla la lista dei pazienti appesa al muro: se il nome è spuntato, può prendere i farmaci e portarli al Day Hospital. Prima però deve firmare un quaderno appoggiato su un tavolo nel corridoio, così la farmacista può sapere se il farmaco è stato prelevato. Sul muro è appesa una lavagna su cui la farmacista segnala se le terapie sono pronte per essere prelevate dagli addetti di altri ospedali' (estratto dal diario etnografico).

La condivisione delle informazioni tra differenti figure professionali, tra i due reparti e anche tra diversi ospedali richiede una coordinazione tra il nuovo sistema e le tecnologie. I passa–farmaci, i documenti con le terapie, le etichette e il diario, i farmaci, la lista dei pazienti, il quaderno, la lavagna sono tutti artefatti con un'esatta collocazione spaziale e che coinvolgono la conoscenza situata delle diverse figure professionali coinvolte nel processo. Il corridoio diventa quindi un ambiente cooperativo in cui gli artefatti fanno da supporto al lavoro di articolazione permettendo la coordinazione tra gli attori coinvolti, nonché garantendo la consegna sicura dei farmaci:

'L'ospedale periferico mi telefona e dice quanti pazienti ha… io gli dico i nomi, e le terapie… ci sono sei terapie per due pazienti… Se vedo che le bottiglie sono sei, i pazienti sono due, allora ok. Se invece sulla lavagna c'è scritto sei ma le bottiglie sono cinque, allora aspetta. Anche perché in Umaca (unità manipolazione

allestimento chemioterapia antiblastica) possono sbagliare e scrivere il nome dell'ospedale sbagliato sulla busta (es. Cles invece che Cavalese). Quando i fattorini partono, firmano sul quaderno…' (Anna, farmacista, intervista 1).
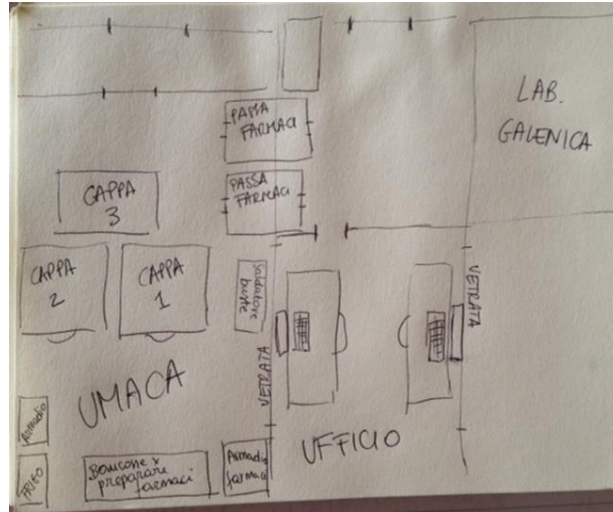
Figura 1   Il corridoio tra la farmacia e il laboratorio.

Le tecnologie contribuiscono quindi a modificare il *landscape* della cura mettendo in connessione luoghi diversi, ridefinendone i significati e creando nuovi luoghi in cui le pratiche di cura possono articolarsi. Nello stralcio seguente vediamo come l'introduzione del nuovo sistema comporti anche la modifica delle pratiche lavorative e l'aggiustamento degli spazi per accogliere le nuove tecnologie:

'All'inizio è stato difficile, perché hai tante cose… perché poi c'è anche il suo contro…parti col tuo vassoio, e già hai quello, il disinfettante, a volte il laccio se ti serve…hai tutte le tue cose…poi devi prenderti su il tablet, il lettore… hai più cose in mano, e all'inizio è stato un po'… comunque non puoi saltare dei passaggi che sono fondamentali solo perché hai questo qua in mano… poi devi ricordarti di non appoggiarlo sul letto del paziente, lo mettiamo di solito su una mensolina, abbiamo fatto un posticino apposta… perché se no si contamina… ci sono delle regole da rispettare, e all'inizio ci sembrava ingombrante…' (Tania, infermiera, intervista 2).

In questo caso, l'adozione del tablet per la somministrazione dei farmaci ha comportato per le infermiere una modifica delle routine con cui gestivano l'approccio al letto del paziente: la materialità dell'artefatto ha quindi richiesto un riallestimento degli spazi di lavoro.

Se da una parte l'introduzione del nuovo sistema ha richiesto la modifica delle routine lavorative e del 'landscape' della cura, dall'altra l'osservazione in Day Hospital e negli spazi della farmacia e del laboratorio ha permesso di mettere in luce come al nuovo sistema siano sopravvissute pratiche lavorative informali supportate dagli artefatti cartacei. Questo perché, in primo luogo, il nuovo sistema e le tecnologie che lo supportano non veicolano tutte le informazioni necessarie allo svolgimento del lavoro e non permettono una modalità intuitive di interazione e accesso alle informazioni. Quando le cose si rompono, o non funzionano, la materialità del tablet rende necessario l'utilizzo di materiale cartaceo:

'Se si attacca sbagliata l'etichetta, se si strappa o se si sporca, non è semplicissimo ristamparla… e poi le etichette dovrebbero avere qualche altra informazione in più… tipo la stabilità del farmaco e la conservazione…soprattutto quando imbustiamo i [farmaci per gli ospedali] periferici, noi dobbiamo continuare ad andare a vedere se va in frigo… anche per le infermiere, gli arriva su, metti che succede qualcosa al paziente e non possono faglila subito, da qua non capisce se deve tenerla in frigorifero, se deve tenerla a temperatura ambiente…perché sulle nostre prestampate lo scrivevamo sempre…' (Giulia, tecnico, intervista 1).

Le informazioni possono essere facilmente aggiunte agli artefatti cartacei durante il work in progress, mentre caricare informazioni attraverso le tecnologie digitali può risultare più lento (Silva et al., 2006). Alcuni studi riportano come le infermiere facciano affidamento sugli artefatti cartacei nel loro somministrare le cure ai pazienti, anche quando sono disponibili alternative tecnologiche, ritenendoli indispensabili al loro lavoro e non rimpiazzabili (Cohen e McGee, 2004; Lu et al., 2005; Tang e Carpendale, 2008). Gli artefatti cartacei contribuiscono anche alla somministrazione sicura dei farmaci: 'stampiamo ancora il cartaceo…perché così abbiamo un doppio controllo…', spiega un'infermiera. In questo caso, la quotidiana rottura della normalità, detta 'breakdown', richiede un lavoro di riparazione e rinegoziazione degli accordi (Bruni e Gherardi, 2007), e la sicurezza è garantita dal lavoro di articolazione: nella figura 2 vediamo un foglio terapia stampato attraverso il nuovo sistema, su cui in un momento di emergenza

sono state segnate delle informazioni aggiuntive (una somministrazione di farmaci imprevista) rivolte all'infermiera del turno successivo. Il materiale cartaceo continua quindi ad essere utilizzato per gestire la comunicazione tra diverse figure professionali e per il passaggio di consegne e rendicontazione:

'Su questo quaderno annoto quando ci sono dei farmaci con un particolare monitoraggio… lo scrivo qua perché se no me lo dimentico… così la sera quando telefono al medico gli comunico cosa hanno dispensato e quando… è come una cartella clinica per questo paziente e per questo farmaco' (Anna, farmacista, intervista 3).
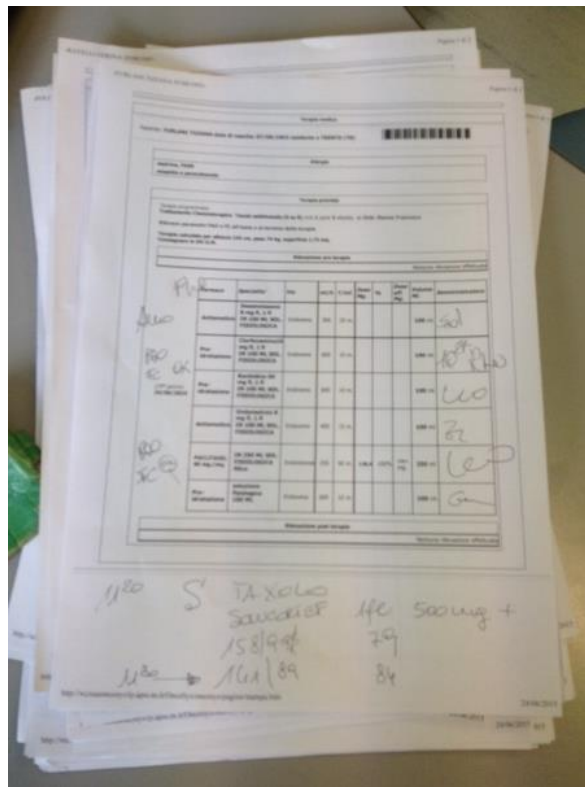
Figura 2   Appunti.

Come evidenziato anche in altri studi (Bringay et al., 2006; Cabitza et al., 2009; Fitzpatrick, 2004; Hardstone et al., 2004; Nomura et al. 2006; Silva et

al., 2006; Tang e Carpendale, 2006), i diversi professionisti della cura, in questo caso la farmacista e il medico, apprezzano la possibilità di consultare i dati su materiale cartaceo, così come arricchire con informazioni necessarie per il coordinamento ma non previste nei form elettronici (Piras e Zanutto, 2016).

In questo primo paragrafo abbiamo visto come il nuovo sistema informativo sia andato ad integrarsi negli spazi organizzativi e nelle pratiche di coordinamento, talvolta comportando una loro modifica, talvolta rendendo necessaria la sopravvivenza di vecchie pratiche allo scopo di garantire la somministrazione sicura dei farmaci. Nel prossimo vedremo come il nuovo sistema abbia contribuito a redistribuire le responsabilità tra attori organizzativi, spazi e tecnologie.

La sicurezza come mutuo controllo

L'implementazione di IT dovrebbe supportare la condivisione delle informazioni tra reparti ed utenti eterogenei (Ellingsen e Monteiro, 2003; Grimson, Grimson e Hasselbring, 2000; Hartswood et al., 2003). Ma la maggior parte degli studi riportano come questi sistemi abbiano ottenuto esiti limitati, e come la loro implementazione sia spesso limitata al supportare l'esistente divisione del lavoro (Lærum, Ellingsen e Faxvaag 2001; Rolland e Monteiro, 2002). Attraverso i dati riportati nelle prossime righe vorremmo confermare i risultati di questi studi, mostrando però come la sicurezza continui ad essere garantita dal lavoro di coordinamento e mutuo controllo tra figure professionali.

Precedentemente all'introduzione del sistema nei due reparti, le prescrizioni dei farmaci venivano inviate al farmacista via fax, e i dati delle etichette venivano scritte a mano dai tecnici di laboratorio, che effettuavano anche la conversione da milligrammi a millilitri necessaria per svolgere il loro lavoro. In seguito all'introduzione del nuovo sistema, solo il farmacista riceve la prescrizione attraverso il sistema, che stampa insieme alle etichette dei farmaci, ed è lo stesso farmacista che effettua la conversione da milligrammi a millilitri.

Lo stralcio riportato descrive il momento in cui, all'interno del laboratorio, i tecnici stanno aspettando di ricevere dalla farmacista la lista dei pazienti e dei rispettivi farmaci da preparare:

'Marta (un tecnico) sta aspettando che arrivino le prescrizioni, e guarda attraverso il vetro che divide il laboratorio dalla farmacia: 'Adesso Anna (la farmacista) stampa le prescrizioni e la lista dei pazienti del giorno… noi non sappiamo niente finché non stampa la

lista (…) anche la conversione (da mg a ml), con il sistema c'è scritto già il… controlliamo, perché a volte succede che il programma sbaglia a fare i calcoli… però è un controllo, non è che devi rifare i calcoli su tutto... ci butti un occhio e lo vedi'… Marta si avvicina al vetro e dà un'occhiata alla scrivania della farmacista su cui nel frattempo è arrivata la lista dei pazienti del giorno, poi dice ad Andrea (un altro tecnico): 'Sarà una lunga giornata!'' (estratto dal diario etnografico).

In seguito all'introduzione del nuovo sistema, i tecnici che lavorano in laboratorio non hanno accesso al sistema e non hanno la possibilità di sapere se una prescrizione è pronta: l'unico modo per avere queste informazioni è dare un'occhiata sulla scrivania della farmacista al di là del vetro che divide l'ufficio dal laboratorio. Come abbiamo visto nel paragrafo precedente, la topografia condivisa permette la coordinazione e l'interazione: ma anche il landscape della cura e gli oggetti che ne fanno parte, in questo caso la vetrata, diventano parte di questo meccanismo di supervisione, insieme agli attori coinvolti nel processo.

Lo stralcio mette anche in luce come, nonostante la nuova divisione del lavoro imposta dal sistema preveda che sia la farmacista ad effettuare la conversione, i tecnici controllino comunque le dosi:

'Ti viene naturale (fare il doppio controllo) quando prendiamo il farmaco lo prendiamo in mg (…) lo controlla l'Anna, ma quando sfugge a lei lo facciamo noi…dobbiamo sempre controllarlo anche noi, tante volte sfugge fuori, ma noi sappiamo che…perché è semplice da fare anche mentalmente' (Andrea, tecnico, intervista 2).

D'altra parte è la stessa farmacista ad aspettarsi il doppio controllo da parte dei tecnici:

'I conti li fanno comunque perché vogliamo il doppio controllo… segnano chi allestisce e chi serve… ma avere le etichette invece del foglio di lavoro è tutta un'altra cosa…' (Anna, farmacista, intervista 3).

La 'gestione sicura' dei farmaci del nuovo sistema di somministrazione implica informazioni 'blindate' e in mano alle figure professionali più alte, e la ridefinizione dei ruoli dei diversi attori coinvolti dovrebbe comportare un maggiore controllo dei superiori sullo staff.

Ma dall'osservazione emerge come la sicurezza continui, nonostante tutto, ad essere supportata e garantita dalla coordinazione tra diverse figure

professionali e dal controllo reciproco. Nel caso di eventi imprevisti, come l'assenza della farmacista, il controllo ritorna nelle mani dei tecnici:

> 'Domani è part–time (la farmacista) e non c'è, e non ci sono altri farmacisti che vengono qua, ci dicono 'arrangiatevi', e come ai vecchi tempi noi non facciamo altro che andare sul programma e stampare il foglio, che non mi viene solo il foglio di lavoro pulito con quello che devo fare io, ma anche gli ancillari, e poi cliccherò sull'etichetta, e mi stamperà un'etichetta, solo che mancano gli ml, io mi faccio i miei conti e li scrivo a mano…' (Gianni, tecnico, intervista 4).

Gli stralci presentati in questo paragrafo illustrano la complessità del lavoro nel reparto, che necessita di essere coordinato tra differenti figure professionali, oggetti ed artefatti: come sostenuto da Schmidt e Simone, '…gli attori si monitorano tacitamente a vicenda, e performano le loro attività supportando la consapevolezza del lavoro di collaborazione; tengono conto delle rispettive attività passate, presenti e in prospettiva per pianificare e mandare avanti il loro lavoro' (Schmidt e Simone, 1996, p. 159).

Conclusioni

La ricerca presentata ha messo in luce come due degli obiettivi cardine dell'introduzione di un nuovo sistema di somministrazione sicura della terapia, il coordinamento e la suddivisione delle responsabilità, siano raggiunti nella pratica grazie ad una serie di fattori che vanno al di là degli standard dei protocolli formali che questi sistemi prevedono.

Innanzitutto, la condivisione delle informazioni tra differenti figure professionali, tra i due dipartimenti e tra diversi ospedali richiede una coordinazione tra il nuovo sistema e le tecnologie. Il coordinamento non è garantito quindi da una singola tecnologia, ma coinvolge artefatti eterogenei, nonché pratiche informali, conoscenza situata e lavoro di articolazione. Se, da una parte, accogliere il nuovo sistema comporta la modifica delle pratiche lavorative e l'aggiustamento degli spazi, dall'altra sopravvivono le vecchie pratiche situate e gli artefatti cartacei.

In secondo luogo, la ricerca ha svelato le micro–politiche del processo: l'introduzione del nuovo sistema vorrebbe imporre una gerarchia e una ridefinizione dei ruoli dei diversi attori coinvolti, prevedendo un controllo dei superiori sullo staff. La stessa topografia condivisa, come abbiamo visto, permette da una parte la coordinazione e l'interazione, ma dall'altra diventa parte di questo meccanismo di supervisione, insieme agli attori coinvolti nel

processo. Lo studio ha però permesso di osservare come, nonostante la responsabilità venga formalmente attribuita ai superiori, nella pratica venga condivisa tra le diverse figure professionali. La sicurezza può essere dunque interpretata come una pratica situata, una proprietà emergente di un sistema sociotecnico, il risultato finale di un processo collettivo di costruzione, un 'fare' che coinvolge persone, tecnologie e forme testuali e simboliche assemblate nell'ambito di un sistema di relazioni materiali (Gherardi, 1997). Un luogo di lavoro 'sicuro', una organizzazione 'sicura' sono il risultato di una opera di quotidiana 'ingegneria dell'eterogeneo' (Law, 1987) di elementi diversi – competenze, materiali, relazioni, comunicazioni, eccetera – che fanno parte integrante delle pratiche di lavoro dei membri dell'organizzazione (Gherardi et al., 1997). La sicurezza de processo, che dovrebbe essere garantita dal coordinamento standardizzato e dai protocolli formali, viene supportata da sapere tacito, vecchie pratiche e lavoro di articolazione, che si rivelano assai più significativi al fine di garantire la sicurezza.

Bibliografia

Bannon, L. e Bødker, S. (1997) Constructing Common Information Spaces. In *Proceedings of the Fifth European Conference on Computer Supported Cooperative Work*. Springer, Berlin.

Bringay, S., Barry, C. e Charlet, J. (2006) Annotations: A functionality to Support Cooperation, Coordination and Awareness in the Electronic Medical Record. *Frontiers In Artificial Intelligence And Applications*, 137, 39–59.

Bruni. A, Pinch, T. e Schubert, C. (2013) Technologically Dense Environments: What For? What Next? *Tecnoscienza*, 4 (2), 51–71.

Bruni A. e Gherardi S. (2007) *Studiare le pratiche lavorative*. Bologna: Il Mulino.

Bossen, C. (2002) The Parameters of Common Information Spaces: The Heterogeneity of Cooperative Work at a Hospital Ward. In *Proceedings of the 2002 ACM Conference on Computer Supported Cooperative Work*.

Bubalo, J., Warden, B.A., Wiegel, J.J., Nishida, T., Handel, E., Svoboda, L.M. e Edillo, P.N. (2013) Does Applying Technology throughout the Medication Use Process Improve Patient Safety with Antineoplastics? *Journal of Oncology Pharmacy Practice*, 20 (6), 445–460.

Cabitza, F., Simone, C. e Zorzato, G. (2009) ProDoc: An Electronic Patient Record to Foster Process–oriented Practices. In *ECSCW 2009*. London: Springer.

Cohen, P. e McGee, D. (2004) Tangible Multimodal Interfaces for Safety– Critical Applications. *Communications of the ACM*, 47 (1), 41–46.

Corbin, J.M. e Strauss, A.L. (1993) The Articulation of Work through Interaction. *The Sociological Quarterly*, 34 (1), 71–83.

Dick, R.S., Steen, E.B. e Detmer, D.E. (1997) *The Computer–Based Patient Record: An Essential Technology for Health Care*. Washington: National Academy Press.

Dourish, P. (2001) Process Descriptions as Organizational Accounting Devices: The Dual Use of Workflow Technologies. In *GROUP 2001*. New York: ACM Press.

Ellingsen, G. e Monteiro, M. (2003) A Patchwork Planet. Integration and Cooperation in Hospitals*. Computer Supported Cooperative Work* (CSCW), 12 (1), 71–95.

Fitzpatrick, G. (2004) Integrated Care and the Working Record. *Health Informatics Journal,* 10 (4), 291–302.

Galligioni, E., Piras, E.M., Galvagni, M., Eccher, C., Caramatti, S., Zanolli, D., Santi, J., Berloffa, F., Dianti, M., Maines, F. e Sannicolò, M. (2015) Integrating mHealth in Oncology: Experience in the Province of Trento. *Journal of Medical Internet Research*, 17 (5), e114.

Gherardi, S., Nicolini, D. e Odella, F. (1997) La cultura della sicurezza sui luoghi di lavoro. *Sviluppo & Organizzazione*, 162, 15–30.

Gherardi, S. (2004) Introduzione. In Gherardi, S. e Strati, A. (a cura di) *La Telemedicina. Fra tecnologia e organizzazione*. Roma: Carocci.

Grimson, J., Grimson, W. e Hasselbring, W. (2000) The SI Challenge in Health Care. *Communications of the ACM*, 43 (6), 48–55.

Hardstone, G., Hartswood, M., Procter, R., Slack, R., Voss, A. e Rees, G. (2004) Supporting Informality: Team Working and Integrated Care Records. In *CSCW '04: Proceedings of the 2004 ACM conference on CSCW*. New York: ACM Press.

Hartswood, M., Procter, R., Rouncefield, M. e Sharpe, M. (2003) Making a Case in Medical Work: Implications for the Electronic Medical Record. *Computer Supported Cooperative Work* (CSCW), 12 (3), 241–266.

Kohn, L.T., Corrigan, J.M. e Donaldson, M.S. (a cura di) (2000) To Err is Human, Building a Safer Healthcare System. *National Academies Press, Washington,* 9, 4–5.

Lærum, H., Ellingsen, G. e Faxvaag, A. (2001) Doctor's Use of Electronic Medical Records Systems in Hospitals: Cross Sectional Survey. *British Medical Journal*, 323 (7325), 1344–1348.

Latour, B. (1992) *Aramis ou l'amour des techniques*. Paris: La Découverte.

Law, J. (1987) Technology and Heterogeneous Engineering: The Case of the Portuguese Expansion. In Bijker, W.E., Hughes, T.P. e Pinch, T. (a cura di) *The Social Construction of Technical Systems: New Directions in the Sociology and History of Technology*, Cambridge: MIT Press.

Lu, Y., Xiao, Y., Sears, A. e Jacko, J. (2005) A Review and a Framework of Handheld Computer Adoption in Healthcare. *International Journal of Medical Informatics,* 74 (5), 409–422.

Milligan, C. (2001) *Geographies of Care: Space, Place and the Voluntary Sector*. Burlington: Ashgate.

Milligan, C. (2009) *There's No Place like Home: Place and Care in an Ageing Society*. Farnham: Ashgate.

Milligan C., Atkinson S., Skinner, M. e Wiles, J. (2007) Geographies of Care: A Commentary. *New Zealand Geographer*, 63 (2), 135–140.

Nomura, S., Hutchins, E. e Holder, B. (2006) The Uses of Paper in Commercial Airline Flight Operations. In *Proceedings of Computer Supported Cooperative Work (CSCW '06)*.

Østerlund, C.S. (2008) Documents in Place: Demarcating Places for Collaboration in Healthcare Settings. *Computer Supported Cooperative Work*, 17 (2–3)

Oudshoorn, N. (2012) How Places Matter: Telecare Technologies and the Changing Spatial Dimensions of Healthcare. *Social Studies of Science*, 42 (1), 121–142.

Phillips, J., Beam, S., Brinker, A., Holquist, C., Honig, P., Lee, L.Y. e Pamer, C. (2001) Retrospective Analysis of Mortalities Associated with Medication Errors. *American Journal of Health–System Pharmacy*, 58 (19), 1835–1841.

Pipek, V. e Wulf, V. (2009) Infrastructuring: Toward an Integrated Perspective on the Design and Use of Information Technology. *Journal of the Association for the Information Systems*, 10 (5), 447–473.

Piras, E.M. e Zanutto, A. (2016) Tinkering Around Healthcare Infrastructures: Nursing Practices and Junction Work. In *COOP 2016: Proceedings of the 12th International Conference on the Design of Cooperative Systems*. Berlin: Springer.

Randall, S. (2000) What's Common about Common Information Spaces?, Paper presented at the *Workshop on Cooperative Organisation of Common Information Spaces*, Technical University of Denmark.

Robinson, M. (1991) Double–level Language and Co–operative Working. *AI & Society*, 5 (1), 34–60.

Rolland, K.H. e Monteiro, E. (2002) Balancing the Local and the Global in Infrastructural Information Systems. *The Information Society*, 18 (2), 87–100.

Schmidt, K. e Bannon, L. (1992) Taking CSCW Seriously: Supporting Articulation Work. *Computer Supported Cooperative Work (CSCW)*, 1 (1–2), 7–40.

Schmidt, K. e Simone, C. (1996) Coordination Mechanisms: Towards a Conceptual Foundation of CSCW Systems Design. *Computer Supported Cooperative Work (CSCW)*, 5, 155–200.

Silva, J., Zamarripa, M., Strayer, P., Favela, J. e Gonzalez, V. (2006) Empirical Evaluation of a Mobile Application for Assisting Physicians in Creating Medical Notes. In *AMCIS 2006 Proceedings.*

Suchman, L.A. (1987) *Plans and Situated Actions: The Problem of Human Machine Communication*. Cambridge: Cambridge University Press.

Tang, C. e Carpendale, S. (2008) Evaluating the Deployment of a Mobile Technology in a Hospital Ward. In *Proceedings of Computer Supported Cooperative Work (CSCW)*.

Vikkelsø, S. (2005) Subtle Redistribution of Work, Attention and Risks: Electronic Patient Records and Organisational Consequences. *Scandinavian Journal of Information Systems*, 17 (1), 3–30.

Assembling Mindfulness: Technologies of the Self, Neurons and Neoliberal Subjectivities

António CARVALHO[*a]

[a] Universidade de Coimbra

Over the past three decades, psychologists, neuroscientists, phenomenologists and educators have displayed a growing interest in mindfulness, a contemplative practice which aims at enhancing the experience of the present moment.

Mindfulness has been implemented in the prevention of stress and heart diseases and in the management of pain. Encounters between scientists and practitioners of mindfulness have filled the public imagination of mindfulness with images of brain scans, visual testimonies of the effectiveness of this practice.

Despite the technical apparatus involved in mindfulness research and thousands of articles written on the topic, early researchers, such as Francisco Varela, recognized that the methodological intricacies of studying contemplative technologies, usually practiced in silence, required the need to intertwine first and third person approaches to the study of consciousness. The passionate and often personal relationship with mindfulness tends to complicate the boundaries between research and self–care, pointing towards new ontological politics which are embodied, somaesthetic and often escape academic orthodoxies.

This paper analyses the assemblage of mindfulness, showing how it entangles topics such as silence, the brain and biopolitics. Through the support of STS literature, the article explores the relationship between the anatomo–politics of mindfulness and contemporary formations of subjectivity.

Keywords*: Mindfulness; technologies of the self; neoliberal subjectivities*

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[*] Corresponding author: **António Carvalho** | e–mail: **antoniomanuelcarvalho@gmail.com**

Introduction

The aim of this paper is to offer a critique of the dissemination of mindfulness practice and research over the past three decades. I argue that mindfulness is a particularly interesting example to understand contemporary ramifications of neoliberalism, neurosciences and practices of the self. The adopted approach includes Foucauldian and STS literature on subjectivity, ontology and technology, recruited to delve into the emergence of a new technology the self which is becoming extremely popular in Europe and North America.

Mindfulness is a process of non–judgemental awareness to moment–to–moment experience, including sensations, emotions, thoughts and movements (Kabat–Zinn, 1991). Inspired by practices of Buddhist meditation, Mindfulness–Based–Stress–Reduction–Therapy (MBSR) was developed by Jon Kabat–Zinn at the University of Massachusetts in the late 1970s. It aimed at increasing the health and wellbeing of those who suffered from headaches, high blood pressure, back pain, heart disease, cancer and AIDS (Kabat–Zinn, 1991). In the 1990s, MBSR was coupled with cognitive–behavioural–therapy (CBT), generating another popular intervention – Mindfulness–Based–Cognitive–Therapy (MBCT). Unlike CBT, MBCT does not aim at changing thoughts, 'the emphasis is on changing awareness of and relationship to thoughts' (Teasdale et al., 2000, p. 616).

Mindfulness is helpful in the treatment of depression, substance abuse, anxiety and pain (Bowen et al., 2006; Grossman et al., 2004), increasing mood regulation, wellbeing, self–control, objectivity, affect tolerance, flexibility, equanimity, concentration, cognition, mental clarity, emotional intelligence, acceptance and compassion (Davis and Hayes, 2011; Heeren and Philippot, 2011; Shapiro, Walsh and Britton, 2003; Zeidan et al., 2010).

Mindfulness triggers significant changes in the human brain (Davidson et al., 2003; Hölzel et al., 2011; Kilpatrick et al., 2011) which have clinical implications, reducing automatic affective processing, altering one's relationship to pain and leading to the cultivation of compassion (Farb, Anderson and Segal, 2012, pp. 6–7).

Mindfulness is considered a priority for implementation by the National Institute for Clinical Excellence (NICE) in the UK (Crane and Kuyken, 2013), and many departments of psychology and neurosciences are actively researching mindfulness (including the Oxford Mindfulness Centre, the Exeter Moods Disorder Centre and the Bangor Centre for Mindfulness Research and Practice). Although the implementation of mindfulness–

based–interventions in Britain is still at an early stage, there is a growing interest in these therapies.

This paper is supported by three strands of scholarly literature. STS (Science and Technology Studies) scholarly work has recently displayed a growing interest in ontology (Latour, 2013; Mol, 1999; Pickering, 2010), suggesting that scientific practice is eminently performative. This has stressed the importance of relationality, couplings between heterogeneous entities (Barad, 2003; Haraway, 2003; Latour, 2005) which do not pre–exist these associations, meaning that mediations (Verbeek, 2011) are political. This extends to the self (Brenninkmeijer, 2010; Carvalho, 2014; Gomart and Hennion, 1999; Rose, 2007), as subjectivities – thoughts, emotions and desires – are also mediated.

Mindfulness–based–therapeutic–interventions enact new modes of existence (Latour, 2013) fostered by couplings between practices of subjectivity, neuroimaging techniques that aim at revealing the 'truth' of inner states, psychological and medical discourses which frame human existence within specific categories (Davidson, 1987) and political devices of governing the population.

The emergence of medical and scientific devices makes up people that are framed and think of themselves in specific ways (Hacking, 2002; Rose, 1998). This involves forms of expertise, inscriptions, performances, translations, negotiations and various forms of stabilization (Callon, 1986; Fleck, 1979; Latour, 1987; Pickering, 1995). Mindfulness therapists and practitioners also undergo a number of transformations, being submitted to assemblages – retreats, workshops, teacher training courses – comprising a number of discourses, practices and devices of self–assessment. Similarly, inner states are understood and measured according to a number of discourses, practices and technologies (EEGs, fMRIs) and mindfulness itself relies on a reconfiguration of human performance.

The second major branch of literature which is relevant here concerns Foucault's research on technologies of the self and governmentality. Foucault's later work focused on practices of subjectivity which are mobilized to maximize physical abilities, to embody specific ethical frameworks and to attain particular states (Foucault, 1988). Technologies of the self allow us to unveil the articulations of the micro–politics of subjectivity and broader political frameworks. As Foucault wrote, 'there is no first or final point of resistance to political power other than in the relationship one has to oneself.' (Foucault, 2006, p. 252).

Mindfulness performs a new hermeneutic of the subject, allowing practitioners to interpret their experience in novel ways. Since technologies of the self are political, this paper recognizes the connections between the micro–politics of mindfulness–based–therapeutic–interventions – entailing performative, experiential and hermeneutical changes – and the macro–politics of contemporary political regimes. Foucault argued that modernity has led to the emergence of a particular type of power coined as governmentality (Foucault, 1978), focused on the management of the population itself, understood as a resource that could be controlled, normalized and enhanced through biopolitics and discipline (Foucault, 1987).

Governmentality shapes neo–liberal forms of subjectivity (Rose, 1998), and notions such as happiness, well–being and self–assessment (Binkley, 2011; McKay, 2013) turn contemporary selfhood into a manageable, quantifiable and improvable endeavour (Brenninkmeijer, 2010; Giddens, 1991; Lupton, 2013). It has been argued that brain plasticity goes hand in hand with neo–liberalism (Pitts–Taylor, 2010), for it puts selves in charge of enhancing their neurochemical selfhood (Rose, 2007). Mindfulness is a good illustration of the neoliberal focus on self–improvement – it consists of a set of technologies of the self and is supported by research relying on the assumption that the brain is flexible (Davidson and Lutz, 2008), justifying the redesign of human behaviour.

This leads to the third branch of scholarly literature, on the commodification of meditation. It has been suggested that current practices of mindfulness have lost their ethical meaning (McMahan, 2008), becoming therapeutic instruments which serve the needs of a population increasingly dissatisfied with the social and political world they inhabit (Zizek, 2005). It has been noted that the proliferation of non–western practices of subjectivity has led to the psychologization, medicalization and commodification of religion (Brown and Leledaki, 2010; Carrette, 2007; Carrette and King, 2005; Lasch, 1979) – instead of being central dimensions to a particular spiritual/religious path, meditative practices are used for self–enhancement.

Scholars concerned with the North/South inequalities have stressed that the appropriation of practices, commodities and substances by northern economies has led to instances of commodification and biopiracy (Scheper–Hughes, 2004; Shiva, 1997), as native/southern populations are alienated from their local knowledges, goods and practices. Mindfulness–based–interventions emerged after Buddhist techniques of meditation were

medicalized, which raises some issues dealing with the commodification of spiritual practices.

Mindfulness is usually portrayed as leading to the stabilization of selfhood, allowing practitioners to attend to moment–to–moment experience in a non–judgemental way. However, meditation often triggers unwanted and difficult episodes. Although there is some research on its negative impacts (Koster and Oosterhoff, 2004; Otis, 1984; Walsh and Roche, 1979), most literature on mindfulness focuses on the positive effects, which means that mindfulness is a 'normalized' and 'commodified' form of meditation.

Mindfulness and Neoliberal Selves

Mindfulness requires a constant attention to our psychosomatic assemblage, inviting practitioners, medical patients who attend MBSR courses and members of the general public to constantly asses their mental and emotional states. Thoughts, emotions, sensations, conversations and relationships can be submitted to a mindful 'gaze', which judges one's contemplative status and adjusts individual responses to daily phenomena. By reducing stress, maximizing happiness and triggering platitudes of relaxation, mindfulness works though the internalization and permanent medicalization of one's existence. As Kristin Barker argues

'mindfulness represents a significant expansion in the definition of disease beyond that advanced by mainstream medicine (…) its etiological model intensifies the need for therapeutic surveillance and intervention (…) it permanently locates individuals within a disease therapy cycle.' (Barker, 2014, p.168).

According to Barker, mindfulness is a form of do–it–yourself medicalization of every moment. Instead of rescuing practitioners from the tentacles of biomedicine, it reproduces, multiplies, expands the domain of illness by framing one's response to everyday life events trough mindful lenses. This mindful gaze depends on new psychological, pastoral, spiritual and medical authorities that present mindfulness as a magic bullet to deal with stress, pain, anxiety, depression and a variety of manifestations that can be reduced to their psychosomatic correlates, therefore potentially resolved by the apparatus of mindfulness.

The mindful way of framing subjectivities is deeply entwined with buzzwords such as well–being, happiness and quality of life (Praissman, 2008), the tenets of modern Buddhism (McMahan, 2008). Mindfulness based stress reduction (Kabat–Zinn, 1991) is flourishing, being used by the British National Health System (Crane and Kuyken, 2013), leading Dawson and Turnbull (2006) to suggest that mindfulness might have become the new opiate of the masses. Mindfulness seems to go quite well with the docilization strategies of contemporary advanced liberal societies and their biopolitical dispositifs, linked to technologies of government that require 'an increasing emphasis on the responsibility of individuals to manage their own affairs, to secure their own security with a prudential eye on the future' (Rose, 2007, p. 4). Technologies of mindfulness would help neoliberal subjects getting on with their stressful lives, helping them adjust with a higher well–being, rendering them more 'stable' and, obviously, docile, by setting up protective bubbles. According to Zizek, meditation is the perfect ideological supplement of capitalism:

> 'The 'Western Buddhist' meditative stance is arguably the most efficient way for us to fully participate in the capitalist economy while retaining the appearance of sanity. If Max Weber were alive today, he would definitely write a second, supplementary volume to his Protestant Ethic, titled The Taoist Ethic and the Spirit of Global Capitalism.' (Zizek, 2005)

Zizek's critique of meditation resonates with William Davies' stance on mindfulness, progressively appropriated by global capitalism, which envisions happiness as a constitutive dimension of contemporary social formations, attempting to reduce popular contestation through the multiplication of forms of enhancing and measuring one's wellbeing. As put by Davies:

> 'Happiness, in its various guises, is no longer some pleasant add–on to the more important business of making money, or some new age concern for those with enough time to sit around baking their own bread. As a measurable, visible, improvable entity, it has now penetrated the citadel of global economic management. (…) the future of successful capitalism depends on our ability to combat stress, misery and illness, and put relaxation, happiness and wellness in their place. Techniques, measures and technologies are now available to achieve this, and they are permeating the workplace, the high street, the home and the human body.' (Davies, 2015, p. 8)

When Mattieu Riccard, a Buddhist monk, was considered the 'happiest person in the world' (Independent, 2007), the public imagination of mindfulness hit a turning point, allowing it to be fully appropriated by neoliberalism. Happiness, nowadays, is not only portrayed as the optimal realization of the human potential but is a measurable, assessed and virtually improvable entity. The anatomo–politics of mindfulness was eventually enframed by a new type of discourse which presents the brain as the site par excellence of the human soul, and by entangling contemplative practices with a number of neurological changes – which can be assessed through various forms of medical imaging – the contemporary quantitative self is emulated as the subjective manifestation of neoliberalism, a social system which presents the world as an assemblage of neural entrepreneurs permanently evaluating and improving their mental states. If phrenology was the attempt, by scientific racism, to measure, quantify and compare behavioural changes between individuals through the analysis of the shape of the skull, mindfulness, supported by a multitude of neurological devices, attempts to maximize one's contemplative and eudemonic status through forms of permanent self–control, thus promoting a new moral economy of the brain.

Mindfulness and methodology: from silence to a new moral economy of the brain

Historically, meditation studies have drawn upon a series of methods to address a multiplicity of research questions. In psychology, different methodologies were used, including tests (such as the Rorschach test, see Brown and Engler, 1986), the personal experience of the author (Walsh, 1979), the analysis of central texts of Buddhist meditation, such as the Visuddhimagga, providing 'maps' for inner space (Goleman, 1996) or even quantitative methods. Sociological and anthropological studies have resorted to comprehensive ethnographies (Cook, 2010; Jordt, 2007; Pagis, 2008; Preston, 1988), semi–structured interviews with meditators (Pagis, 2008; Selim, 2011), life–stories of practitioners (Leledaki, 2007) and the personal experience of the researcher (Preston, 1988). More recently, neuroscientific and neurophenomenological studies have measured the brainwaves of experienced meditators through fMRI's and other technological instruments, justifying the assumption that meditation has

real, measurable effects on the brains (and minds) of practitioners (see, for instance, Lutz et al., 2004).

These different approaches are ways of tackling phenomena taking place at the realm of 'inner experience', which can raise a set of methodological issues: how to translate the inner world? Can we use words to talk about those experiences that belong to the realm of the ineffable? Can we trust the accounts of those who go through these states? Are academic approaches to meditation based on personal experiences 'objective'? As Wittgenstein states, 'What we cannot speak about we must pass over in silence.' (Wittgenstein, 1961, p. 89); if we assume that meditation is about the ineffable, the unreachable and untranslatable, then meditation research would become an impossible endeavour. However, instead of becoming a *verboten* field of study, it requires the deployment of innovative methodologies that recognize the particularities of the topic. Varela and Shear (1999) argue that links have to be created between first and third person approaches to the study of consciousness. This involves the deployment of a set of methodologies in order to 'move towards an integrated or global perspective on mind where neither experience nor external mechanisms have the final word. The global perspective requires the explicit establishment of mutual constraints, a reciprocal influence and determination' (Varela and Shear, 1999, p. 2). A good example of intertwining first and third person approaches is, for instance, crossing verbal reports of meditative experiences with their physiological correlates, measured in laboratories (Shear and Jevning, 1999).

The laboratory progressively turned mindfulness practice into a manifestation of contemporary forms of neoliberalism, presenting this technology of the self as responsible for significant changes in the human brain. If the brain, in contemporary societies, is often presented as a faithful correlate of the 'self' (Rose and Abi–Rached, 2013), mindfulness research fosters a moral economy of the human brain. Since this practice, through permanent attention towards one's emotions and sensations, is promoted as a device to enhance well–being, concentration and self–control, the brain, as the locus of mindfulness–induced changes, becomes the moral ground for these modes of experience.

What exactly is this new moral economy of the brain? According to Ricard, Lutz and Davidson, the brain scans of advanced meditators reveal a number of differences when compared to those of non–meditators. For instance, the practice of mindfulness leads to 'diminished activity in anxiety–related areas, such as the insular cortex and the amygdala' (Ricard, Lutz and

Davidson, 2014, p. 41) and loving–kindness meditation (which consists in developing feelings of love, empathy and benevolence towards others) increase the activity of 'brain regions that fire up when putting oneself in the place of another–the temporoparietal junction, for instance' (ibidem, p. 41).

Through these findings, politicians, educators, psychologists and managers can have solid scientific evidence that justifies the implementation of mindfulness in a variety of institutions and settings, including the military (Stanley and Jha, 2009). Turning the brain into a multitude of areas which are correlated with some behavioural functions and traits allows the moment–to–moment visualization of the transformation of the human mind through mindfulness. The flexibility of one's psychosomatic assemblage is rendered transparent through new technologies of inner and outer vigilance, including technologies of the self such as mindfulness (and even mindfulness apps reminding practitioners to go back to their practice, see Mani et al., 2015) – and medical imaging technologies.

A novel network of technologies turned the old, colonial, quantified and racial skull of phrenology – a stable, unchangeable and measurable entity recruited to quantify racial differences – into the contemporary neoliberal brain, flexible and potentially submitted to a vast array of devices to maximize the contemplative and eudemonic status of the citizen in the most diverse circumstances. The neoliberal discourse of wellbeing and happiness created forms of neural entrepreneurship which couple the quantified self with visually appealing images of activated regions of the human brain, 'proving' that specific technologies of self–control have the potential to adjust one's brain to the moral economies propagated by psychologists and neuroscientists, internalizing the gaze of medical imaging as a mechanism of permanent self–assessment.

Conclusion: meditative islands of stability

According to Pickering (2014) modern science attempts to enact performative islands of stability, creating machines that capture nonhuman agency in an ideally stable, continuous and efficient manner. However, socio–technical disasters – such as the Fukushima crisis in 2011 – prove that the hubris of modernity, an expression of what Heidegger coined as

enframing (Heidegger, 1977), is not able to fully contain machinic and natural forces.

Similarly, mindfulness is an attempt to blackbox non–neoliberal forms of meditation, focused on exploration, self–discovery, transcendence and even madness. In fact, in the Mahasi Sayadaw tradition of Vipassana there are some stages of insight, called Dukkha Nanas, whose experience can generate fear and terror (Koster and Oosterhoff, 2004). Research on the negative effects of meditation is still an underrepresented field, considering the numerous studies that promote the positive outcomes of mindfulness.

The domestication of meditation and its unpredictable outcomes into medicalized devices, such as MBSR and MBCT, is an attempt to limit mindfulness to the shackles of neoliberalism, framing contemplative practices within psy categories such as happiness, well–being and self–control. Meditation, instead of potentially fostering new aesthetics of existence (Foucault, 1984), novel ways of being in the world that couple theory and the body, is exclusively aimed at maximizing one's immunological status (Sloterdijk, 2013), supported by new routines, smartphone apps and vindicated by technologies of medical imagining.

The contemporary assemblage of mindfulness is, therefore, an excellent case study not only to investigate the commodification of spiritual practices but also to assess the degree and scope of medicalization currently imposed and promoted by neoliberal discourses. A vast array of proposals, including mindfulness in schools, at work or the dissemination of state–sponsored MBSR and MBCT applications in Europe, indicate that governments, educators and corporations recognize the disciplinary and transformative potential of mindfulness. The early instability and danger of meditation as transgression was progressively tamed and is now relegated to the fringes of religious discourses, obscured by the imperial march of mindfulness as a technology of the neoliberal self.

References

Barad, K. (2003) Posthumanist Performativity: Toward an Understanding of How Matter Comes to Matter. *Signs: Journal of Women in Culture and Society*, 28 (3), 801–31.

Barker, K. (2014) Mindfulness Meditation: Do–It–Yourself Medicalization of Every Moment. *Social Science & Medicine*, 106 (1), 168–176.

Brenninkmeijer, J. (2010) Taking Care of One's Brain: How Manipulating the Brain Changes People's Self. *History of the Human Sciences*, 23 (1), 1–20.

Binkley, S. (2011) Happiness, Positive Psychology and the Program of
Neoliberal Governmentality. *Subjectivity*, 4 (4), 371–394.

Bowen, S., Witkiewitz, K., Dillworth, T.M., Chawla, N., Simpson, T.N., Ostafin,
B.D., Larimer, M.E., Blume, A.W., Parks, G.A. and Marlatt, G.A. (2006)
Mindfulness Meditation and Substance Use in an Incarcerated
Population. *Psychology of Addicted Behaviour*, 20 (3), 343–347.

Brown, D. and Engler, J. (1986) The Stages of Mindfulness Meditation: A
Validation Study – Part I and II. In Wilber, K., Engler, J. and Brown, D.
(eds.), *Transformations of Consciousness*. Boston and London:
Shambhala.

Brown, D. and Leledaki, A. (2010) Eastern Movement Forms as Body–Self
Transforming Cultural Practices in the West: Towards a Sociological
Perspective. *Cultural Sociology*, 4 (1), 123–154.

Callon, M. (1986) Some Elements of A Sociology Of Translation:
Domestication of the Scallops and the Fishermen of St. Brieuc Bay. In
Law, J. (ed), *Power, Action and Belief: A New Sociology of Knowledge?*
London and New York: Routledge.

Carrette, J. (2007) *Religion and Critical Psychology*. London and New York:
Routledge.

Carrette, J. and King, R. (2005) *Selling Spirituality: The Silent Take Over of
Religion*. London and New York: Routledge.

Carvalho, A. (2014) Subjectivity, Ecology and Meditation: Performing
Interconnectedness. *Subjectivity*, 7 (2), 131–150.

Crane, R. and Kuyken, W. (2013) The Implementation of Mindfulness–Based
Cognitive Therapy in the UK Health Service. *Mindfulness*, 4 (3), 246–254.

Cook, J. (2010) *Meditation in Modern Buddhism*. New York: Cambridge
University Press.

Davies, W. (2015) *The Happiness Industry: How the Government & Big
Business Sold Us Wellbeing*. London: Verso.

Davidson, A. (1987) Sex and the Emergence of Sexuality. *Critical Inquiry*, 14
(1), 16–48.

Davidson, R., Kabat–Zinn, J., Schumacher, J., Rosenkranz, M., Muller, D.,
Santorelli, S.F., Urbanowski, F., Harrington, A., Bonus, K. and Sheridan, J.F.
(2003) Alterations in Brain and Immune Function Produced by
Mindfulness Meditation. *Psychosomatic Medicine*, 65 (4), 564–570.

Davidson, R. and Lutz, A. (2008) Buddha's Brain: Neuroplasticity and
Meditation. *IEEE Signal Process Mag*, 25 (1), 176–174.

Davis, D. and Hayes, J. (2011) What Are the Benefits of Mindfulness? A Practice Review of Psychotherapy–Related Research. *Psychotherapy*, 48 (2), 198–208.

Dawson, G. and Turnbull, L. (2006) Is Mindfulness the New Opiate Of the Masses? Critical Reflections from a Buddhist Perspective. *Psychotherapy in Australia*, 12 (4), 60–64.

Farb, N., Anderson, A. and Segal, Z. (2012) The Mindful Brain and Emotion Regulation in Mood Disorders. *Canadian Journal of Psychiatry*, 57 (2), 70–77.

Fleck, L. (1979) *Genesis and Development of a Scientific Fact*. Chicago: University of Chicago Press.

Foucault, M. (1978) La gouvernementalité. In Foucault, M., *Dits et Écrits II*, 1976–1988. Paris: Gallimard.

Foucault, M. (1984) On the Genealogy of Ethics: An Overview of Work in Progress. In Rabinow, P. (ed.), *The Foucault Reader*. New York: Pantheon Books.

Foucault, M. (1987) *The History of Sexuality – Volume One, An Introduction*. New York: Random House.

Foucault, M. (1988) Technologies of the Self. In Martin, L.H., Gutman, H. and Hutton, P.H. (eds.), *Technologies of the Self, a Seminar with Michel Foucault*. Amherst: The University of Massachusetts Press.

Foucault, M. (2006), *The Hermeneutics of the Subject – Lectures at the Collège de France 1981–1982*. New York: Picador.

Giddens, A. (1991) *Modernity and Self–Identity*. Cambridge: Polity Press.

Goleman, D. (1996) *The Varieties of Meditative Experience*. London: Thorsons.

Gomart, E. and Hennion, A. (1999) A Sociology of Attachment: Music Amateurs, Drugs Users. In Law, J. and Hassard J. (eds.), *Actor Network Theory and After*. Oxford: Blackwell.

Grossman, P., Niemann, L., Schmidt, S. and Walach, H. (2004) Mindfulness–Based Stress Reduction and Health Benefits – A Meta–Analysis. *Journal of Psychosomatic Research*, 57 (1), 35–43.

Hacking, I. (2002) *Historical Ontology*. Cambridge: Harvard University Press.

Haraway, D. (2003) *The Companion Species Manifesto: Dogs, People, and Significant Otherness*. Chicago: Prickly Paradigm Press.

Heeren, A. and Philippot, P. (2011) Changes in Ruminative Thinking Mediate the Clinical Benefits of Mindfulness: Preliminary Findings. *Mindfulness*, 2 (1), 8–13.

Heidegger, M. (1977) *The Question Concerning Technology and Other Essays*. New York: Harper & Row.

Hölzel, B., Carmody, J., Vangel, M., Congleton, C., Yerramsetti, S.M., Gard, T. and Lazar, S.W. (2011) Mindfulness Practice Leads to Increases in Regional Brain Gray Matter Density. *Psychiatry Research*, 191 (1), 36–43.

Independent (2007) The happiest man in the world? *Independent*, 21 January. [Online] Available at: http://www.independent.co.uk/news/uk/this–britain/the–happiest–man–in–the–world–433063.html [Accessed: December 19th, 2016].

Jordt, I. (2007) *Burma's Mass Lay Meditation Movement*. Athens: Ohio University Press.

Kabat–Zinn, J. (1991) *Full Catastrophe Living*. New York: Delta Trade Paperbacks.

Kilpatrick, L.A., Suyenobu, B.Y., Smith, S.R., Bueller, J.A., Goodman, T., Creswell, J.D., Tillisch, K., Mayer, E.A. and Naliboff, B.D. (2011) Impact of Mindfulness–Based Stress Reduction Training on Intrinsic Brain Connectivity. *Neuroimage*, 56 (1), 290–298.

Koster, F. and Oosterhoff, M. (2004) *Liberating Insight: Introduction to Buddhist Psychology and Insight Meditation*. Chiang Mai: Silkworm Books.

Kuijpers, H., Van Der Heijden, F., Tuinier, S. and Verhoeven, W. (2007), Meditation–induced psychosis. *Psychopathology*, 40 (6), 461–464.

Lasch, C. (1979) *The Culture of Narcissism*. New York and London: W. W. Norton & Company.

Latour, B. (1987) *Science in Action*. Cambridge: Harvard University Press.

Latour, B. (2005) *Reassembling the Social. An Introduction to Actor–network Theory*. New York: Oxford University Press.

Latour, B. (2013) *An Inquiry Into Modes of Existence*. Cambridge: Harvard University Press.

Leledaki, A. (2007) *Inner and Outer Journeys*: *A Qualitative Life History of Modern Yoga and Meditation as Body–Self–Transforming Pedagogies*. PhD Thesis. University of Exeter.

Lupton, D. (2013) Quantifying the Body: Monitoring and Measuring Health in the Age of mHealth Technologies. *Critical Public Health*, 23 (4), 393–403.

Lutz, A., Greischar, L.L., Rawlings, N.B., Ricard, M. and Davidson, R.J. (2004) Long–term Meditators Self–induce High–amplitude Gamma Synchrony during Mental Practice. In *Proceedings of the National Academy of Science USA*, 101 (46), 16369–16373.

Mani, M., Kavanagh, D.J., Hides, L. and Stoyanov, S.R. (2015), Review and Evaluation of Mindfulness–Based iPhone Apps. [Online] *JMIR Mhealth Uhealth*. 19 (3).

McKay, F. (2013) Psychocapital and Shangri–Las: How Happiness Became both a Means and End to Governmentality. *Health, Culture and Society*, 5 (1), 36–50.

McMahan, D. (2008) *The Making of Buddhist Modernism*. New York: Oxford University Press.

Mol, A. (1999) Ontological Politics: A Word and Some Questions. In Law, J. and Hassard, J. (eds), *Actor Network Theory and After*. Oxford: Blackwell.

Otis, L.S. (1984) Adverse Effects of Transcendental Meditation. In Shapiro, D.H. and Walsh, R.N. (eds.), *Meditation: Classic and Contemporary Perspectives*. Hawthorne: Aldine Publishing Company.

Pagis, M. (2008) *Cultivating Selves: Vipassana Meditation and the Microsociology of Experience*. Unpublished PhD Thesis. Department of Sociology, University of Chicago.

Pickering, A. (1995) *The Mangle of Practice: Time, Agency & Science*. Chicago and London: Chicago University Press.

Pickering, A. (2010) *The Cybernetic Brain: Sketches of Another Future*. Chicago: University of Chicago Press.

Pickering, A. (2014) Islands of Stability: Engaging Emergence from Cellular Automata to the Occupy Movement. *Zeitschrift für Medien– und Kulturforschung*, 1, 121–134.

Pitts–Taylor, V. (2010) The Plastic Brain: Neoliberalism and the Neuronal Self. *Health*, 14 (6), 635–652.

Praissman S. (2008) Mindfulness–Based Stress Reduction: A Literature Review and Clinician's Guide*. Journal of the American Academy of Nurse Practitioners*, 20 (4), 212–216.

Preston, D.L. (1988) *The Social Organization of Zen Practice*. Cambridge: Cambridge University Press.

Ricard, M., Lutz, A. and Davidson, R. (2014) Mind of the Meditator. *Scientific American*, 311 (5), 38–45.

Rose, N. (1998) *Inventing Our Selves*. Cambridge: Cambridge University Press.

Rose, N. (2007) *The Politics of Life Itself: Biomedicine, Power and Subjectivity in the Twenty–First Century*. Princeton: Princeton University Press.

Rose, N. and Abi–Rached, J. (2013) *Neuro. The New Brain Sciences and the Management of the Mind*. Princeton: Princeton University Press.

Selim, N. (2011) *Doing Body, Doing Mind, Doing Self: Vipassana Meditation in Everyday Life*. Master's Dissertation in Medical Anthropology, University of Amsterdam.

Shapiro, S., Walsh, R. and Britton, W. (2003) An Analysis of Recent Meditation Research and Suggestions for Future Directions. *Journal for Meditation and Meditation Research*, 3, 69–90.

Shear, J. and Jevning, R. (1999) Pure Consciousness: Scientific Exploration of Meditation Techniques. In Varela, F. and Shear, J. (eds.), *The View From Within: First–person Approaches to the Study of Consciousness*. Bowling Green: Imprint Academic.

Scheper–Hughes, N. (2004) Parts Unknown: Undercover Ethnography of the Organs–trafficking Underworld. *Ethnography*, 5 (29), 29–73.

Shiva, V. (1997) *Biopiracy: The Plunder of Nature and Knowledge*. Brooklyn: South End Press.

Sloterdijk, P. (2013) *You must change your life*. Cambridge: Polity Press.

Stanley, E.A. and Jha, A.P. (2009) Mind Fitness: Improving Operational Effectiveness and Building Warrior Resilience. *Joint Force Quarterly*, 55 (4), 144–151.

Teasdale, J.D., Segal, Z.V., Williams, J.M.G., Ridgeway, V.A., Soulsby, J.M. and Lau, M.A. (2000) Prevention of Relapse/Recurrence in Major Depression by Mindfulness–Based Cognitive Therapy. *Journal of Consulting and Clinical Psychology*, 68 (4), 615–623.

Varela, F. and Shear, J. (1999) First Person Accounts: Why, What, and How. In Varela, F. and Shear, J. (eds.), *The View From Within: First–person Approaches to the Study of Consciousness*. Bowling Green: Imprint Academic.

Verbeek, P.–P. (2011) *Moralizing Technology: Understanding and Designing the Morality of Things*. Chicago and London: The University of Chicago Press.

Walsh, R. (1979) Meditation Research: An Introduction and Review. *Journal of Transpersonal Psychology*, 11 (2), 161–174.

Walsh, R. and Roche, L. (1979) Precipitation of Acute Psychotic Episodes by Intensive Meditation in Individuals with a History of Schizophrenia. *American Journal of Psychiatry*, 136 (8), 1085–1086.

Wittgenstein, L. (1961) *Tractatus Logico–Philosophicus*. London and New York: Routdledge.

Zeidan, F., Johnson, S.K., Diamond, B.J., David, Z. and Goolkasian, P. (2010) Mindfulness Meditation Improves Cognition: Evidence of Brief Mental Training. *Consciousness and Cognition*, 19 (2), 597–605.

Zizek, S. (2005), Revenge of Global Finance. *In These times*, 21 May. [Online] Available at:
http://inthesetimes.com/article/2122/revenge_of_global_finance
[Accessed: December 19th, 2016]

Where Are the Girls in STEM?

Asrun MATTHIASDOTTIR[a] and Jona PALSDOTTIR[*b]

[a] Reykjavik University; [b] Ministry of Education in Iceland

It's no news that the Science, Technology, Engineering and Mathematics (STEM) sector is gender biased at all levels, in schools, workplaces and academia. Many reasons have been identified why few women attend STEM education, e.g. the organization of STEM education, institutional cultures, family influence, community groups and models, the impact of peers, the media and popular culture. Public actions to change this situation have been taken, for example to influence young girls during compulsory schooling and to initiate events like 'Girls in ICT Days'. These initiatives draw the girls' attention to the diverse possibilities in STEM education and jobs. Female role models from the technical sector have been utilised in order to break down stereotypes and open up girls' minds to the world of technology. Although more women have now completed PhDs and are in faculty positions in STEM education at university level, development is slow and women are less often promoted and receive fewer grants than their male contemporaries.

In this paper we will give an overview of the situation in Iceland and present results from a survey in which female university computer science students were asked to outline their reasons for choosing STEM education.

Keywords: STEM; gender bias; computer science

Introduction

The Science Technology Engineering Mathematics (STEM) sector is gender biased at all levels, in schools, workplaces and academia. Reports have been produced and studies carried out in order to investigate and understand the reasons for this and to find out how to improve the current situation. There are multiple reasons why few women attend STEM education and pursue careers in STEM (Liben and Coyle, 2014).

Elkjær (1992) studied gender behaviour in the classroom and described the gender relationship in the classroom as 'hosts'–'guests', with boys being

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[*] Corresponding author: **Asrun Matthiasdottir** | e–mail: **asrun@ru.is**

the hosts and girls the guests. She claimed that girls had more freedom while boys were in a more limited situation as hosts.

Stoeger and colleagues (2013), in their analysis of the literature, found three factors that can explain the gender disparity in STEM. Firstly, environmental influences, i.e. boys are believed to be more talented than girls who are believed to be less suited for STEM. Secondly, individual goals and interest, and thirdly, 'the psychological entities that represent the action opportunities available to individuals' (Stoeger et al., 2013, p. 409). The authors have developed an e–mentoring system with the aim of providing support, counselling, advice, instruction and knowledge sharing for women in STEM.

Previously, achievement and personality traits were considered important factors in explaining the differences between girls' and boys' attraction to STEM. More recently Stoeger et al. (2013) pointed out that the academic achievement of girls in STEM today are no less than those of boys and studies are looking away from traits such as giftedness, interest and motivation, as explanations.

The influence of social and structural factors which may act as barriers is identified and discussed in the literature. Ahuja (2002) looks into those factors in her literature review and emphasises how important it is to identify specific factors which are accountable for the gender imbalance, especially in information technology (IT). She discerns social and structural factors, where social factors include work/family conflict, social expectations, and informal networks. Structural factors include lack of role models and mentors, occupational culture, institutional structures and demographic composition.

The effect of stereotypes has recently gained interest, but the results have not been homogeneous. Some students may be interested in the STEM fields because of these stereotypes while they may have a negative influence on others (Cheryan, Master and Meltzoff, 2015). Cheryan and colleagues (Cheryan, Master and Meltzoff, 2015) point out the importance of students realising that they do not need to be a certain type of person to be successful in engineering or computer science.

Research has shown that the genders tend to focus differently on technical matters. Boys focus more on mathematics and hardware and girls on creativity, communication, or job opportunities (Funke, Berges and Hubwieser, 2016). This knowledge gives the educational providers an opportunity to offer STEM education with more emphasis on subjects and study organisation which might attract girls.

In the National Centre for Women and Information Technology (NCWIT) report, *Girls in IT: The facts* (Ashcraft, Eger and Friend, 2012) it is pointed out that 'girls comprise 56% of all Advanced Placement (AP) test–takers, 46% of all AP Calculus test–takers, but only 19% of AP Computer Science test–takers' (Ashcraft, Eger and Friend, 2012, p. 3). The four main influencing factors reported are: 1. Educational influence, 2. Family, social groups and role models, 3. Peer influence, and 4. Media. The report claims that more studies are needed which focus on gender in a broader context in relation to existing computing programs. The influence of parents, peers, and popular culture, as well as the interactions of race, class, and gender in students' identity development are all factors which need to be considered. The authors suggest that schools should offer programmes that focus on how computing can address social problems (Ashcraft, Eger and Friend, 2012).

In the Empowering Women Through Education report (McCracken et al. 2015), gender sensitive institutional cultures and practices are considered important for girls' education. The authors conclude that 'male academics tend to earn more than female and women are more likely to be associated with non–science subjects. This segregation reinforces gender stereotypes throughout the education system' (McCracken et al., 2015, p. 51).

The report Solving the Equation. The Variables for Women's Success in Engineering and Computing (Corbett and Hill, 2015) gives detailed recommendations regarding women and men working in engineering and computing to employers, educators, colleges, universities , policy makers, parents and girls. The authors point out that girls need to know what engineering and computing are about in order to make an informed choice and policy makers could use educational programs and research funds to help improve the representation of women in these fields.

A high proportion of Nordic young people complete university studies, but the percentage of female students who choose STEM remains static. Guidelines (Puggaard and Bækgaard, 2016) have been published by the Nordic council of ministers in Denmark, Finland, Iceland, Norway, Sweden, Åland, Faroe Islands and Greenland, on how to attract girls and young women to engineering and science. The emphasis is on industry, higher education and compulsory education institutions. As an example from these guidelines, the hiring process in industry should change and the importance of positive role models should be emphasised. The guidelines for higher education institutions include encouragement to create a safe learning environment with focus on cooperation instead of competition. Within

compulsory education institutions, school counsellors should be encouraged to stimulate interest among girls in engineering and science (Puggaard and Bækgaard, 2016).

The manner in which STEM is presented is important and the earlier in a child's life, the better. Reports and research have identified those factors on which we should focus; more research is needed, in addition to the introduction and implementation of current knowledge. Bolton and Muzio (2008) examine three professional groups: teaching, law and management and conclude that 'the relationship between gender and professionalism is a complex one, as feminization can acquire a strategic significance and be deployed by certain sections to further their own professional project' (Bolton and Muzio, 2008, p. 294). It is essential to adopt best practice and develop more projects in order to build on present knowledge.

The Icelandic focus

Iceland is well known for gender equality and has been at the top of the World Economic Forum's Gender Equality Index since 2009. This does not tell the whole story because gender–based inequalities and discrimination still exist in Iceland. The weakest link is the labour market, which is still gender–segregated, especially when it comes to remuneration in female–dominated professions. Women and men are not equally paid for the same work and it has been stated that women worked without pay for the first 36 days of the year 2016 (Anon, 2016). Women's participation in the labour market in Iceland is among the highest in the world as it is difficult to provide for a family with one salary. The situation is supported by a good kindergarten system where all children aged two to five can attend at relatively low cost (Oddsdottir et al., 2015). An identified wage difference of 10% between male and female members of the VR (The Commercial Workers' Union of Reykjavik) can only be explained by the wage–earner's gender. This income gap has remained similar since 2009 (VR, 2016).

Compulsory education for children aged 6–16 is free in Iceland and the genders have equal access to schools. The gender proportion at the upper secondary school level has been almost equal since 1975 and it still is, but girls composed 59% of those who graduated in 2013. The situation is different at the tertiary level as women made up 63% of registered students in 2014 and 65% of graduated students in 2013 (Statistic Iceland, 2016).

When we look closer at the university level, the gender balance is far from even in different disciplines. In Figure 1, we see that the proportion of women exceeds that of men in most disciplines with the exception of

science, mathematics, computer science, engineering, manufacturing and construction. This is a clear indication of the gender–segregated choices that boys and girls make in education.
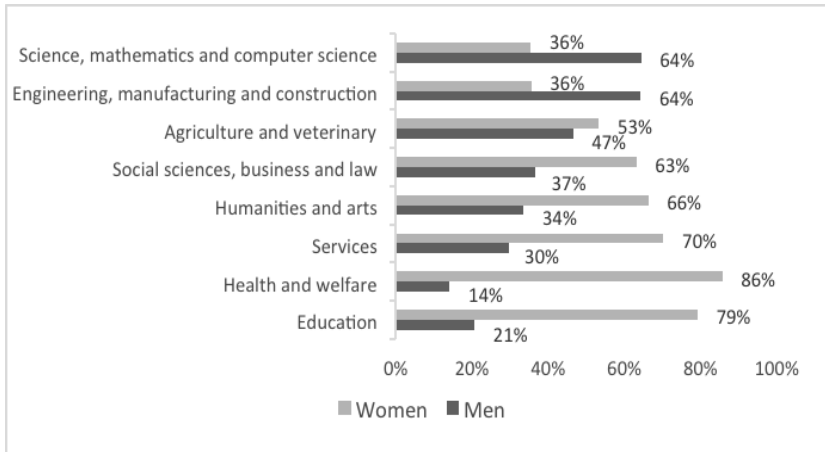
Figure 1   Proportions of males and females in different disciplines at the university level in Iceland (Statistic Iceland 2016).

No systematic efforts or projects have been implemented at the university level to recruit more girls into STEM, but some smaller scale projects have been ongoing, e.g. Girls in *ICT Day* at Reykjavik University (Matthiasdottir and Falgren, 2015). A gender equality counsellor is employed at the Ministry of Education, Culture and Science, to monitor the application of the provisions of the Article 23 of the Gender Equality Act, No. 10/2008. The Article states that the ministry must observe compliance with gender equality in educational institutions and give advice and guidance on how to promote gender equality.

Women's increased education in Iceland has not secured gender equality, it has simply not been sufficient. There is not equality in the management of enterprises although the situation is better after recent legislation, i.e., law no. 13/2010, stating that when there are more than three on the board of a company the proportion of each sex must not be lower than 40%. Women are still the majority of those working in care–taking, teaching and other services in the public sector with lower salaries.

In this paper, the focus will be on women studying computer science at Reykjavik University in order to gain a better understanding of why they

chose this subject and whether there are some common elements in their reasons.

Method

Data gathering was in two phases, first a pilot study was conducted by a short e–mail questionnaire and then an anonymous online questionnaire study was conducted.

E–mail questionnaire

In order to design the online questionnaire, it was decided to contact six women studying computer science at Reykjavik University. They were all studying in one of the author's classes and were the only female students in the class (n=6). The class consisted solely of 6 women and as such, formed a convenient sample. An e–mail was sent in which they were asked three questions: Why did you choose computer science? Would you rather have chosen another subject? Are you looking forward to working as computer scientist? The women were a convenient sample as they were students of one of the authors (AM). All six answered the questions.
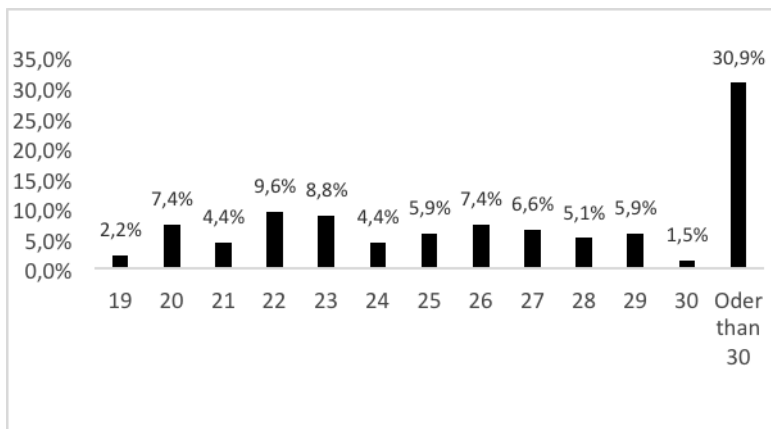
Figure 2   Age of the participants (n=136).

Online Questionnaire

Participants

The participants were all (n=220) women studying computer science BSc programme at Reykjavik University and 138 (63%) answered. The BSc is a 3–year program or 6 semesters and 84% of the participants were in semester 1–6 and 16% had spent more than 6 semesters on their study. Fourteen percent where 19–21 years old, 55% where 22–30 years old and 31% where older than 30 as shown in Figure 1.

Measures

An online questionnaire, with eight questions, was designed for the purpose of the study. The answers from the e–mail pilot study guided the selection of questions. These consisted of two background questions and six questions concerning the participants' attitudes towards their study in computer science. The background questions identified the student's age and semester. The first 2 question asked about the student's use of computers in elementary school and upper secondary school. Nine answering options were given (one being something else). Next, the students were asked when they became interested in computer science. This question had four answering options. The fourth question concerned participants' computer skill before commencing computer science study at university level. Five Likert scale answering options were given, ranging from Very much to Very little. The fifth question was 'Why did you select computer science' with 12 answering options (one being something else) and the last question was 'Did you have the opportunity to choose another profession' with the answering possibilities Yes, No and If yes, then what?

Procedure

The website Free Online Surveys (https://freeonlinesurveys.com) was used to distribute the questionnaire online. The survey was opened on the 24th of February 2015 and closed 30 days later. An introductory e–mail was sent at the beginning to the participants and a reminder was sent on the 13th March to encourage them to answer. The data were exported into Excel for analysis, but a report from the system was also used.

Results

E–mail questionnaire

The participants answered three questions and as stated before, the first question was: 'Why did you choose computer science?' Two participants said they had a role model; one was influenced by her father who was a programmer and the other was influenced by her brother and his computer games. One participant took a computer science line in upper secondary school and saw this as a natural next step and one had attended a good presentation of the computer science program at RU. One participant gave a very practical reason: 'Due to my age, I considered this to be a practical education where I would get a legal profession after 3rd years of studies and probably a job immediately after graduation. I chose this not out of interest; I had just had done some Excel exercises in colleges but nothing more than that.'

The second question was: 'Would you rather have chosen another subject?' The participants mentioned graphical design, medicine, law and anthropology, but three said that now they did not consider any other subject and were happy about their choice of profession. This answer shows the influence of age: 'If I had been twenty when I went to university I would have gone into medicine and specialized as a forensic scientist and worked on autopsies. I do not know why but these were fascinating to me, and many found it strange. I think I might have been more comfortable as a surgeon.'

The third question was: 'Are you looking forward to working as a computer scientist?' Participants were all looking forward to starting work as computer scientists. One was extremely proud to be graduating soon but another one was not sure about her ability to handle a good job after graduation, 'It would be nice to be able to work with something you're learning. I actually do not have that good self–confidence and I am rather nervous when it comes to trying to find work, my ability might not be sufficient to be hired and I am likely to be stressed at the begin with while I am mastering the job.'

Overall the participants were practically minded as this example shows: 'I want to work as a secondary school teacher, I am a teacher, but the salaries are too low. Because of my age I considered this to be a practical education as I would get a certification after 3 years and probably a job right after graduation – I did not choose this out of interest. I think I would have been comfortable as a surgeon. I had always wanted to study this too

(computer science), but thought it was something I could not learn –I was never good at maths.'
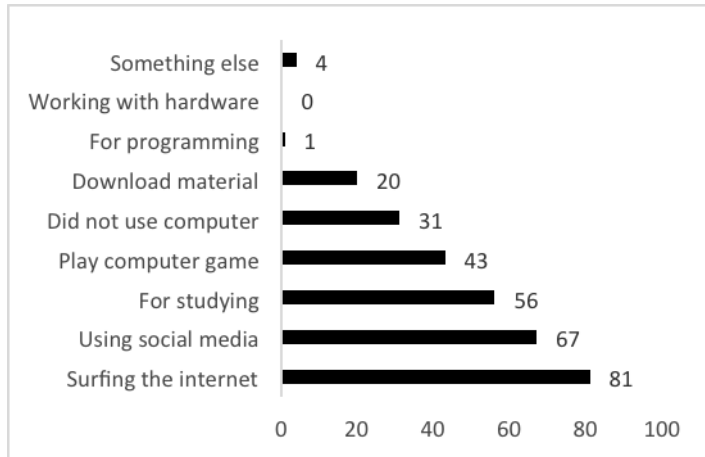
Figure 3   Participants use of computers in compulsory education (could select three items, n=138).

Online questionnaire

The students where asked how they use computers in compulsory education (age 6–15). Figure 3 shows that most of the participants identified surfing the internet (81), then using social media (67) and using computers for studying (56). Four said 'something else' and two reported working with Photoshop, one said she used a typewriter instead of a computer and one said IRC (Internet Relay Chat).

Figure 4 shows that most (115) participants reported use of computers for studying in upper secondary school, then surfing the internet (85) and using social media (85). Two reported 'something else' and both said they practiced typewriting using computers.

Participants were asked about their computer skills when they started studying computer science at university level and 26% reported poor or very poor skills and 18% very good or good as Figure 5 shows.

Figure 6 shows that 45% of the participants became interested in computer science after 22 years of age.
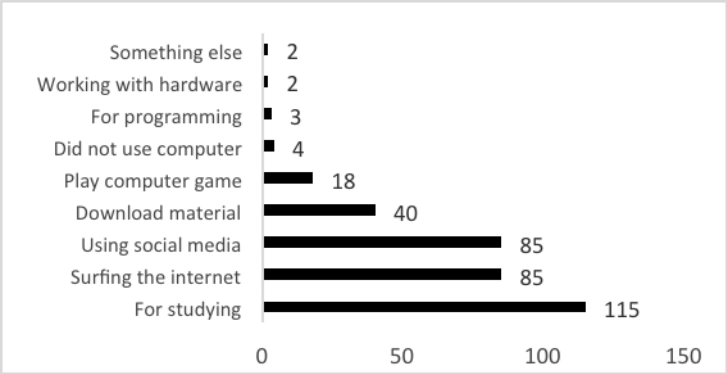
Figure 4   Participants use of computers in upper secondary school (could select three items, n=138).
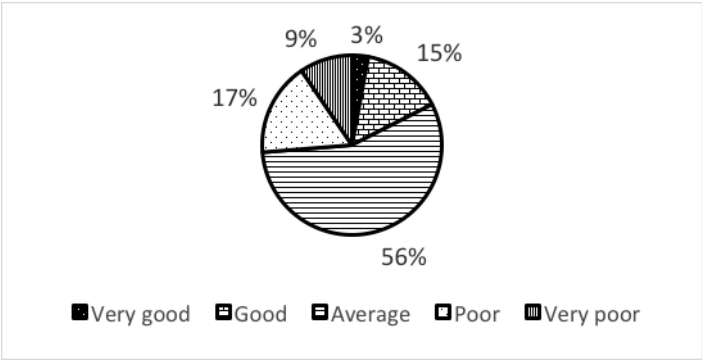
Figure 5   Participants computer skills before they started studying computer science (n=137).
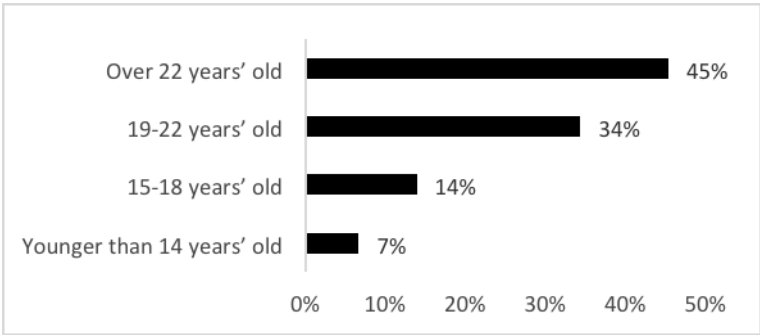
Figure 6   Age when participants got interested in computer science (n=137).

When the participants were asked why they chose to study computer science, 82 said they were interested in the profession as Figure 7 shows. They also identified good employment prospects (82), good salaries (61) and an interest in math and science (58) as reasons for their choice.
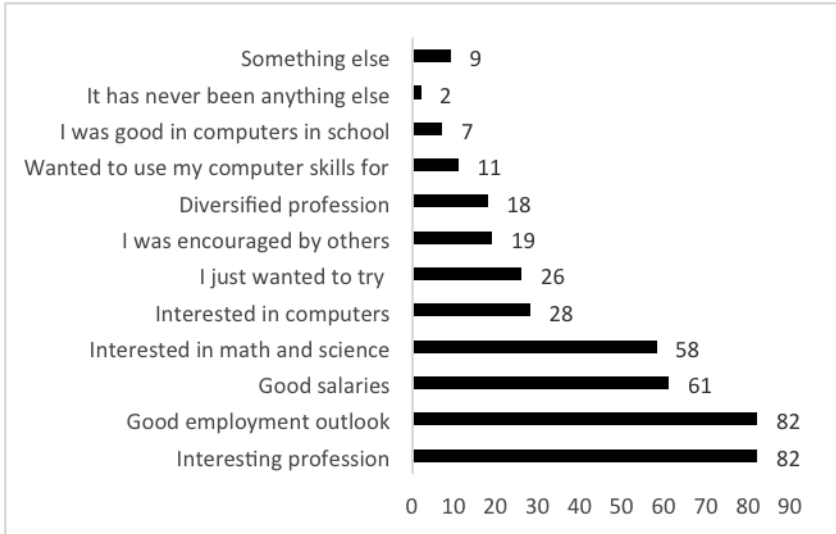
Figure 7   Participants reason for selecting compute science (could select three items, n=138).

Half (50%) of the participants had considered taking an alternative subject at university and mentioned several other careers which they had contemplated. Table 1 shows how often some professions where mentioned, mainly STEM subjects, e.g. math, chemistry, nutrition, pharmacy, geology and physics, but also subjects such as sports science, language and pedagogy.

Table 4   Professions that the participants had considered (n=62).

Subject		Subject		Subject	
Engineering	18	Business study	8	Architecture and design	5
Medicine	5	Becoming a pilot	4	Psychology	4
Law	3	Nurse	2	Teacher	2

Discussion

This study of female students in STEM at the university level shows that they are practically minded when it comes to choosing a subject. They claimed that they chose STEM subjects, like computer science, because they believed this would lead to high paid employment and good job opportunities, even though they may have preferred to study other subjects. They were not unhappy in their studies and were looking forward to working in the field.

Most of the participants embarked on their computer science study rather late as more than half of them were over 25 years old. This indicates that they had either already studied another subject at university level or had taken some years off before going to university. The study of computer science was not an early decision as half of them developed an interest in computers only after 22–years of age. This finding begs the question, why? Did they not know enough about the content of STEM or the opportunities available in this profession, for example the possibility of a high salary after comparatively fewer years (three) of study? Further research is required to examine the educational and work history of girls in STEM.

The participants did not consider themselves as having good computer skills when they started computer science and they had mainly used computers for practical purposes in elementary and upper secondary school. Almost half of them had used computers as teenagers so possibly they underestimated their skills. The influence of computer confidence in STEM would form an interesting topic for further research in relation to students' selection of study subject and choice of eventual employment.

This is a small scale study that did not give consistent answers but nevertheless it supports the existing literature.

References

Ahuja, M.K. (2002) Women in the Information Technology Profession: A Literature Review, Synthesis and Research Agenda. *European Journal of Information Systems*, 11 (1), 20–34.

Anon (2016) Jafnrétti. *VR stéttarfélag*. [Online] Available from: www.vr.is [Accessed: December 12th, 2016].

Ashcraft, C., Eger, E. and Friend, M. (2012) Girls in iT: The Facts. *National Center for Women & Information Technology (NCWIT)*. [Online] Available from:

http://www.bgwomeninict.org/language/bg/uploads/files/documents__0/documents__83629f0d73af0b954068af2b53b04dc5.pdf [Accessed: December 19th, 2016].

Bolton, S. and Muzio, D. (2008) The Paradoxical Processes of Feminization in the Professions: The Case of Established, Aspiring and Semi–professions. *Work, Employment and Society*, 22 (2), 281–299.

Cheryan, S., Master, A. and Meltzoff, A.N. (2015) Cultural Stereotypes as Gatekeepers: Increasing Girls' Interest in Computer Science and Engineering by Diversifying Stereotypes. *Frontiers in Psychology*, 6 (49), 1–8.

Corbett, C. and Hill, C. (2015) Solving the Equation. The Variables for Women's Success in Engineering and Computing recommendation. *AAUW report.* [Online] Available from: https://www.ehu.eus/documents/2007376/3500574/solving_the_equation.pdf [Accessed: December 20th, 2016].

Elkjær, B. (1992) Girls and Information Technology in Denmark: An Account of a Socially Constructed Problem. *Gender and Education*, 4(1–2), 25–40.

Funke, A., Berges, M. and Hubwieser, P. (2016) Different Perceptions of Computer Science. [Online] In *Learning and Teaching in Computing and Engineering (LaTICE)*. Paper presented at the International Conference 2016, IEEE, 14–18. [Online] Available from: http://ieeexplore.ieee.org/document/7743145/ [Accessed: December 20th, 2016].

Liben, L.S. and Coyle, E.F. (2014) Chapter Three. Developmental Interventions to Address the STEM Gender Gap: Exploring Intended and Unintended Consequences. *Advances in Child Development and Behavior*, 47, 77–115.

Matthiasdottir, A. and Falgren, K.H. (2015) Hvað þarf til að auka áhuga kvenna á tölvunarfræði? *Tölvumál*. [Online] Available from: http://www.sky.is/index.php/toelvumal/item/1763–hvadh–tharf–til–adh–auka–ahuga–kvenna–a–toelvunarfraedhi [Accessed: December 19th, 2016].

McCracken, K., Unterhalter, E., Márquez, S. and Chełstowska, A. (2015) *Empowering Women and Girls through Education. Study for he FEMM Commitee.* [Online] Available from: http://www.europarl.europa.eu/RegData/etudes/STUD/2015/510022/IPOL_STU(2015)510022_EN.pdf [Accessed: December 13th, 2016].

Oddsdottir, E.E., Sigurðsson, A.M., Swandal, S. and Árnadóttir, A.K. (2015) *Gender Equality in the Arctic. Current Realities, Future Challenges*.

[Online] Conference report. Available from https://www.mfa.is/media/nordurslodir/Gender–Equality–in–the–Arctic.pdf. [Accessed: December 19th, 2016].

Puggaard, M.P. and Bækgaard, L. (2016) *Handbók um leiðir til að laða stúlkur og ungar konur að verkfræði– og raunvísindagreinum*, Norræna ráðherranefndin. [Online] Available from: https://norden.diva–portal.org/smash/get/diva2:968885/FULLTEXT03.pdf [Accessed: December 14th, 2016].

Statistic Iceland (2016) Hagstofa Íslands. *Hagstofa Íslands*. [Online] Available from: http://hagstofa.is/ [Accessed: December 19th, 2016].

Stoeger, H., Duan, X., Schirner, S., Greindl, T. and Ziegler, A. (2013) The Effectiveness of a One–year Online Mentoring Program for Girls in STEM. *Computers & Education*, 69, 408–418.

VR (2016) Launamunur kynjanna óbreyttur milli ára. *VR stéttarfélag*. [Online] Available from: https://www.vr.is/frettir/launamunur–kynjanna–obreyttur–milli–ara/ [Accessed: December 19th, 2016].

Yu, K.–C., Lin, K.–Y., Han, F.–N. and Hsu, I–Y. (2012) A Model of Junior High School Students' Attitudes toward Technology. *International Journal of Technology and Design Education*, 22 (4), 423–436.

Le ricercatrici in fisica: primi risultati di un progetto di ricerca

Sveva AVVEDUTO[*a], Maria Carolina BRANDI [a], Maria Girolama CARUSO [a], Loredana CERBARA [a], Ilaria DI TULLIO [a], Daniela LUZI [a] e Lucio PISACANE [a]

[a] CNR – Istituto di Ricerche sulla Popolazione e le Politiche Sociali, Roma

In questo contributo si presentano i primi risultati ottenuti nell'ambito del Progetto Europeo GENERA che si pone l'obiettivo di sostenere gli enti pubblici di ricerca e le Università nell'implementazione dei Gender Equality Plan (GEP) in particolare nel settore della fisica.

I dati, raccolti da fonte amministrativa, descrivono i profili delle ricercatrici in fisica ponendo particolare attenzione al percorso di carriera ed evidenziano, pur in una situazione di lenta positiva evoluzione, il perdurare di differenze di genere nella progressione di carriera.

Keywords: *Ricerca; fisica; percorsi di carriera*

Introduzione

Il rapporto della Commissione Europea She Figures 2015 (European Commission, 2016) che presenta i dati comparabili a quelli del 2012, mostra che, nonostante si sia registrato un incremento delle ricercatrici pari al 4% nei precedenti 8 anni, la presenza femminile nelle università e nei laboratori di ricerca europei era pari al 33%, un dato rimasto invariato dal 2009.

Gli avanzamenti di carriera inoltre rimangono caratterizzati da un'evidente segregazione verticale.

Infatti le donne sono molto numerose nelle prime fasi della carriera con una percentuale di presenze nel livello iniziale del 45% (Grade C) , che diminuisce al 37% al livello successivo (Grade B) per ridursi al solo 21% al livello apicale (Grade A) . La presenza femminile in termini di numerosità varia nei diversi settori scientifici ma le donne sono particolarmente

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[*] Corresponding author: **Sveva Avveduto** | e–mail: **sveva.avveduto@cnr.it**

sottorappresentate nelle discipline cosiddette STEM (science, technology, engineering, mathematics) e continua a verificarsi una segregazione orizzontale che si riverbera in una non equa distribuzione femminile nei diversi settori disciplinari dove la sotto–rappresentazione femminile si fa ancora più acuta. Nel 2013 infatti le studentesse erano solo il 31% del totale e le laureate a livello ISCED 5 il 35% , e tra queste raggiungeva il livello ISCED 6 rispettivamente il 34% e il 37%.

La situazione peggiora se si guarda al personale accademico che al livello iniziale (Grade C) presenta una percentuale di donne del 33%, per poi diminuire ai livelli successivi: 24% al Grade B e 13% al Grade A.

Le due diverse forme di segregazione verticale e orizzontale, dunque, si intersecano e si rafforzano a vicenda evidenziando una disparità in termini sia di opportunità di entrata che di evoluzione nella carriera.

I rapporti tra genere scienza e tecnologia sono stati oggetto di numerosi studi in passato e le interpretazioni dei fenomeni di sotto rappresentazione della componente femminile sono state avanzate tenendo in considerazione vari aspetti di diversa natura: economica, tecnologica, sociale, psicologica e così via.

Tra gli studiosi ad esempio, Blickenstaff (2005) ha esaminato criticamente le varie ipotesi che sono state fatte nella letteratura accademica dei paesi anglosassoni (USA, UK, Australia), tra il 1984 ed il 2003 per spiegare la scarsa presenza femminile nelle professioni collegate alle scienze, alla tecnologia, all'ingegneria ed alla matematica (STEM). Le possibili cause prese in esame sono molte e assai diverse tra loro: differenze biologiche tra uomini e donne, scarsa attitudine delle ragazze verso le materie scientifiche, mancanza di modelli femminili tra scienziati e ricercatori famosi, una pedagogia delle scienze che favorisce i maschi, le pressioni culturali per indirizzare le ragazze verso i tradizionali ruoli femminili. Scartando ipotesi che si sono verificate indiscutibilmente errate ed oggi considerate risibili, come quelle che facevano riferimento a differenze biologiche o alla scarsa attitudine delle donne allo studio delle scienze, questo autore identifica come particolarmente negativo l'atteggiamento esplicitamente o implicitamente sessista dell'insegnamento delle materie scientifiche, nelle scuole come nelle università, arrivando alla conclusione che il fenomeno della scarsa presenza femminile nelle attività STEM è comunque dovuto a numerose concause sociali e che non è possibile cambiare la situazione agendo solo sul versante dell'insegnamento delle scienze.

Tra le altre cause prese in considerazione da Blickenstaff (2005) per spiegare la scarsa presenza femminile nelle scienze STEM, vi è anche l'ipotesi di una visione intrinsecamente maschile nell'epistemologia scientifica, ipotesi avanzata da diverse autrici che fanno un riferimento più esplicito al movimento femminista.

D'altra parte, Wajcman (2000), esaminando la ricerca sociologica femminista delle ultime decadi del XX Secolo riguardo alla tecnologia, arriva alla conclusione che l'avversione alla tecnologia, considerata totalmente negativa e patriarcale e tipica di una prima fase di questi studi, è ormai superata ed è stata sostituita da una visione dei rapporti tra genere e tecnologia molto più complessa. Secondo questa autrice, infatti è ormai stabilito che i concetti di 'mascolinità', 'femminilità' e 'tecnologia' non sono categorie fisse ed univoche. In particolare, gli ultimi studi di quel periodo guardavano alle tecnologie informatiche come un possibile strumento di potere per le donne ('cyberfemminismo'), vedendo nel cyberspazio un possibilità di costruire un mondo libero da gerarchie di genere.

In effetti, questa ipotesi trova una parziale conferma nella ricerca empirica di Faulkner (2000) tra i softwaristi di una importante multinazionale. L'autrice esamina la dicotomia e le gerarchie tra le diverse attività che confluiscono in questa professione: chi si occupa prevalentemente degli aspetti tecnologici della programmazione e quanti invece sono impegnati in attività maggiormente legate con rapporti interpersonali (come quelle gestionali), tra il lavoro specialistico e quello più eterogeneo e tra quello più teorico e quello prevalentemente sperimentale. L'autrice conclude che queste dicotomie riscontrate negli studi sociologici riguardanti l'ingegneria effettivamente esistono anche nell'informatica, ma che il valore gerarchico di una attività rispetto all'altra, che viene più o meno consciamente riconosciuto dai softwaristi, distorce quella che è la pratica reale della professione ed è sostanzialmente un retaggio della concezione dell'ingegneria che si è sviluppata tra la fine del XIX e l'inizio del XX secolo. Faulkner conclude anche che le differenze di genere tra i softwaristi interagiscono con queste dicotomie in modo contraddittorio e che in generale tra donne e uomini che lavorano nell'informatica non ci sono differenze sistematiche nelle preferenze e nella scala di valori rispetto alle varie attività.

Rimane però un fatto incontestabile che in alcuni settori scientifici, come nella biologia, la presenza femminile è abbondante, mentre in altri, e specialmente nella fisica e nell'ingegneria, è decisamente scarsa. Le ragioni di queste differenze sono state fino ad ora scarsamente studiate.

SVEVA AVVEDUTO, MARIA CAROLINA BRANDI, MARIA GIROLAMA CARUSO, LOREDANA
CERBARA, ILARIA DI TULLIO, DANIELA LUZI, LUCIO PISACANE

A livello internazionale la situazione di squilibrio tra i generi nella scienza sembra lentamente migliorare. Un recente studio (Ceci et al., 2014), mostra che anche se nelle scienze tecnologiche, ingegneristiche e matematiche si sono verificati forti squilibri di genere in passato, la situazione è nettamente migliorata negli ultimi anni. Un altro studio (Bodewits e Gramlich, 2016) ha suggerito che, almeno nel Regno Unito, mentre alcuni settori scientifici come la biologia e le biotecnologie sono ormai saturi ed offrono quindi poche possibilità di sviluppo di carriera, altri, come la fisica e l'ingegneria, soffrono ancora di una considerevole carenza di personale: in questi campi quindi si potrebbero aprire migliori possibilità anche per le donne interessate ad una carriera scientifica.

La ricerca di Ceci e colleghi (2014) ha avuto una vasta risonanza, anche sulla stampa (Matter, 2014). Quello però che altri studiosi hanno contestato a questo studio è stato il fatto che esso ipotizza che la società moderna richieda un numero sempre maggiore di personale di ricerca e che queste maggiori possibilità lasciano ormai un largo spazio anche alle donne nelle carriere scientifiche. Questa ipotesi però è in contraddizione del fatto che solo una percentuale molto bassa di post–doc (2,03% tra i maschi, 4,28% delle donne) riesce ad entrare stabilmente nel sistema accademico, almeno nel caso degli Stati Uniti (Benderly, 2014a).

Le analisi sopra citate si inscrivono in un filone di studi che è avanzato per vie parallele prendendo in esame ora gli aspetti più direttamente legati alla struttura della società o all'organizzazione del lavoro fino ad arrivare ai compiti e quindi alle differenti discipline.

La situazione infatti varia al variare dei contesti disciplinari anche nei soli settori STEM. Secondo un'indagine internazionale pubblicata su Nature (Brainard, 2011), la fisica spicca tra queste discipline come un terreno dominato dagli uomini ove le donne hanno difficoltà di ingresso e di progressione di carriera. Il settore infatti, oltre alla minore partecipazione di ricercatrici, presenta una marcata sotto–rappresentazione nelle posizioni di vertice.

Il Progetto Europeo GENERA (Gender Equality Network in the European Research Area) si rivolge proprio a questo ambito disciplinare ponendosi l'obiettivo di sostenere gli Enti pubblici di ricerca e le Università nell'implementazione dei Gender Equality Plan (GEP), ovvero dei piani di azione da sviluppare all'interno di ciascuna istituzione, e orientati a riequilibrare le disparità di genere nelle carriere scientifiche, a promuovere

l'equilibrio di genere nei processi decisionali e, infine, sostenere la creazione di un sistema di monitoraggio.

Attualmente i GEP sono presenti circa nel 36% delle istituzioni di ricerca europee (European Parliament, 2013). In Italia si è iniziato a sviluppare uno strumento che fa da pre–condizione e ponte per lo la creazione dei GEP, i bilanci di genere, e, in questo senso rilevanti esperienze si sono svolte presso l'Università degli studi di Ferrara e l'Università degli Studi di Napoli Federico II. Tali strumenti si stanno ulteriormente diffondendo grazie anche all'impegno delle Rettrici che si è di recente manifestato nell'ambito della CRUI.

Il Progetto GENERA e i GEP

Il progetto GENERA è uno dei progetti finanziati dal programma H2020 della Commissione Europea all'interno della Call for proposal nella sezione Gender equality in Research and Innovation (GERI).

GENERA si propone di favorire l'introduzione nelle università e negli enti che svolgono e finanziano la ricerca in fisica l'introduzione sistematica di cambiamenti culturali e istituzionali attraverso lo sviluppo di piani di azione positiva a misura delle singole istituzioni che li adottano.

Per raggiungere tali obiettivi le azioni che GENERA si propone di svolgere sono molteplici: dalla raccolta dei dati attualmente in possesso delle istituzioni per ottenere un primo quadro d'insieme comparabile al livello europeo e di enti, all'organizzazione di giornate nazionali ad hoc per la promozione e discussione delle tematiche di genere opportunamente selezionate da ciascun partner del Progetto (Gender in Physics Days), alla predisposizione di un tool kit che sia di supporto alle amministrazioni interessate per la realizzazione ed il lancio dei GEP.

I piani di uguaglianza di genere sono definiti come 'a consistent set of provisions and actions aiming at ensuring Gender Equality' (European Commission, 2014). Il Gender Equality Plan è uno strumento che mira a identificare e rimuovere le pratiche che possono produrre 'gender bias', riconoscere strategie innovative per superare distorsioni legate al genere; monitorare i progressi attraverso lo sviluppo di indicatori di genere (Council of the European Union, 2012) I GEP costituiscono uno degli strumenti di gender mainstreaming, in cui non ci si limita a individuare, in uno specifico contesto di ricerca, le azioni volte a rimuovere il gender bias e, quindi, le cause di diseguaglianza tra I generi, ma anche a misurare i progressi che l'attuazione di tali azioni hanno comportato in un certo lasso di tempo.

Diventano così dei veri e propri sistemi di monitoraggio che implicano un'approfondita analisi delle condizioni strutturali e organizzative di partenza su cui basare gli obiettivi che si intendono raggiungere attraverso le azioni positive individuate e/o implementate e misurarne poi l'impatto.

E' pertanto essenziale anche nella fase di un primo sviluppo di un GEP raccogliere e analizzare i dati capaci di evidenziare le diverse dimensioni della partecipazione femminile alle attività di ricerca.

Il presente lavoro pertanto si inquadra in questo ambito con lo scopo sia di fornire una prima analisi sulle ricercatrici in fisica del CNR, che di individuare i gap informativi insiti in archivi non strettamente sviluppati in un'ottica di genere. Questo permetterà di proporre cambiamenti sia nelle modalità e contenuti della raccolta dei dati che nel loro selettivo utilizzo per la introduzione dei piani di uguaglianza di genere e il successivo monitoraggio dei risultati.

Metodologia

Il Consiglio Nazionale delle Ricerche IRPPS ha intrapreso un'attività di monitoraggio dei dati amministrativi, illustrati nel seguito di questo lavoro, con l'obiettivo di dare avvio ad un'attività di monitoraggio sulle disparità di genere propedeutica all'adozione di un vero e proprio GEP.

In questo paragrafo vengono brevemente indicati i criteri di scelta del collettivo che, per la specifica struttura del CNR, necessitano di una particolare attenzione.

I dati amministrativi sono una fonte preziosa e non onerosa e sono stati selezionati per individuare i punti salienti della presenza femminile nella fisica, la progressione di carriera, la conciliazione vita/lavoro. Non essendo però raccolti con finalità specifiche di ricerca spesso presentano lacune, e richiedono ovviamente un lavoro di sistematizzazione e di ripulitura. I dati qui presentati rappresentano il primo tentativo di raccolta da archivi amministrativi, con particolare riferimento al personale con laurea in fisica.

Come è noto, il Consiglio Nazionale delle Ricerche (CNR) è il più antico ed il principale Ente pubblico di ricerca italiano. Sin dalla sua origine, è stato caratterizzato dal fatto di essere un ente di ricerca multidisciplinare, e la ricerca nei vari settori delle scienze fisiche ha sempre costituito una parte importante della sua attività.

Negli ultimi decenni, il CNR si è evoluto sempre di più da una attività di ricerca multidisciplinare, ma con una separazione abbastanza netta tra le

varie discipline, verso una sempre maggiore interdisciplinarietà. Questo ha comportato, soprattutto dopo la riforma dell'Ente del 2003 (Decreto legislativo 4 giugno 2003 n. 127), un significativo cambiamento nella sua organizzazione. Alcuni settori importanti di ricerca nelle scienze fisiche, come tutta l'astronomia e buona parte della geofisica, sono stati trasferiti ad altri enti, mentre istituzioni di ricerca prima indipendenti sono confluite nel CNR.

Attualmente quindi il CNR non è più articolato per discipline, ma per 'Dipartimenti tematici', e 'settori di attività', raggruppati in 'macroaree', alcune disciplinari, altre tematiche. A livello operativo, rimane comunque la storica divisione in Istituti.

Non è perciò automatico identificare chi svolge prevalentemente la sua attività di ricerca nelle scienze fisiche, in quanto i Dipartimenti non hanno una definizione disciplinare.

Ai fini di questo studio si è perciò considerato tutto il personale di ricerca con laurea in Fisica, indipendentemente dalla 'macroarea' di appartenenza, e tutto quello attivo in un istituto connesso alle scienze fisiche indipendentemente dalla laurea.

Va notato che i dati disponibili presso l'Amministrazione Centrale del CNR riguardano esclusivamente coloro che hanno un rapporto di lavoro a tempo indeterminato, contratti di ricercatore a tempo determinato o di diritto privato. Essi quindi escludono coloro che usufruiscono di assegni di ricerca e borse di studio o di rapporti di lavoro meno stabilizzati (prestazioni a fattura su partita IVA, ecc.).

I dati forniti dall'ente sono aggiornati al 2014 e sono stati elaborati a partire da diversi archivi amministrativi. L'archivio del personale di ricerca copre il periodo che va dal 1973 al 2014.

I primi risultati dell'indagine

L'analisi dell'archivio del personale elaborata in base ai criteri di appartenenza sopra descritti, ha prodotto un collettivo totale di 793 persone, per il 94,5% laureate in Fisica: tra queste, le donne sono 256 (32,3%). Il personale di ricerca si concentra prevalentemente nei dipartimenti tematici 'Materiali e dispostivi', nel quale operano 496 persone (di cui il 30,2% sono donne), 'Terra e ambiente' (82 persone, delle quali il 42,7% donne) ed 'Energia e trasporti' (69 persone, delle quali le donne rappresentano il 30,4%).

Più indicativa è però la distribuzione delle ricercatrici per macroaree (Tabella 1). Tra loro, la maggior parte lavora ovviamente nella macroarea tematica delle 'Scienze fisiche', ma ci sono significative presenze femminili in quella di 'Scienze della Terra e ambientali', 'Materiali' e 'Matematica e informatica'. In alcune macroaree connesse alla fisica, la presenza femminile è invece molto limitata o, in alcuni casi si rileva una totale assenza.

Tabella 1 *Distribuzione per macroarea delle ricercatrici del collettivo*

Macroarea	%
Ingegneria industriale	3,91
Progettazione e/o gestione impianti, strumentazioni, servizi	0,39
Scienze agrarie, agroalimentari e veterinarie	0,39
Scienze biologiche	1,17
Scienze chimiche	3,13
Scienze della terra e ambientali	11,72
Scienze e Tecnologie dei Materiali	7,42
Scienze fisiche	53,52
Scienze matematiche e informatiche	5,86
Scienze mediche	0,39
Scienze storiche, filosofiche, pedagogiche e psicologiche	0,39
Scienze, tecnologie e valorizzazione dei beni culturali	1,17
Supporto alla ricerca	0,39
Altro	10,16
Totale	**100,00**
Totale in valore assoluto	**256**

Riguardo ai settori di attività scientifica, che istituzionalmente vengono indicati dai ricercatori stessi (Tabella 2), la percentuale più alta di ricercatrici in Fisica lavora in 'Fisica della materia' (30,1%), mentre percentuali minori si riscontrano in 'Fisica sperimentale e applicata' (7,8%) nelle 'Scienze dell'atmosfera e del clima' (8,6%). Il 24% delle donne del nostro campione lavora in altri settori disciplinari nei quali la presenza femminile si limita ad una persona.

Tabella 2 Distribuzione per settore di attività scientifica delle ricercatrici del collettivo.

Settore	%
Biofisica	5,9
Fisica della materia	30,1
Fisica e chimica dei plasmi	5,1
Fisica sperimentale ed applicata	7,8
Fisica teorica	3,5
Metodologie didattiche, didattica e pedagogia speciali	3,1
Modellistica, simulazione e ottimizzazione	0,8
Oncologia molecolare	0,4
Scienza e tecnologia dei materiali nanostrutturati e nanosistemi	3,1
Scienza e tecnologia dei materiali per elettronica e fotonica	3,1
Scienze dell'atmosfera e del clima	8,6
Altro	24,3
Totale	**100,0**
Totale in valore assoluto	**256**

In generale, la popolazione femminile nel personale di ricerca in Fisica è più giovane di quella maschile (il 41% delle donne ha meno di 45 anni, contro il 37,2% degli uomini [fig. 1]). Tuttavia, tra i pochi ricercatori con meno di 40 anni di età (solo il 14% del totale del nostro campione) gli uomini sono più del doppio delle donne.

La scarsa presenza di ricercatrici di età inferiore ai 40 anni potrebbe derivare da un periodo di precariato più lungo per le donne rispetto agli uomini.

Tuttavia, l'Amministrazione ha fornito la distribuzione per sesso ed età degli anni di precariato solo di quanti, nel nostro collettivo, hanno ora un contratto stabile ma, prima dell'assunzione, hanno avuto un rapporto di lavoro a termine riconosciuto come tale dall'Ente (350 persone in tutto, delle quali 111 donne).

Da questi dati risulta che la media del periodo di lavoro a termine è stata di 4,87 anni per gli uomini e di 4,51 per le donne.

Anche le distribuzioni per età sono abbastanza simili (fig. 2) ma per le fasce di età più anziane si riscontrano periodi di precariato sensibilmente più brevi per le donne rispetto agli uomini.
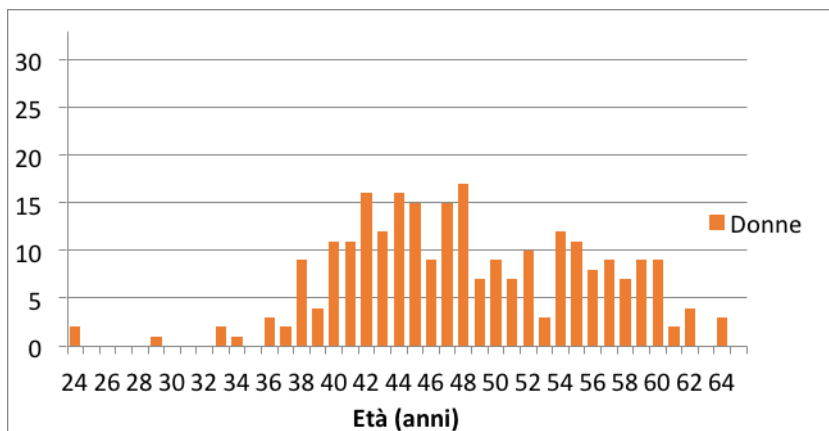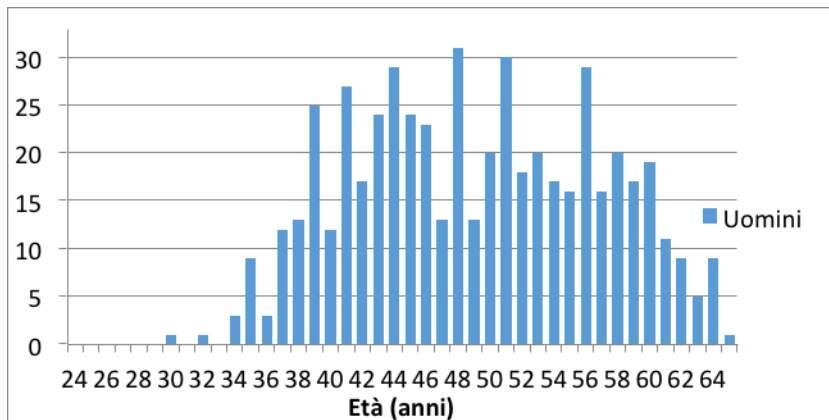
Figura 1   L'età del collettivo per genere.

Questi dati tuttavia rispecchiano l'annoso problema delle assunzioni nella ricerca scientifica che avvengono in tornate numerose e a distanza di molti anni senza tener conto delle esigenze della ricerca, e in mancanza di una programmazione di sviluppo del paese. Questo è dovuto prevalentemente alla scarsità di finanziamenti erogati dai governi dagli anni '90 in poi.
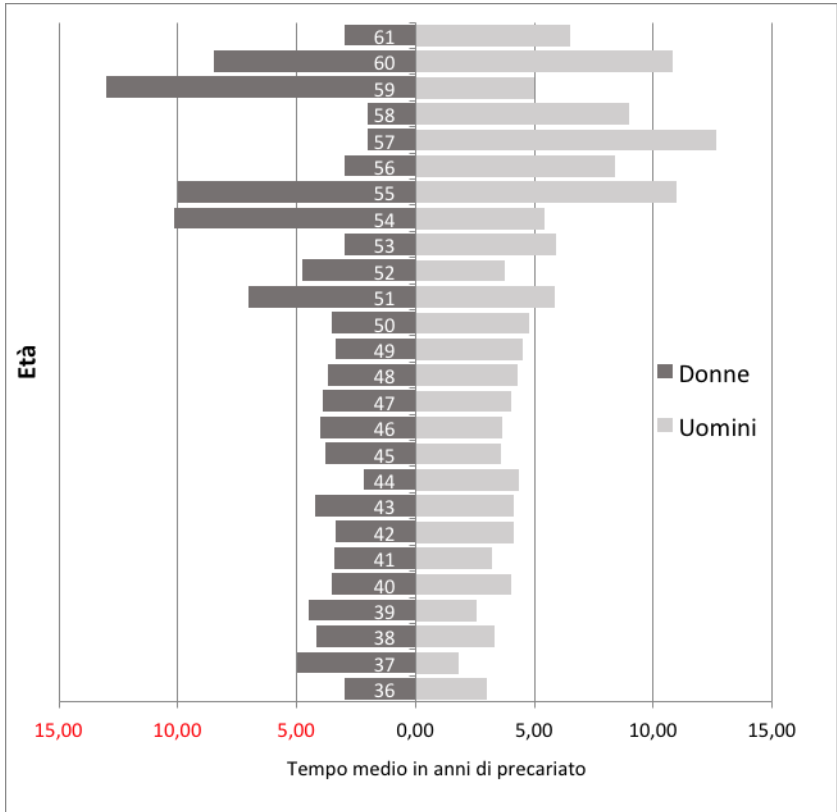
Figura 2   Tempo medio in anni di precariato per età e genere.

Bisogna però ribadire che i dati relativi ai contratti a tempo determinato precedenti l'assunzione dei ricercatori che ora hanno un contratto stabile, non riguardano tutti coloro che hanno avuto rapporti di lavoro meno formalizzati e che sono sempre stati la maggioranza dei precari del CNR.

Alla diversa distribuzione per età delle donne e degli uomini del nostro campione contribuisce certamente anche il fatto che fino agli anni '90, la percentuale delle donne che intraprendevano la carriera di ricerca in fisica era abbastanza limitata. Per quanto riguarda gli ultimi anni invece il sostanziale blocco delle assunzioni ha fatto entrare un numero di persone tanto limitato da impedire considerazioni statistiche. Non possiamo però non notare che tra i pochi ricercatori che sono stati assunti prevalgono nettamente gli uomini.

La distribuzione per sesso nei tre profili di ricercatore illustra ancora una volta il concetto, ben noto, del 'soffitto di cristallo' che blocca lo sviluppo di carriera delle donne nella ricerca scientifica (vedi Avveduto e Pisacane, 2013; Palomba, 2000). Il 77,7% delle donne è infatti collocato nel profilo più basso (Ricercatore), il 18,8% in quello intermedio (Primo Ricercatore) e solo l'1,6% in quello più alto (Dirigente di Ricerca). Nei tre profili, le percentuali di donne ed uomini (Tabella 3) hanno un andamento esattamente contrario.

Questo problema per altro non è presente solo al CNR e neppure solo nel sistema di ricerca italiano. Infatti, la stessa Unione Europea vede nella mancanza di una effettiva parità di genere nella ricerca un elemento che ostacola notevolmente la creazione dell'Area Europea della Ricerca (Georghegan–Qin, 2012).

Tabella 3   Distribuzione per sesso nella dirigenza e nei tre profili di ricercatore.

Livello	Donne (%)	Uomini (%)
Direttori	2,0	2,8
I livello – Dirigente di Ricerca	1,6	6,3
II livello – I Ricercatore	18,8	25,7
III livello – Ricercatore	77,7	65,2
Totale	**100,0**	**100,0**
Totale in valore assoluto	**256**	**537**

Inoltre, nel 2014, tra le poche donne direttrici di ricerca, la più giovane in carriera che ha raggiunto questo livello era stata assunta nel 1982, mentre l'ultimo tra gli uomini è entrato stabilmente al CNR nel 1992. Una situazione analoga si riscontra nel livello di Primo ricercatore: in questo livello, non ci sono donne assunte dopo il 1993, al contrario di quanto accade tra gli uomini. Questi dati dimostrano che la carriera delle donne è decisamente più lenta di quella dei maschi.

Ci si chiede se una delle cause della scarsa presenza femminile nei livelli più alti del CNR possa essere il maggior carico familiare che pesa sulle donne.

Dal punto di vista anagrafico, lo stato civile risulta molto simile tra ricercatrici e ricercatori: il 54,3% delle donne e il 52,7% degli uomini è coniugato, mentre non lo è rispettivamente il 43,8% e il 44,3%. I casi di divorzio, separazione e vedovanza sono molto rari per entrambi i sessi. Tuttavia, la percentuale di coloro che risultano all'Ente avere persone a carico è molto diversa: 30,7% per le donne, contro 69,3% tra gli uomini.

Questo dato non può però far supporre che l'impegno familiare sia minore per le donne rispetto agli uomini. Infatti, è molto più comune che i figli siano registrati a carico degli uomini.

È invece un dato che le ricercatrici del nostro collettivo hanno un numero medio di assenze dal lavoro molto superiore a quello degli uomini: dai dati trasmessi dall'Amministrazione Centrale del CNR, risulta infatti che esse hanno avuto 169 giorni di assenza in media dal 2005 al 2014, contro 32 giorni dei ricercatori. In particolare, i giorni d'assenza sono stati giustificati per una malattia del figlio per il 53,5% delle donne, contro solo 11,6 per gli uomini. Inoltre, per le donne il 98,5% delle assenze sono dovute a congedo parentale, contro solo l'1,5% per gli uomini. È naturale che questo tipo di assenza sia più alta per le donne, dato che essa include anche il congedo obbligatorio per maternità. Tuttavia, la bassissima percentuale di uomini che hanno usufruito di questo tipo di congedo mostra evidentemente che l'assistenza familiare pesa in modo maggiore sulle donne rispetto agli uomini. Infatti, il congedo parentale deriva dal diritto spettante sia alla madre e sia al padre di godere di un periodo di dieci mesi di astensione dal lavoro da ripartire tra i due genitori e da fruire nei primi dodici anni di vita del bambino ed è stato introdotto proprio per contrastare l'abitudine socialmente consolidata che vede la madre maggiormente coinvolta nella cura dei figli.

Non è comunque quello delle assenze per maternità e per assistere i figli l'unico problema che le ricercatrici debbono affrontare. Ad esempio, il gruppo di esperti istituito dalla Direzione Generale 'Ricerca' della Commissione Europea per selezionare le migliori strategie per lo sviluppo di un sistema di ricerca unificato in Europa, ha svolto un'analisi qualitativa molto approfondita sui problemi che si pongono alla carriera delle ricercatrici (ERA Expert Group, 2008).

Un punto che la Commissioni ha messo in particolare evidenza è la difficoltà che le ricercatrici incontrano nella mobilità internazionale. Secondo questa analisi, mentre per le ricercatrici che non hanno legami familiari od affettivi la situazione non è molto diversa da quella dei maschi, i problemi maggiori si pongono per le ricercatrici sposate ed in particolare quelle che hanno figli. In questo caso, difficilmente la ricercatrice prenderà la decisione di spostarsi in un'altra nazione, indipendentemente da quanto possano essere attraenti dal punto di vista scientifico o economico, le possibilità che le si offrono di accettare un lavoro all'estero. Questa inevitabile difficoltà può certamente pesare sulla carriera della ricercatrice (Brandi, 2012).

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Un recente studio (Benderly, 2014b) ha in effetti mostrato che non solo le donne, ma anche gli uomini che pongono i problemi familiari e la cura per i propri figli sullo stesso piano della loro attività scientifica hanno problemi nel loro sviluppo di carriera.

Conclusioni

I risultati di questa prima analisi sono sufficienti a indicare una serie di punti critici ma anche importanti elementi di partenza su cui basare la realizzazione di piani di azioni positive nel CNR.

Nei settori di attività scientifica afferenti alla fisica si rileva una presenza femminile del 32%, valore in linea con alcuni dati rilevati dai partner europei del Progetto Genera, quali per esempio l'Università di Ginevra (Montaruli, 2017).

Mentre la nostra indagine conoscitiva ha messo in evidenza che il fenomeno del 'tetto di cristallo' è presente anche al CNR, risulta invece più complesso rilevare il fenomeno, che pure si considera internazionalmente molto consistente della cosiddetta 'leaky pipeline'.

Infatti nel caso del CNR i fenomeni di abbandono della carriera di ricercatore andrebbero osservati a partire dai primi contratti di ricerca, borse di studio o assegni di ricerca, per i quali purtroppo i dati non sono disponibili al livello centrale.

Analogamente, pur avendo la disponibilità di dati relativi allo stato civile, al carico familiare e alle assenze, sono possibili solo analisi che parzialmente ci consentono di rilevare tutti i fenomeni collegati all'equilibrio vita–lavoro. Ciò permetterebbe anche di rilevare in modo più approfondito la scarsa presenza femminile nelle funzioni apicali

In definitiva andrebbe rafforzata una visione di genere nella raccolta dei dati che dovrebbe diventare una delle prime proposte da introdurre in un GEP al fine di consentire lo sviluppo di un sistema di monitoraggio valido nel tempo. Ciò permetterebbe di calibrare gli interventi che l'adozione di un GEP può mettere in atto. Gli ulteriori sviluppi della nostra analisi, uniti anche ad una serie di interviste svolte sia al livello italiano che europeo, potranno consentire di giungere ad ulteriori risultati per l'adozione coerente nei Paesi ed negli Enti partner di GENERA dei piani di azioni positive.

Bibliografia

Avveduto, S. e Pisacane, L. (2013) *Portrait of a Lady. Women in Science: Participation Issues and Perspectives in a Globalized Research System*. Roma: Gangemi Editore.

Benderly, B.L. (2014a) Where Do Postdoc Go? Science Careers. *Science AAAS.* [Online] http://www.sciencemag.org/careers/2014/10/where–do–postdocs–go. [Accesso: 30 Maggio 2016].

Benderly, B.L. (2014b) Paradigm and Prejudice, Science Careers. *Science AAAS*. [Online] http://www.sciencemag.org/careers/2014/12/paradigms–and–prejudice. [Accesso: 31 Maggio 2016].

Blickenstaff, J.C. (2005) Women and Science Careers: Leaky Pipeline or Gender Filter? *Gender and Education*, 17 (4), 369–386.

Bodewits, K. e Gramlich, P. (2016) Women in Science: Clogging the Leaky Pipeline. *Naturejobs*. [Online] http://blogs.nature.com/naturejobs/2016/03/23/women–in–science–clogging–the–leaky–pipeline/ [Accesso: 07 Luglio 2016].

Brainard, S. (2011) Network for Women. *Nature*, 474, 669. [Online] http://www.nature.com/naturejobs/2011/110630/pdf/nj7353–669b.pdf. [Accesso: 20 Marzo 2017].

Brandi, M.C. (2006) *On the Wind (Portati dal Vento)*. Roma: Odradek Edizioni.

Brandi, M.C. (2012) *Skilled migrations: è possibile una riflessione di genere?*. In *Rapporto italiani nel mondo 2012*. Roma: Fondazione Migrantes.

Ceci, S.J., Ginther, D.K., Kahn, S. e Williams, W.M. (2014) Women in Academic Science: A Changing Landscape. *Psychological Science in the Public Interest*, 15 (3), 75–141.

Council of the European Union (2012) *Conclusions on a Reinforced European Research Area Partnership for Excellence and Growth*. Brussels: Council of the European Union Press.

ERA Expert Group (2008) *Realizing a Single Labour Market for Researchers*. Brussels: European Commission Directorate–General for Research, EUR 23321 EN.

European Commission (2014) *Communication from the Commission to the Council and the European Parliament. European Research Area – Progress Report.* Brussels: European Commission.

European Commission, DGRS (2016) *She Figures 2015*. Brussels: European Commission.

European Parliament (2013) Regulation (Eu) no 1291/2013 of The European Parliament and of the Council of 11 December 2013 establishing Horizon

2020 – the Framework Programme for Research and Innovation (2014 – 2020). *Official Journal of the European Union*, L 347/104 (EN).

Faulkner, W. (2000) Dualism, Hierarchies and Gender in Engineering. *Social Studies of Science*, 30 (5), 759–792.

Georghegan–Quin, M. (2012) [Speech 12/44] *ERA Conference 2012: Fostering Efficiency Excellence and Growth*, ERA Conference 2012, Brussels. [Online] *europa.eu/rapid/press–release_SPEECH–12–44_en.pdf* [Accesso: 20 Maggio 2016].

Matter, G. (2014) Academic Science isn't Sexist. *New York Times*. [Online] https://www.nytimes.com/2014/11/02/opinion/sunday/academic–science–isnt–sexist.html?_r=0 [Accesso: 20 Giugno 2016].

Montaruli, T. (2017) *The Gender Equality Network in Physics in the European Research Area (GENERA) in Physics Day in Geneva Objectives of the day*. Gender in Physics Day 2017, Geneva. [Online] https://indico.cern.ch/event/525539/contributions/2152246/attachments/1401903/2140457/GiP–presentation.pdf [Accesso: 1 Agosto 2017].

Palomba, R. (2000) *Figlie di Minerva. Primo rapporto sulle carriere femminili*. Milano: Franco Angeli.

Università degli Studi di Ferrara, (2016) *Bilancio di genere 2015*. Ferrara: Italia Tipolitografia Srl.

Università degli Studi di Napoli Federico II, (2016) *Primo Bilancio di Genere dell'Ateneo Fridericiano.* Napoli: FedOAPress.

Wajcman, J. (2000) Reflection on Gender and Technology Studies: In What State is the Art?. *Social Studies of Science*, 30 (3), 447–464.

Developing an Organic Strategy of Change to Challenge Gendered Stereotypes around the Technological (In)Ability of Women in Architecture

Maria Silvia D'AVOLIO[*a]

[a] University of Sussex

Architecture is characterised by a lack of women in the profession and a significant drop–out after qualification all over Europe, despite decades of policies of inclusion.

The practice of architecture requires the use of specialised instruments and technologies that often collide with the social assumptions and stereotypes around the conflicted relationship between women and technology. Women are socially perceived as inadequate users of technology in terms of: knowledge of the specific characteristics of objects, ability to use an instrument other than for its basic outcomes, and capacity to use technology in collaboration with co–workers.

What can be done to challenge this widespread social perception? The suggestion offered here is to develop an organic strategy of combined actions able to foster a simultaneous change on different levels: individual, relational, cultural and structural. The paper offers an outline of a possible framework of analysis to be initially applied to the architectural field as a specific case study, with the possibility to subsequently adapt it to other STEM sectors. The framework draws upon the concepts of Technologically Dense Environments and Integral Theory's AQAL method, used respectively to collect and organise empirical data.

Keywords: Women in STEM; women in architecture; gender and technology; gender stereotypes; technologically dense environments

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[*] Corresponding author: **Maria Silvia D'Avolio** | e–mail: **m.d–avolio@sussex.ac.uk**

1. Introduction

The architectural sector is marked by a lack of women throughout the profession, as demonstrated by research conducted in 2014 by the Architects' Council of Europe on 26 European countries (ACE–CAE, 2015). Today, in the UK, 46% of architecture students are women, whereas only 25% of chartered architects are female (Royal Institute of British Architects, 2015), highlighting a considerable drop–out after education. In Italy, however, 40% of architects are women – proportionally more than in the UK – but, despite the higher presence, they still earn 37% less than men (CSAPPC–CRESME, 2013). Many studies have been carried out in the last 15 years on the topic (Caven, 2004; Fowler and Wilson, 2004; Powell and Sang, 2015) and almost all of them suggested, among other factors mainly related to the dominant masculine culture of architecture, a strict relationship between this trend and the technological expertise required to practice the profession. Architecture is not considered a traditional STEM (Science, Technology, Engineering and Mathematics) field, however, both its discipline and practice include some aspects typical of various STEM sectors, such as the study of mathematics, physics, statics and technological applications, to name a few. Furthermore, in 2012 architecture was added by the US government as a STEM occupation in the Standard Occupational Classification (SOC) system (Bureau of Labour Statistics USA, 2012) and, more recently, to the STEM Designated Degree Program List (Immigration and Customs Enforcement, 2016).

In the first part, this paper will offer a summary of the existing literature about the relationship between gender and technology, with a particular interest in the implications of policy–making that arise from different theoretical approaches. The main objective of this paper, discussed in the second half, is to outline a methodological framework of analysis aimed at developing an organic strategy of change able to challenge gendered stereotypes about the women–technology relationship in architecture. The framework is comprised of two main phases: understanding how these stereotypes have been created and are reproduced, through the collection of original empirical data; and organising these data in order to evaluate the most efficient way to develop systematic strategies of change on different levels: individual, relational, cultural and structural. The two parts of the analysis are drawn respectively from the concepts of 'Technologically Dense Environments' (Bruni, Pinch and Schubert, 2013), focussed on understanding the gendered power dynamics occurring in the architectural

field, with particular respect to technology; and Integral Theory's AQAL model (Esbjörn–Hargens, 2010).

In particular, this framework is designed to analyse the architecture field as a case study, but it could be subsequently adapted to other STEM sectors, in order to have a comprehensive general insight of the women–technology relationship in different technology–related fields.

2. Gender and technology

The main approaches used to analyse the relation between technology and gender are based on two different positions: technology defined as inherently masculine, or as gender–neutral (Grint and Woolgar, 1995). The first approach considers technology as designed and created with a masculine user in mind, both in terms of physical aspect and applications (Oldenziel, 1999; Wajcman, 2001). This would explain the lower presence of women as effective users of technology, which is practically and conceptually distant from them. The other approach considers technology as gender–neutral. However, society is structured in a way in which women have a lesser access to technology, thus explaining their lower presence. Eventually, this view offers an outcome similar to the one suggested by the previous approach.

This difference should not be understood exclusively in terms of ontology and theoretical perspective; rather, the use of one model of gender–technology relation over another has a direct influence in the design and application of practical policies of change (Grint and Woolgar, 1995). For example, in order to aspire to gender equality, the first approach would lead to policies that would enable women to develop their own technology, as a parallel to the male one: if a masculine technology exists, then a feminine technology should also exist. In fact, the latter does already exist, but it is not as mainstream and influential as the male one (Oldenziel, 1999). It is present, but only in the social and working realms traditionally associated with women and femininity, for example, in household appliances (Chabaud–Rychter, 1995) or in machinery associated with typical women's labour – textile, fabrics, etc (Rostgård, 1995). In other cases, technology is able to swap 'gender' over a period of years, such as the computer programmer, which originated as female labour and subsequently was perceived as male (Light, 1999). By contrast, other jobs have been subjected to the phenomenon of feminization (Bolton and Muzio, 2008), such as typing (de Groot and Schrover, 1995).

The second approach, probably more popular in technology and gender literature (Ahuja, 2002; Cheryan, Master and Meltzoff, 2015; Lu and Sexton, 2010; Phipps, 2008; Sang and Powell, 2012), suggests that many policies can be adopted in order to reach gender equality: widening participation projects in school, mentoring support, discrimination laws in the workplace, gender quotas, disruption of stereotypes, etc. These policies, following a process of analysis and understanding of the cultural and structural forces involved in the oppression of women, would be able to address and, possibly, resolve the gender imbalance. The organic strategy of change proposed in this paper draws upon this latter approach.

2.1 Barriers to a full participation of women in STEM fields

Numbers speak clearly about a constant and worrying underrepresentation of women in STEM across Europe (Office for National Statistics, 2015; WISE, 2014). Several studies have outlined the conflicted relationship between women and technology as the main barrier to the full participation of women in the field (Cockburn and Ormrod, 1993; Elkjaer, 1992). Thus far, some of the main factors which have been identified as contributing to shaping this relationship negatively are: personal and cultural stereotypes, the environment, and the presumed technological inability of women (Cheryan, Master and Meltzoff, 2015).

Female employment, particularly in scientific fields, is influenced by *stereotypes* that unconsciously lead both employers and women themselves to consider men as more adequate for certain kind of jobs or more worthy of reaching high positions (Barreto, Ryan and Schmitt, 2009). Skeggs (1997), in addition, argues that official institutions, such as the state and the educational system, legitimate structural domination by unconsciously leading women to internalise their subordination. On the other side, it can be argued that women in STEM seem to be able to deal with jobs perceived as masculine better than they can cope with the culture, values and expectations of professions created by men for men (Evetts, 1998). This happens because they do not lack the technical skills required to perform the job, but rather 'a whole set of properties which the male occupants normally bring to the job […] for which men have been tacitly prepared and trained as men' (Bourdieu, 2001, p. 62).

Furthermore, another set of stereotypes appears to discourage women from initially choosing a career in STEM fields: stereotypes around the culture of STEM. These stereotypes operate on three main levels: the people in the field, the work itself, and the values of the field (Cheryan, Master and

Meltzoff, 2015). People in tech, specifically in computer science, are portrayed as socially isolated, interested only in tech culture, characterised by a specific 'nerdy' appearance (Cheryan et al., 2013), and these stereotypes are promoted and repeated by media representation on TV or online. The standard technology user seems to be a white–cis–heterosexual–young male, therefore tech culture is dominated by a univocal hegemonic masculinity. Some recent studies, like Dunbar–Hester's work on radio activism, stressed the fact that, given this common assumption, technical skills are not 'desirable and commensurate with a feminine identity' (2014, p. 66). Therefore, only women who are already challenging traditional feminine presentation of the self are likely to also challenge the dominant gender identity associated with technology (Dunbar–Hester, 2014).

Moreover, work in STEM fields is perceived as not collaborative, a characteristic that various authors (Diekman et al., 2010; Dixon, 1998; Thornham and McFarlane, 2011) have problematised as incompatible with women's sociability and their need to fulfil communal goals. However, this view risks limiting, in essentialist terms, the understanding of various women's interests, and relies on a form of biological determinism difficult to prove empirically. Finally, Cheryan, Master and Meltzoff (2015, p. 2) identify as 'values of the field' specific cultural aspects such as typical masculine interests and the stereotype of the inherently 'genius' nature of men, needed to succeed in these fields.

Moving beyond stereotypes, recent studies are exploring the relationship between the physical *environment* and the interest of women in technological fields (Cheryan, Meltzoff and Kim, 2011). The argument is that stereotypically 'geeky' classrooms and working spaces are able to discourage the initial interest of young girls in scientific fields.

Finally, it is necessary to stress the importance of the assumed technological *inability* of women as perceived by the whole society, women included. This assumption is deeply rooted to the point that, sometimes, women perform a 'habitual 'feminine' position of incompetence' (Walkerdine, 2006, p. 526). From their cross–generational study about women in the gaming industry and teenagers' choice of workshops, Thornham and McFarlane found a common pattern according to which both women and young girls 'are actively excluding themselves from (technological) activities using gendered discourses of sociability and incompetence' (2011, p. 68). The reasons behind the employment of this particular practice may be interpreted as the performance of what others

expect from women, and women's fear of being considered less feminine because of their ability in a field dominated by men (Thornham and McFarlane, 2011).

3. Developing an organic strategy of change

In this second part of the paper I will outline concepts and methodologies useful in outlining a new methodological framework of gendered analysis, aimed at developing strategies of change addressed at challenging gendered stereotypes about the women–technology relationship. In particular, I will focus on the architecture sector as a case study, but the framework could be easily adapted to other technology–based fields.

In order to develop an effective organic strategy of change, some operations of data collection and analysis need to be previously planned. Firstly, it is important to understand how stereotypes about women and technology have been created and are reproduced and, secondly, it will be essential to plan a compelling way to address these stereotypes and challenge them in different areas of social interaction.

3.1 Stereotypes about women and technology in architecture

Architecture, as a profession in the construction industry, can be considered based in two main work settings: the office and the construction site (Watts, 2009). Women's interaction with other actors in these two environments is shaped by stereotypes about their appearance, their physical strength and adequateness, their ability to cope with technology and with the culture of a masculine profession (Caven, 2004; Sang, Dainty and Ison, 2014). Cynthia Cockburn, in some of her studies on the importance of holding technological mastery (1985; 1991; 1993), suggests that often these stereotypes are indirectly reproduced by men, in order to maintain male dominance in workplaces.

In the interest of challenging these stereotypes, it is essential to understand how gendered relationships and power dynamics act in both of these work settings. Therefore, a useful way to gain a deeper insight into how these mechanisms work would be taking into account the concept of 'Technologically Dense Environments' (TDE) and employing it through a gendered lens. A TDE is not necessarily an environment in which technology is present in large amounts (Bruni, Pinch and Schubert, 2013). To meet this specific definition, the technology present in a TDE needs to be more than a

simple tool, and to be able to narrate 'the nature of interactions and work organisation practices' (Bruni, Pinch and Schubert, 2013, p. 55). Drawing upon the way in which Pinch, in the same article, defines the objects employed in everyday life, it is possible to understand to what extent an architecture workplace could be defined as a TDE: making the technological object analytically interesting. What matters are the technological relations (human–object, human–human, individual–community) in a field where technological objects are essential in order to create and show the effort of labour. Employing TDE with a gendered perspective means to consider that the practice of architecture requires the use of specialised instruments and technologies that often collide with the social assumptions and stereotypes around the conflicted relationship between women and technology. Women are socially perceived as inadequate users of technology in terms of:

- *knowledge* of the specific characteristics and components of the means they're using;
- *ability* to use an instrument other than for its basic outcomes – women are expected to use technology as basic and not proficient users;
- capacity to use technology in *collaboration* with co–workers.

A collection of empirical data is essential to an analysis of the gendered relationships that occur in architectural practice. These data about women's technological knowledge, ability and interaction should be gathered through individual interviews or focus groups from different actors involved in the construction industry, such as clients, contractors, construction workers and male colleagues; from representation in the media; and from educational environments, both at school and higher education level. Particular focus should be placed on the technological relations that occur between women and objects, women and other actors involved in the workplace, the construction site or the educational environment, and between individuals and groups. For a gendered understanding of these mechanisms it would be useful to collect and analyse these empirical data using the three main points outlined above, obtained from the concept of TDE (Bruni, Pinch and Schubert, 2013): *knowledge*, *ability* and *collaboration*. Furthermore, and more importantly, the process of analysis and coding of the data should be supported and guided by women in the field themselves, through the understanding coming from their own experiences and perceptions, according to feminist principles of reflexivity (Naples, 2003).

In addition, it would be useful to carry out a process of document analysis on historical accounts regarding female participation in

architectural practices in the past (for example Walker, 1986). The comparison between historical and current practices would lead to an understanding of the changes in the use of technological instruments, with a particular focus on their differential access depending on the user's gender. And the comparison would also offer an insight on the historical development of the gendered relations occurring between various professional figures in architectural practice.

'To look at history from a feminist viewpoint means to redefine in fundamental ways the accepted historical categories and to make visible hidden structures of domination and exploitation' (Federici, 2004, p. 13).

These processes are aimed at obtaining a better understanding of how gendered stereotypes have been created and are reproduced in society, and how power relations involved in the architectural field have been historically gendered, and still are. Ultimately, this understanding would be useful in designing effective policies of change, as explained in the next paragraph.

3.2 Challenging stereotypes

As outlined above, women's technological inability in the architectural field, as much as in other technological environments, could be defined as *perceived* more than *real* (Dryburgh, 1999). It is a societal perception, following decades of male predominance in technological discourses and practices. And it is the perception of women themselves, that they – both actively and not – perform a position of incompetence (Walkerdine, 2006). In this paper, I am suggesting that this widespread social perception could be challenged by adopting an organic strategy of combined actions, able to foster simultaneous change on different levels: individual, relational, cultural and structural.

To organise the data gathered from the previous phase of the methodological framework, I propose to use and adapt Integral Theory's AQAL model, developed by Ken Wilber (Esbjörn–Hargens, 2010). Despite Wilber not being an academic, his research managed to create an instrument able to channel different paradigms and approaches into a singular and comprehensive structure. The theoretical consequences might appear problematic in wider discussions of his whole theory, but here I would like to rely exclusively on the AQAL (All Quadrants All Levels) quadrant model. The quadrant distinctions act on two main axes, the individual–collective and the exterior–interior, eventually leading to four separate areas: intentional, behaviour, culture and social system. The quadrant has received vast interest from different disciplines (mostly

ecology, business, and well–being), specifically because of its simplicity expressed in a comprehensive form.

Therefore, I am proposing to adapt the quadrant with regard to the specific case study of women as technology users in architecture. In addition, actions for change already implemented in the field will also be considered and hence organised and integrated in each section (individual, relational, cultural and structural) with the data previously collected. My suggestion is that considering the most appropriate strategies of action for each level of change and employing all of them at the same time would offer a more effective route to change.

The *individual* level stands for one's personal thoughts, beliefs and values. This aspect, applied to the purpose of challenging women's perceived technological inability, could be translated into strategies aimed at confronting personal stereotypes and developing 'professional role confidence' (Cech et al., 2011). In the case of architecture, for example, role models and mentoring programmes are certainly useful actions, with female architects going to schools to talk about their experiences as architects; or workshops aimed exclusively at girls. One factor to take into account is the importance of having female teachers, in order to disrupt the current duality between *experts*, usually embodied by male teachers, and *novices* (Dunbar–Hester, 2014).

The *relational* level has to do with behaviours and skills one has learned and exhibits, and could be applied into a change in workplace dynamics (relevant to women's feelings of inadequateness) and in the cultural requirement, discussed above, to perform inability. And, by extension, to challenge sexual division of labour and practices. In our case, effective actions could be implemented in mixed workshops run throughout the whole educational path (from primary school to university). Teachers should be trained and prepared to address imbalanced power relations that occur between male and female students: workshops are generally characterised by a marked division of tasks according to presumed associations between male and female qualities or skills.

Cultural is the aspect probably most interwoven with stereotypes and, as previously outlined, includes family and relationships in general. A useful strategy of action would address the reproduction of gender stereotypes, employed in any relational environment, from the family to the educational system. These stereotypes influence more generally social expectations (such as the need to create a family), and more particularly interaction with technology. However, culture is the area where interactions aimed at

change are most difficult to employ. In the architecture case, considerable help could come from women's representation in media and TV: reproduced stereotypes should be called out, and new forms of portrayal should be prioritised. Also the physical appearance of the classroom, as mentioned above, plays a big role in girls' willingness to attend technology training, so schools should make an effort to challenge this visual discrimination.

The *structural* level is concerned with laws, institutions, social services and government. An action for change focussed on this sphere would aim to challenge practices naturalised in educational or other social environments, social services and institutions. Considering this specific case, the institution of education could play a big role in disrupting gender differences in technology pathways, for example by increasing the number of scholarships for women interested in pursuing STEM careers, or providing economic help to all–female start–ups. The sphere of the social system, of the four categories, seems to be the easiest in which to initiate change, because of its institutions and laws, which can be simply promoted and actualised. However, it must be recognised that it would be risky, useless or even counterproductive to force a change from above if the culture of a given population is not ready to accept that change.

All these different actions have already been employed in the architectural field, at different points and in different countries, but their disconnected implementation has hindered significant change so far. Therefore, a plausible solution could be to recognise the necessity of promoting all these actions at the same time, allowing the possibility for each of them to work as a catalyst for others, or to overlap.

4. Conclusions

In conclusion, it can be argued that the relationship between women and technology is problematic, to the point of limiting women in choosing, staying and advancing in STEM careers. This paper represents a brief outline of a methodological approach aimed at developing an organic strategy of change focussed on challenging stereotypes around the perceived technological inability of women in architecture.

After exploring the main literature about the gender–technology relationship, with a particular focus on the policy implications related to different approaches, I summarised the main factors that influence women's self–perception in relation to technology. These factors mainly revolve

around stereotypes, especially those about the culture of STEM fields, their environment, and the (in)ability of women, both perceived and performed.

I then outlined a methodological framework aimed at understanding how gendered stereotypes about the women–technology relationship have been created and are currently reproduced, and how it would be possible to challenge these stereotypes. This approach is comprised of two phases: (1) gathering and analysing original empirical data according to a framework based on the relationship between women and technology, drawn upon the TDE concept; and (2) organising these data according to a quadrant model adapted from the concept of Integral Theory's AQAL model. The final purpose of this analysis is the creation of an organic strategy of change able to work on different levels at the same time: individual, relational, cultural and structural.

To conclude, this approach could be utilised not only with regard to architecture, but could be implemented for other technology–based fields, in order to offer a more general understanding of the women–technology relationship in the broader STEM sector.

References

ACE–CAE (2015) *13th Economic Trends Survey of the Architects' Council of Europe. January 2015.* [Online] Available from: http://www.ace–cae.eu/fileadmin/New_Upload/7._Publications/Press_Release/2015/13–_Economic_Trends_Survey_–_January2015.pdf [Accessed: June 28th, 2015].

Ahuja, M.K. (2002) Women in the Information Technology Profession: A Literature Review, Synthesis and Research Agenda. *European Journal of Information Systems*, 11 (1), 20–34.

Barreto, M.E., Ryan, M.K. and Schmitt, M.T. (2009) *The Glass Ceiling in the 21st Century: Understanding Barriers To Gender Equality*. Washington: American Psychological Association.

Bolton, S. and Muzio, D. (2008) The Paradoxical Processes of Feminization in the Professions: The Case of Established, Aspiring and Semi–professions. *Work, Employment & Society*, 22 (2), 281–299.

Bourdieu, P. (2001) *Masculine Domination*. Stanford: Stanford University Press.

Bruni, A., Pinch, T. and Schubert, C. (2013) Technologically Dense Environments: What for? What next?. *Tecnoscienza: Italian Journal of Science & Technology Studies*, 4 (2), 51–72.

Bureau of Labour Statistics USA (2012) *Options for defining STEM (Science, Technology, Engineering, and Mathematics) occupations under the 2010 Standard Occupational Classification (SOC) system. August 2012.* [Online] Available from: https://www.bls.gov/soc/Attachment_A_STEM.pdf [Accessed: February 22nd, 2017].

Caven, V. (2004) Constructing a Career: Women Architects at Work. *Career Development International*, 9 (5), 518–531.

Cech, E., Rubineau, B., Silbey, S. and Seron, C. (2011) Professional Role Confidence and Gendered Persistence in Engineering. *American Sociological Review*, 76 (5), 641–666.

Chabaud–Rychter, D. (1995) The Configuration of Domestic Practices in the Designing of Household Appliances. In Gill, R. and Grint, K. (eds.), *The Gender–Technology Relation. Contemporary Theory and Research*. London: Taylor and Francis.

Cheryan, S., Master, A. and Meltzoff, A.N. (2015) Cultural Stereotypes as Gatekeepers: Increasing Girls' Interest in Computer Science and Engineering by Diversifying Stereotypes. *Frontiers in Psychology*, 6 (49), 1–8.

Cheryan, S., Meltzoff, A.N. and Kim, S. (2011) Classrooms Matter: The Design of Virtual Classrooms Influences Gender Disparities in Computer Science Classes. *Computers & Education*, 57 (2), 1825–1835.

Cheryan, S., Plaut, V.C., Handron, C. and Hudson, L. (2013) The Stereotypical Computer Scientist: Gendered Media Representations as a Barrier to Inclusion for Women. *Sex Roles*, 69 (1–2), 58–71.

Cockburn, C. (1985) *Machinery of Dominance*. London: Pluto Press.

Cockburn, C. (1991) *In the Way of Women: Men's Resistance to Sex Equality in Organizations*. Ithaca: Cornell University Press.

Cockburn, C. and Ormrod, S. (1993) *Gender and Technology in the Making*. London: SAGE.

CSAPPC–CRESME (2013) *Rapporto 2013 sulla professione di Architetto. April 2013.* [Online] Available from: http://www.old.awn.it/AWN/Engine/RAServeFile.php/f/Documenti%20CNAPPC/Rapporto_annuale_2013_1.pdf [Accessed: June 28th, 2015].

de Groot, G. and Schrover, M. (eds.) (1995) *Women Workers and Technological Change in Europe in the Nineteenth and Twentieth Centuries*. London: Taylor & Francis.

Diekman, A.B., Brown, E.R., Johnston, A.M. and Clark, E.K. (2010) Seeking Congruity between Goals and Roles: A New Look at why Women Opt Out

of Science, Technology, Engineering, and Mathematics Careers. *Psychological Science*, 21 (8), 1051–1057.

Dixon, C. (1998) Action, Embodiment and Gender in the Design and Technology Classroom. In Clark, A. and Millard, E. (eds.), *Gender in the Secondary Curriculum: Balancing the Books*. London: Routledge.

Dryburgh, H. (1999) Work Hard, Play Hard: Women and Professionalization in Engineering–Adapting to the Culture. *Gender & Society*, 13 (5), 664–682.

Dunbar–Hester, C. (2014) *Low Power to the People. Pirates, Protest, and Politics in FM Radio Activism*. Cambridge: MIT Press.

Elkjaer, B. (1992) Girls and Information Technology in Denmark: An Account of a Socially Constructed Problem. *Gender and Education*, 4 (1–2), 25–40.

Esbjörn–Hargens, S. (2010) *Integral Theory in Action: Applied, Theoretical, and Constructive Perspectives on the AQAL Model*. Albany: SUNY Press.

Evetts, J. (1998) Managing the Technology but not the Organisation: Women and Career in Engineering. *Women in Management Review*, 13 (8), 283-90.

Federici, S. (2004) *Caliban and the Witch*. Brooklyn: Autonomedia.

Fowler, B. and Wilson, F. (2004) Women Architects and Their Discontent. *Sociology*, 38 (1), 101–119.

Grint, K. and Woolgar, S. (1995) On Some Failures of Nerve in Constructivist and Feminist Analyses of Technology. In Grint, K. and Gill, R. (eds.), *The Gender–Technology Relation: Contemporary Theory and Research*. London: Taylor & Francis.

Immigration and Customs Enforcement (2016) *STEM Designated Degree Program List*. May 2016. [Online] Available from: https://www.ice.gov/sites/default/files/documents/Document/2016/stem–list.pdf [Accessed: February 22nd, 2017].

Light, J.S. (1999) When Computers Were Women. *Technology and Culture*, 40 (3), 455–483.

Lu, S.L. and Sexton, M. (2010) Career Journeys and Turning Points of Senior Female Managers in Small Construction Firms. *Construction Management and Economics*, 28 (2), 125–139.

Naples, N.A. (2003) *Feminism and Method. Ethnography, Discourse Analysis, and Activist Research*. London: Taylor & Francis.

Office for National Statistics (2015) *UK Labour Market: August 2015. Estimates of employment, unemployment, economic inactivity and other employment–related statistics for the UK.* [Online] Available from: https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/e

mploymentandemployeetypes/bulletins/uklabourmarket/2015–08–12 [Accessed: September 18th, 2016].

Oldenziel, R. (1999) *Making Technology Masculine: Men, Women and Modern Machines in America, 1870–1945*. Amsterdam: Amsterdam University Press.

Phipps, A. (2008) *Women in Science, Engineering and Technology: Three Decades of UK Initiatives*. Sterling: Trentham Books.

Powell, A. and Sang, K.J.C. (2015) Everyday Experiences of Sexism in Male–dominated Professions: A Bourdesian Perspective. *Sociology*, 49 (5), 919–936.

Rostgård, M. (1995) The Creation of a Gendered Division of Labour in the Danish Textile Industry. In de Groot, G. and Schrover, M. (eds.), *Women Workers and Technological Change in Europe in the Nineteenth and Twentieth Centuries*. London: Taylor & Francis.

Royal Institute of British Architects (2015) *RIBA Education Statistics 2014/2015.* [Online] Available from: https://www.architecture.com/Files/RIBAProfessionalServices/Education/2015/EducationStatistics2014–15.pdf [Accessed: September 18th, 2016].

Sang, K.J. and Powell, A. (2012) Equality, Diversity, Inclusion, and Work–life Balance in Construction. In Dainty, A. and Loosemore, M. (eds.), *Human Resource Management in Construction: Critical Perspectives*. Abingdon: Routledge.

Sang, K.J., Dainty, A.R. and Ison, S.G. (2014) Gender in the UK Architectural Profession: (Re)Producing and Challenging Hegemonic Masculinity. *Work, Employment & Society*, 28 (2), 247–264.

Skeggs, B. (1997) *Formations of Class and Gender: Becoming Respectable*. London: Sage.

Thornham, H. and McFarlane, A. (2011) Cross-generational Gender Constructions. Women, Teenagers and Technology. *The Sociological Review*, 59 (1), 64–85.

Wajcman, J. (2001) Gender and Technology. In Wright, J.D., Smelser, N.J. and Baltes, P.B. (eds.), *International Encyclopedia of the Social and Behavioral Sciences* (vol. 9). Amsterdam/New York: Elsevier.

Walker, L. (1986) The Entry of Women into the Architectural Profession in Britain. *Woman's Art Journal*, 7 (1), 13–18.

Walkerdine, V. (2006) Playing the Game. Young Girls Performing Femininity in Video Game Play. *Feminist Media Studies*, 6 (4), 519–537.

Watts, J.H. (2009) 'Allowed into a Man's World' Meanings of Work–Life Balance: Perspectives of Women Civil Engineers as 'Minority' Workers in Construction. *Gender, Work and Organization*, 16 (1), 37–57.

WISE (2014) *Women in Science, Technology, Engineering & Mathematics: from Classroom to Boardroom*. *UK Statistics 2014*. [Online] Available from: https://www.wisecampaign.org.uk/uploads/wise/files/WISE_UK_Statistics_2014.pdf [Accessed: October 21th, 2016].

Technology and Cultures of (In)Equality: Reflections from Collaborative App Development

Athena–Maria ENDERSTEIN[*a]

[a] University of Hull

This paper explores the use and development of technologies in research on gender and cultures of equality in Europe, arguing for a reflexive, critical and collaborative technological design process. It presents the GRACE research project which investigates the production, performance and transformation of cultures of equality in Europe. This piece focuses on the development of a smartphone application which is a sub–project within GRACE. The first reflections from a community autoethnographic practice are shared wherein the Digital Grace group tackles questions of technological determinism, neutrality, digital inequalities, divides and access, and prevailing data regimes. Key themes include the importance of reflexivity, adaptivity in digital communication, iterative and value–centred design process, and awareness of power and inequalities in socio–technical practices. Through this autoethnographic practice collaborative construction, consensus building and transparency have become central values. By holding in tension both feminist ethics and the constraints of unequal socio–technical systems the Digital Grace group is seeking transformative ways of doing technology.

Keywords: *Reflexivity; technology; socio–technical practices; culture; equality*

Introduction

As Haraway (1991, p. 192) mythically professed almost three decades ago, we are inhabiting a mythical time, becoming 'chimeras, theorized and fabricated hybrids of machine and organism'. We participate in the ever–closer binding of technology in the material reality of everyday, personally courting the beasts of globalization and digitalization. As Stingl (2016, p.

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[*] Corresponding author: **Athena–Maria Enderstein** | e–mail: **aenderstein@women.it**

xxix) argues socio–historical accounts which rely on modernisation logics and the idea of technology as the embodiment of progress depend on the construction of Others/Otherness, and thus rely on and expand existing inequalities. In this paper I argue that reflexivity and critical engagement with technologies is indispensable in research and action aimed at investigating and developing cultures of equality. The reflections shared in this paper emerge from the multi–site European project GRACE, which investigates the transformation, production and performance of gender and cultures of equality in Europe. The case referred to in this paper focuses specifically on the specialist sub–group 'Digital Grace' tasked with developing a smartphone application.

I begin with several key theoretical reference points which speak to the interrelation of technology and (in)equalities, exploring technological determinism, neutrality, access, digital inequalities and datafication. I then outline the research context, describe the GRACE research project and provide an account of the feminist epistemology and autoethnographic methodology applied by Digital Grace. This is followed by a discussion of the reflections of group members, drawing on the theoretical considerations previously outlined. Finally, I consider the implications for working with difference, (in)equalities and technology within the global systems of digitalization and knowledge production.

The GRACE consortium of universities and researchers is spread across eight institutions in six different European countries. Much of the work that is takes place in the project, as with many similar multi–site research projects, is carried out online. This quotidian engagement with Internet technologies for collaboration and communication, has foregrounded the interplay between technology and (in)equalities. Although it is beyond the scope of this piece to explore in–depth the debates of the science, technology and society field, in the following sections I outline some key theoretical concerns.

The limits of technological determinism

The field of emergent technologies and methods in social science research is growing rapidly, and the list of advantages of online methods is substantial (Hesse–Biber and Griffin, 2013). The Internet makes it possible to engage with internationally dispersed samples, it also allows recordable participant observation, and access to a wealth of data through social media platforms and online forums, facilitating access to previously hard to reach communities, and allowing for the collection of unprecedented amounts of

data on large samples (boyd and Crawford, 2012). On the researcher side, as in the GRACE project, Internet technologies support the development of communities of scholarship and facilitate knowledge exchange. The number of digital libraries, academic databases and search engines are evidence of this. These tools are cast as unique sources of new and useful insights and multiple research opportunities, echoing a recurring public discourse of technology and the Internet as a historical rupture (Jones and Czerniewicz, 2010).

This perspective is one of technological determinism, whereby technologies emerge as if from nowhere following an inevitable and consistent progression, and effect significant unilateral transformations in society (Wajcman, 2002; Wyatt et al., 2000). The technological determinist stance is often assumed by default because it is close to the everyday lived experience of most individuals (Randolph, 2011). In contexts where there is high diffusion of Internet technologies a clear example is the case of smartphone technology. Mobile operating systems such as Android make use of over–the–air programming to distribute new software and configurations. In this case technological changes are, in a material sense, taking place over night and are operable by the user the next day.

One example of the ubiquity of the logics of technological determinism, particularly that of straightforward social change, is the debate around digital natives. 'Digital natives', or the 'Net Generation', are phrases commonly found in policy, commercial and educational contexts to refer to the current generation of young people who possess a natural facility and high level of skill in the use and production of new technologies. Jones and Czerniewicz (2010, p. 318) clarify this point 'in the determinism that is inherent in arguments based on the Net Generation and digital natives, education has to adapt to technologically induced changes rather than shaping the technology–related changes that are taking place in accordance with educational requirements and the needs of staff and students'.

In practice, the notion of digital natives as a homogenous group is has little empirical support (Bennett, Maton and Kervin, 2008; Helsper and Eynon, 2010). Within the so called 'digital natives' group there is a diversity both in terms of access and in terms of digital skills, cross–cut by variables of class, gender and social location. As Wajcman (2002) argues, although discourses of technological determinism hold a common sense appeal, they are inaccurate to the material production of technological artefacts. Furthermore, technology is one factor in social change among many others and 'to say that technology's social effects are complex and contingent is

not to say that it has *no* social effects' (Mackenzie and Wajcman, 1999, p. 3). It is not that technology does not affect society, it is that technological determinism paints an incomplete picture and as such is a poor theory of social change. Rather, there is a symbiotic relationship between technology and social change.

Neutrality and technological instrumentalism

In contrast to the determinist stance instrumentalist conceptions of the interaction between society and technology (Tiles and Oberdiek, 1995, p. 34), focus on user adaption of technological artefacts as inherently neutral tools (Wyatt et al., 2000, p. 11). In this understanding innovations are technologically induced, following an internal logic of progression, unrelated to the constellation of socio–historical forces which constitute the context in which they are used (Greene, 2001, p. 4–6). Although this approach recognizes the role of users, a value–neutral concept of technology reifies polarity in dominant public and scientific discourses on technoscience which vacillate between 'euphoric affirmation or pessimistic refusal' (Weber, 2006, p. 400). In simple terms technologies become tools for 'evil' or ' good', irrespective of how they were made in the first place.

This polarity and the presupposed internal, disembodied logic of technological innovation characterizing the instrumentalist stance are untenable given that 'the processes by which technologies themselves are created are just as riven with choice and conflict as any other historical process' (Wyatt et al., 2000, p. 11). Technologies are embedded, and arise from, the very materiality of life and as such cannot be neutral. Sassen (2002, p. 367), for example, argues that there is no purely digital space, every virtual electronic space is already material by virtue of this human embeddedness. Similarly, Miller and Sinanan (2014, p. 9) argue for a theory of attainment whereby the digital space of social media is an extension of existing human sociality, in that 'mediation is an intrinsic condition of being human'. If a social constructionist view is taken as Wyatt et al. (2000, p. 11) suggest, this approach allows for an interpretative flexibility in which the stabilization of meaning is imbricated in the creation and the consumption of the artefact (Bijker, 1995). From this viewpoint the value–laden, socio–historically intertwined, nature of socio–technical practices is rendered visible. The following discussion on the digital divide, data regimes and datafication stands in evidence of this interaction.

Access and the digital divide

Besides bearing the ideologies of their makers, new information technologies are part of existing geopolitical systems of inequality and power. These technologies, while perhaps appearing clean, and new and full of potential to everyday user of the Western industrialized cultural matrix, do not necessarily live up to the democratizing promises of optimistic neutrality discourses. The digital divide, the growing gap in power and resources between the information rich and the information poor (Wajcman, 2002), is not simply a problem of access to technology. Stigl (2025, p. xvii) argues that digital culture is an extension of coloniality, an 'extension of the very bourgeois civil society that has constituted the global north and that runs on an operating system that is *not* so much written as a wonderful networking culture'. This is starkly evident in the case of access and consumption patterns of Internet usage which are 'a function of, interalia, place, education, race, income and gender but also bound up with the structures of the production of the Internet itself' (Wyatt et al., 2000, p. 24). For example, when the commercial information infrastructure of the Internet was made available in the form of the World Wide Web in 1993, the main Internet exchange points were in the United States and Internet service providers had to lease international lines rendering the usage costs much higher for those located outside the US. Thus, the production costs of the material infrastructure of these new information technologies extend existing inequalities and create new ones both within and between societies.

In addition to the production of the physical infrastructure of the Internet and communication technologies, digital inequalities are amplified through current socio–technical practices. These practices have evolved following the convergence of systems theory, cyberscience, and new life sciences which involve 'the translation of the world into a problem of coding (Haraway, 1991, p. 164). Weber (2006) describes this as a constant disassembly and reassembly of the natural and material. It is through these iterations of miniaturization, engineering, design and rebuilding that the inequalities of the world are built into new technologies. Daniels (2009, p. 109) explains this clearly: 'for the women working in a microchip factory in China or a call centre in India, the Internet is not a subversive potential future but a work place rooted in economic necessity'. There are many different possible relations to digital technologies dependent on social location and current material realities. Gajjala asks the important question: 'if cyberspace is being produced at the expense of millions of men and

women all over the world, who are not even able to enjoy it's conveniences, how can we make claims that these technologies are changing the world for the better' (Gajjala, 2003, p. 49).

In digital and virtual spaces this fragmentation and codification, which builds inequalities and power into Internet technologies, finds expression in digital datafication (Gurumurthy, 2016, p. 1). Datafication is the compartmentalization, and digital recording of material life in measurable bits, embodied in the prosumer social media figure. Ritzer and Jurgenson (2010, p. 19) argue that the Internet and Web 2.0, meaning the user generated web, has heralded a 'dramatic explosion in prosumption', where the individual is simultaneously producer and consumer. In the case of social media sites the prosumer participates in the data economy through their immaterial affective labour by sharing thoughts, emotions and opinions. This is important information for capitalism as the businesses that run social media platforms sell the information generated by prosumers to advertisers in a vicious commodification of self. Through a continued channelling of data to the Data Rich the existing digital divide is widened (Boyd and Crawford, 2012). Thus, following Wajcman (2002), I see technological innovation as embedded in, and shaped by, the socio–historical milieu, and the values of its users and designers. Consequently, reflexivity and critical engagement are indispensable in the use and development of technology.

Research context, project outline and methodology

Equality is described as fundamental European value in the 2009 Lisbon Treaty and the EU claims to have the most progressive gender regime in the world (Abels and Mushaben 2012, p. 1). Broadly speaking over the past six decades gender equality policies have shifted from an understanding of equality as sameness, to difference, to strategies of transformation such as gender mainstreaming and diversity mainstreaming (Jacquot, 2010; Rees, 2005; Squires, 2005). However, despite a pervasive discursive commitment to equality there are persistent 'high levels of employment segregation, persistent pay gaps, the widespread acceptance of gender stereotypes and tolerance of sexism, together with unacceptable levels of domestic violence and persistent homophobia and sexual orientation based discrimination tell a different story' (Beveridge and Velluti, 2008, p. 2).

It is in this context that the GRACE project is positioned as multi–site transnational investigation of gender and cultures of equality. This research

focuses on urban, intellectual and activist, textual and artistic, and mediated sites where cultures of gender equalities are produced and contested. The project consists of 15 early stage researchers, organised into five workpackages (mediated cultures, urban cultures, intellectual and activist cultures, textual and artistic cultures of gender equality, employing cultures of gender equality), located in eight institutions (seven academic and one non–academic) in six countries (England, Spain, Hungary, Poland, Italy, Netherlands). It is funded by the Marie–Sklodowska–Curie Innovative Training Network initiative. The researchers are PhD candidates at their institutions in parallel to their work in the GRACE research project. In addition to the core research work–packages the researchers are divided into two working groups: one is focused on creating a Museum of Equality, and the other, named Digital Grace, is developing a smartphone application. The development of the Grace App is envisaged as a means of exploring the potential of technologies in the cultural production of gender equality and it is envisaged as tool for in transversal skills development. This paper presents the insights and reflections that have emerged from the smartphone development process to date.

The communication between the 15 researchers, supervisors, expert advisors and project staff is conducted through the online networking software developed for the project, the so–called digital hub. This software supports interaction between users and facilitates collaborative working through shared editable documents, messaging features, and the creation of group spaces. The interpersonal connections between the researchers and the social life of the project itself are built through this online social network. More specifically, the empirical data presented here emerges from a community autoethnography involving six of the researchers of Digital Grace that was conducted through this digital hub.

Through online communication and collaboration the Digital Grace group has elaborated a shared reflexive development process for the Grace App. Outside of the social studies of science and technology movement there is a general lack of reflexivity on how researchers themselves engage with Internet and digital technologies (see Wajcman, 2002). However, there is a significant body of scholarship and cyberfeminist writing on the complexities of the liberatory and oppressive potential of ICTs (Daniels, 2009; Everett, 2004; Wajcman 2009; Weber, 2006). This body of literature speaks to the political reflexivity, which is a fundamental principle of feminist research and has brought the Digital Grace team to debate interrelationships of power and knowledge in their use of technology. Weber (2006, p. 402)

writes that at the heart of feminist studies 'lies the search for better, or at least more visible, ways to design and use categories, knowledge and, technologies, to shape artefacts, and worlds in order to make exclusions visible'. Departing from these epistemological anchor points the Digital Grace team seeks to actively locate themselves and acknowledged their positionality in the Grace App development process (Hesse–Biber, p. 2014).

To cultivate reflexivity and provide an enduring account of our progress and interaction through the development process the Digital Grace team employed an autoethnographic practice which is currently ongoing. Ellis (2004, p. 31) provides the following description of autoethnography: 'as a form of ethnography, autoethnography overlaps art and science; it is part *auto* or self and part *ethno* or culture[…] autoethnography refers to the process as well as what is produced from the process'. In this methodology researcher bodies (both physical and virtual) and felt experience become research instruments, as these are recorded they coupled with an analytic interpretation. Digital Grace is engaged in a community autoethnography, a topic guided and interpretative approach. In this approach here is a dialogical interaction between conversations, collaborative decisions of themes and key questions, followed by responses and analysis which are then picked up again in group conversation. As Toyosaki et al. (2009) suggest, this community ethnography has the goals of critical participation and community building. In the following section I present some key reflections that have emerged from the first iteration of the Digital Grace autoethnography. We disused themes and key questions about the Grace App development process, wrote on these individually, collected the texts together online, and then brought this material back into collaborative discussion and analysis. The writings of the members of the Digital Grace team have been anonymized and their names have been replaced with DG and a number.

Reflections on collaborative app development: digital opportunities and inequalities

The design process of the Grace App has been guided by collaboration and consensus building, but complicated by distance. Through this process a divergence has emerged between the feminist ethics of the group, the planned functionalities of the Grace App and the realities of the inequalities embedded in the commercial infrastructure of the Internet (Burnett et al., 2009; Stingl, 2016; Wyatt et al., 2000). The use of the digital hub to carry out

conversations and decision–making has brought to light both the constraints and opportunities that Internet technologies provide for researcher communities (Daniels, 2009). DG1 observed that 'it has been a process of re–learning to communicate and an experiment of communication in virtual spaces'. Indeed the 're–learning' process has involved the adaption of different technological artefacts, types of software as well as technological infrastructure, to overcome the distance in space that often 'translates into a distance of mutual understanding' (DG1). It is through this process of adaptation and convergence that DG5 explains:

> 'We managed to crate a kind of safe space or exclusive spaces for ESRs (early stage researchers) to develop a group culture based on mutual trust and respect (although the Internet is neither a safe nor intimate space).'

This experience stands in contrast to a technological determinist understanding of people as passive users of technology (Wajcman, 2002; Wyatt et al., 2000). We have learnt through reflexive engagement with technological tools, and by using a variety of tools in different ways we have been able to imagine and create alternative spaces. As described in the theory of attainment (Miller and Sinanan, 2014), we have experienced our group move and grow within a digital space as an extension of our physical sociality.

The digital hub is the nodal point of communication between researchers and staff in the GRACE project. The hub was designed with a critical eye to exploring how a digital platform may function in facilitating the development of a research community and positive organisational culture at a distance. It represents an enduring account and documentation of the interactions between the group and the evolution of the project overtime. By looking back over this digital record In the GRACE project it is clear that such software relies on the competence of researchers as 'digital natives'. However, in practice the experiences of the researchers and staff in the project destabilize determinist notions of the Net Generation as a homogenous group. Digital Grace discussed the fact that there are differences between researchers in terms of resources and skills to use the online networking software. In a broader social group these differences will be further amplified. Reflecting on these questions of skills and access DG6 wrote:

> 'There have been times that it has been really hard to connect on the hub because of logistical things, like being out of Internet

connection…it has made me think about the politics of access and the fact that some voices are privileged over others depending on how well connected people are.'

By critically discussing the question of access, the group became more aware of the 'democratizing potential of the Internet' rhetoric visible in policy and commercial media about the Internet as a space open and available to everyone, waiting to be used (Jones and Czerniewicz, 2010). We concluded that this rhetoric not only obscures the costs of the production of Internet technologies (see Gajjala, 2003), but also obscures pre–existing inequalities and international systems of power and knowledge production. DG5 outlines this reality: 'we should also be aware of the limits of our apps being exclusively available for smartphone owners (age, region, socioeconomic profile) with certain skills (literate, knowing certain languages – especially English)'. By challenging an instrumentalist view of technology as neutral, the importance of the values and priorities of the group as 'developers' emerged.

The centrality of values and priorities, both theoretical and practical, took clear form at the brainstorming stage. We grappled with the consolidation of fascinating app designs for collective mapping projects, knowledge and skills sharing, gamification and community building. We faced several tensions between epistemological perspectives and potential app content, between inclusivity and feasibility, and found ourselves differently constrained and enabled in terms of skills, aims, and knowledge. As we have progressed through to prototyping models and mapping costs it has become apparent that values play a pivotal role in the design process because they set the boundaries for action. Technologies are profound statements of ideological positionality. As DG2 has noted:

'The overall process opened my eyes to the complexities of actually creating a product that is coherent with a general feminist ethos…I find myself wondering: to what extent are we willing to sacrifice the values we hold dear in order to deliver the final product?'

Our conclusion is that we cannot be absolved from responsibility for the technologies that we make and use, and that we have to act reflexively, as DG6 has described 'I think we've managed to navigate through these obstacles, not by ignoring them, but by making them explicit and discussing'.

Part of negotiating these priorities is deciding which affordances to include in potential apps, how to build prototypes, and how to render the final version available to the public. It has become clear, as expressed by

DG5, that there are 'important implications when designing programs that will be available on platforms of powerful transnational corporations such as Google or Apple'. This is because these corporations are not benevolent giants; their business models are built on the prosumer and the harvesting of their data and meta–data. DG4 talks about this tension:

> 'We have also taken into consideration issues of privacy and security when discussing the potential features of the app and we have reflected on the necessity of creating safe spaces, which especially came as a challenge again when deciding not to make the content user–generated.'

The collection and use of data by these corporations is what boyd and Crawford (2012) call the socio–technical phenomenon of Big Data. These authors declare 'the era of Big Data has begun. Computer scientists, physicists, economists, mathematicians, political scientists, bio–informaticists, sociologists, and other scholars are clamouring for access to the massive quantities of information produced by and about people, things, and their interactions' (boyd and Crawford 2012, p. 662). As Lupton (2014) illustrates in a review of digital health technologies, we need to be wary of discourses of techno–solutionism that fail to problematize the datafication of the individual that is envisaged by medical digital technologies. Referencing the example of digital health technologies DG4 expressed the concerns of the wider researcher group 'one possible unwanted by–product or misuse of our app(s) could be user data collection (geo–tracking, personal data etc.) which would not contribute to making online spaces safe spaces'. On all sides of the digital divide we are in a data regime. Rather we need to be looking at approaches which re–imagine community and connectedness in a time of shifting subjectivity and sociality. In our work as researchers we need to consider what datafication and the surveilled subject means for collecting data about people (Gurumurthy, 2016), and, crucially, the technologies that we use to do this. These reflections have pushed us to seek alternatives; we are constantly looking for examples of other apps and other initiatives that use technologies to engender transformation and equalities. By sharing these examples on the digital hub and discussing them we envision more inclusive ways of developing our own app.

To explore alternatives, DG6 conceptualizes the Grace App in terms of Barad's (2007) agential realism, where the app is a diffraction apparatus a 'material–discursive practice in which human and non–human elements intra–act' in the remaking of boundaries. This Digital Grace member summarizes our position and our direction 'so, without being oblivious to

the multiple inequalities and problems arising from Internet use, Big Data, etc. (on the contrary being well aware of them!) we can, (I'd say we must) intra–act with this technology to open up spaces and remake boundaries so as to impact what comes to matter through it'.

Conclusion

In this paper I argue that the use of emergent technologies in social science research should be characterized by reflexive practice, which takes account of the critiques of technological determinism and neutrality, and engages with politics of datafication and questions of digital access. The reflections detailed above illuminate a trajectory of first seeking awareness, and second seeking change. This is a call to the re–politicisation of the use and development of technologies and research tools so that these are consistent with our epistemologies. As Digital Grace members have discussed this is certainly time consuming and very resource dependent. However, it is also important to do as it promotes flexibility and critical awareness in dealing with the myriads of complexities that arise at the intersections of technology and society. The community autoethnography that has emerged from this reflexive and collaborative engagement, allows us to hold a notion of the Internet as a place of potential subversion and resistance as well as a place of oppression. As Wyatt et al. (2000, p. 44) write, now almost two decades ago, musing over what forms and directions ICTs might take in the 21st century: 'the internet is not yet 'for everyone' and is unlikely to be so in the near future, but anything which keeps the internet open to such a possibility is worth creating or preserving'.

References

Abels, G. and Mushaben, J.M. (eds.) (2012) *Gendering the European Union. New Approaches to Old Democratic Deficits*. Basingstoke: Palgrave Macmillan.

Banks, S. P. and Banks, A. (2000) Reading 'The Critical Life': Autoethnography as Pedagogy. *Communication Education*, 49 (3), 233–238.

Barad, K. (2007) *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning*. Durham: Duke University Press.

Bennett, S., Maton, K. and Kervin, L. (2008) The 'Digital Natives' Debate: A Critical Review of the Evidence. *British Journal of Educational Technology*, 39 (5), 775–786.

Beveridge, F. and Velluti (eds.) (2008) *Gender and the Open Method of Coordination*. New York: Ashgate Publishing.

boyd, D. and Crawford, K. (2012) Critical Questions for Big Data. Provocations for a Cultural, Technological, and Scholarly Phenomenon. *Information Communication and Society*, 15 (5), 662–679.

Daniels, J. (2009) Rethinking Cyberfeminism(s): Race, Gender, and Embodiment. *WSQ: Women's Studies Quarterly*, 37 (1), 101–124.

Ellis, C. (2004) *The Ethnographic I: A Methodological Novel about Autoethnography*. Walnut Creek, CA: AltaMira Press.

Everett, A. (2004) On Cyberfeminism and Cyberwomanism: High-Tech Mediations of Feminism's Discontents. *Signs*, 30 (1), 1278–1286.

Gajjala, R. (2003) South Asian Digital Diasporas and Cyberfeminist Webs: Negotiating Globalization, Nation, Gender, and Information Technology Design. *Contemporary South Asia*, 12 (1), 41–56.

Green, L. (2001) *Technoculture: From Alphabet to Cybersex.* Crows Nest: Allen and Unwin.

Gurumurthy, A. (2016) Data: The New Four–Letter Word for Feminism. *GenderIT* [Online]. Available from: http://www.genderit.org/articles/data–new–four–letter–word–feminism [Accessed: November 21st, 2016].

Haraway, D. (1991) *Simians, Cyborgs and Women: The Reinvention of Nature.* New York: Routledge.

Helsper, E.J. and Eynon, R. (2010) Digital Natives: Where is the Evidence? *British Educational Research Journal*, 36 (3), 503–520.

Hesse–Biber, S.N. (ed.) (2014) *Handbook of Feminist Research: Theory and Praxis.* Thousand Oaks: SAGE Publications.

Jacquot, S. (2010) The Paradox of Gender Mainstreaming: Unanticipated Effects of New Modes of Governance in the Gender Equality Domain. *West European Politics,* 33 (1), 118–135.

Jones, C. and Czerniewicz, L. (2010) Describing or Debunking? The Net Generation and Digital Natives. *Journal of Computer Assisted Learning*, 26 (5), 317–320.

Lupton, D. (2014) Critical Perspectives on Digital Health Technologies. *Sociology Compass*, 8 (12), 1344–1359.

MacKenzie, D. and Wajcman, J. (eds.) (1999) *The Social Shaping of Technology*. Buckingham: Open University Press.

Miller, D. and Sinanan, J. (eds.) (2014) *Webcam*. Cambridge: Polity Press.

Randolph, L.P. (2011) *International Exploration of Technology Equity and the Digital Divide: Critical, Historical and Social Perspectives.* Hershey, PA: IGI Global.

Rees, T. (2005) Reflections on the Uneven Development of Gender Mainstreaming in Europe. *International Feminist Journal of Politics*, 7 (4), 555–574.

Ritzer, G. and Jurgenson, N. (2010) Production, Consumption, Prosumption. The Nature of Capitalism in the Age of the Digital 'Prosumer'. *Journal of Consumer Culture,* 10 (1), 13–36.

Sassen, S. (2002) Towards a Sociology of Information Technology. *Current Sociology*, 50 (3), 365–388.

Squires, J. (2005) Is Mainstreaming Transformative? Theorizing Mainstreaming in the Context of Diversity and Deliberation. *Social Politics*, 12 (3), 366–388.

Stingl, A.I. (2016) *Digital Coloniality of Power: Epistemic Disobedience in the Social Sciences and the Legitimacy of the Digital Age*. London: Lexington Books.

Tiles, M. and Oberdiek, H. (1995) *Living in a Technological Culture: Human Tools and Human Values*. New York: Routledge.

Toyosaki, S., Pensoneau–Conway, S.L., Wendt, N.A. and Leathers, K. (2009) Community Autoethnography: Compiling the Personal and Resituating Whiteness. *Cultural Studies, Critical Methodologies*, 9 (1), 56–83.

Wajcman, J. (2002) Addressing Technological Change: The Challenge to Social Theory. *Current Sociology,* 50 (3), 347–363.

Wyatt, S., Henwood, F., Miller, N. and Senker, P. (eds.) (2000) *Technology and In/equality: Questioning the Information Society*. London: Routledge.

Weber, J. (2006) From Science and Technology to Feminist Technoscience. In Davis, K., Evans, M. and Lorber, J. (eds.) *Handbook of Gender and Women's Studies*. London: SAGE Publications.

Precision Medicine between Bodies and Environment: A Comparative Analysis

Ilaria GALASSO[*][ab] and Giuseppe TESTA[†][ab]

[a] Università di Milano, [b] Istituto Europeo di Oncologia

As part of a full–fledged project analyzing precision medicine by investigating its epistemic and practical significance through the lens of STS, our paper is aimed at analyzing the import of competing framings of precision medicine in terms of public health. In particular, we analyze what we propose to call the 'distraction argument', questioning precision medicine as a distraction from the most effective and urgent interventions addressing public health issues.

In our paper we analyze the 'distraction argument' by scrutinizing its implicit presuppositions. First, by reviewing the literature, we distinguish two possible approaches to health as they seem to be assumed by the 'distraction argument': one focused on the body, the other focused on the (social) environment. Next, we investigate the import of precision medicine by casting a comparative analysis among emerging initiatives proposing different framings. We observe that the allocation of our case studies is not always univocal: in particular, the American Precision Medicine Initiative seems to have the potential to combine the two approaches, invalidating the 'distraction argument'. Thence, we conclude that precision medicine has the potential to embrace different approaches to health and to significantly contribute to (social) environment centered interventions, but the actualization of this potential is all the more problematic in the current phase of political transition.

Keywords*: Precision medicine; social determinants of health; individual treatments; health policies*

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[*] Corresponding author: **Ilaria Galasso** | e–mail: **ilaria.galasso@ieo.it**
[†] Corresponding author: **Giuseppe Testa** | e–mail: **giuseppe.testa@ieo.it**

Introduction

This work is part of a full–fledged project on precision medicine in which we apply several analytical streams from Science and Technology Studies (STS) to investigate, through a comparative approach, how the epistemology of the precise is being articulated across different scales, in the biomedical and in the political domain alike. Specifically, we aim at defining which interdisciplinary configurations and which resources, scientific, discursive and political, are being harnessed to drive the precision medicine agenda and what is their import for the understanding of public health at the level of institutional self–reflexivity. To this end, we are following the implementation of the leading precision medicine projects worldwide, by interviewing key actors within the emerging fields of precision medicine as well as public health practitioners, and by participating in the requests for feedback proposed by precision medicine projects in order to gain insight into the participatory dimensions of such projects. Through this clarifications of the epistemological and normative orders that are crystallizing around precision medicine, we also hope to provide empirically ground for a normative framework that addresses the integration of public health issues, especially related to health disparities, in the precision medicine agenda. In this context, the present paper is especially focused on the investigation of the reach of precision medicine for public health.

In particular, in the paper we analyze what we call the 'distraction argument', namely the position that questions precisely the reach of precision medicine claiming that, by pursuing an exceedingly narrow focus on the biomedical domain, it represents 'a distraction' from more urgent social interventions. In order to dissect this argument, we first scrutinize its implicit presuppositions. In particular: i) the implicit presupposition that there are two possible distinct approaches to health, and ii) the implicit presupposition that the reach of precision medicine is limited to the approach considered as the least effective in terms of public health. To scrutinize the first assumption, we propose a review of relevant distinctions of health approaches in the literature. For the second presupposition, we investigate the place of precision medicine by considering relevant emerging initiatives as case studies. Thence we discuss the possible falsification of this second presupposition, which would invalidate the 'distraction argument'. Finally, we conclude by discussing the questions that are opened by this perspective.

Precision medicine

Precision medicine is emerging as a key trope in biomedicine, catalyzing significant investments and reorganization of research agendas across the world. The National Institute of Health defines it as 'a groundbreaking approach to disease prevention and treatment based on people's individual differences in environment, genes and lifestyle' (nih.gov), aimed at 'delivering the right treatments, at the right time, every time to the right person' (Obama, 2015b). The vision is thus predicated on the notion that current therapies belong to a largely unsatisfactory 'one size fits all' model. Precision medicine is thus being presented as the superior alternative that promises a multi–layered analysis of both the genetic and environmental underpinnings of disease, scaled down (or up, depending on the vantage pointed all the way to the level of the individual patient or prospective patient).

The interest in precision medicine is rising steadily, among scientists, clinicians and publics. The wide popularity dates back to January 2015, when the US president Barack Obama, at the State Of The Union Address, launched 'a new initiative of precision medicine' (Obama, 2015a). Obama presented the Precision Medicine Initiative (hereafter PMI) as a very promissory project. He remarked: 'We want a country that extends its promise of opportunity to everybody who's willing to work for it. We want to have a nation in which the accidents and circumstances of our birth aren't determining our fate, and therefore born with a particular disease or a particular genetic makeup that makes us more vulnerable to something; that that's not our destiny, that's not our fate – that we can remake it' (Obama, 2015b). A promise that is fully representative of the American dream of personal opportunities especially typical of the Obama–era.

'The distraction argument'

While the promise of the PMI has been generating many positive reactions, it has also spurred several lines of criticisms, among which we focus here on what we propose to call 'the distraction argument', on the basis of its most prominent articulation in a perspective article in the *New England Journal of Medicine* by the political scientist Ronald Bayer and by the physician and epidemiologist Sandro Galea (Bayer and Galea, 2015). In the light of the evidence of a social gradient in health (Marmot and Wilkinson, 1999), which seems to be especially relevant in a society exacerbated by social inequalities such as the US (Centers for Disease

Control and Prevention, 2013; National Research Council and Institute of Medicine, 2013), the two authors claimed that 'the challenge we face to improve population health does not involve the frontiers of science and molecular biology. It entails development of the vision and willingness to address certain persistent social realities', and hence, they 'worry that an unstinting focus on precision medicine by trusted spokespeople for health is a mistake – and *a distraction* from the goal of producing a healthier population' (Bayer and Galea, 2015, p. 201, emphasis added by ourselves). A similar argument was put forth by the medical doctors John Coote and Michael Joyner in a correspondence piece for *The Lancet* (Coote and Joyner, 2015). Here the two physicians argued that precision medicine 'could be *a distraction* from low cost and effective population–wide interventions and policies', since they 'believe precision medicine is not the route to a healthy world and instead urge a renewed and increased focus on public health and prevention' (ibidemem, p. 1617).

In order to dissect the 'distraction argument' and its implications, we propose to decompose it by highlighting the implicit presuppositions on which it is predicated. Indeed, the very notion that something is distracting from something else obviously assumes that there are two distinct things at play, in our case two distinct approaches to health. Thence, we can recognize the following as the first assumption of the 'distraction argument':

1. Two distinct approaches to health are possible.

Next the proponents of the 'distraction argument', grounding on the literature on the social determinants of health and health disparities, claim that:

2. One of the two approaches is more effective than the other in terms of public health (thence should be prioritized).

Their point is that precision medicine is *a distraction* from the most effective approach. This claim assumes that:

3. The reach of precision medicine is limited to the least effective approach.

And finally:

4. Solely inscribed within the least effective approach, the hype of precision medicine is somehow distracting from the most urgent approach.

We propose to discuss these assumptions one by one. In particular we suggest considering the distinction of two alternative approaches to health through a review of the most relevant literature, and to investigate the collocation of precision medicine between the two approaches through the analysis of case studies.

Two approaches to health

In terms of its genealogy, the binary notion of two distinct and de facto mutually exclusive approaches to health owes much to the long–standing recognition of the role that environmental exposures play in the determination of health outcomes. A case in point Geoffrey Rose's seminal article *Sick Individuals and Sick Populations* (Rose, 1985), in which he distinguishes between strategies focusing on the vulnerabilities of individuals and strategies focusing on the external general causes of disease for the whole population. More precisely, he distinguishes:

1. The ''high risk' strategy', meaning 'interventions that are appropriate to the particular individuals', that 'does not seek to alter the underlying causes of the disease but to identify individuals who are particularly susceptible to those causes', a strategy that 'does not deal with the root of the problem, but seeks to protect those who are vulnerable to it' (ibidemem, p. 35).

2. The 'population strategy', that he describes as the 'attempt…to shift the whole distribution of exposure in a favourable direction' and 'to remove the underlying causes that make the disease common' (ibidemem, p. 37).

A similar distinction has been proposed much more recently by Ron Zimmern (2016a; 2016b), founder of the PHG Foundation. The distinction by Zimmern is especially interesting for our analysis, because it was put forth within a debate about the reach of precision medicine for population health. Zimmern proposes to distinguish between:

1. Interventions specifically directed at and possibly tailored to individuals (and this is the case of precision medicine according to his analysis), meaning 'interventions that are directed at individuals and intended to achieve its effect through the agency of those specific individuals.'

2. 'Externally generally directed interventions', meaning 'interventions that are directed at the external environment without reference to any particular individual…where the intention is to improve that environment…for all individuals that are exposed to it.' (Zimmern 2016b).

In light of these dichotomies, it appears fruitful to revisit the debate that took place towards the end of the '90s about the role of epidemiology, and which anticipates also the current controversy around precision medicine as a distraction. Against the backdrop of the growing literature on the social determinants of health, the role of epidemiology in the '90s was questioned with a proposal to redirect its disciplinary toolkit towards socio–political change. In particular, Neil Pearce, in the article *Traditional Epidemiology, Modern Epidemiology and Public Health* (Pearce, 1996), urged a shift from a *bottom–up* and *individual* approach, to a *top–down* and *population* approach. Rothman and colleagues, replying to Pearce in the article *Should the Mission of Epidemiology Include the Eradication of Poverty?* (Rothman, Adami and Trichopoulos, 1998), defended instead the need for epidemiology to maintain its disciplinary identity by upholding a *downstream* and *biological* approach and shying away from undertaking a decisively more *upstream* and *social* ambition. The most articulated and well–structured distinction within this debate was eventually proposed by Anthony John McMichael, in the article *Prisoners of the Proximate* (McMichael, 1999), and it is especially relevant for our analysis in its literal anticipation of the 'distraction argument'. McMichael predicted, in fact, that 'the advent, early next century, of 'bar–coded' individual genotypes on microchips may yet further *distract* us from the task of managing our social and natural environments.' (ibidemem, p. 896).

Importantly, and contrary to the other authors cited above, McMichael operates a more fine–grained partition between the concepts used to capture the scales of health–related interventions. Specifically, while the other analyses had aligned, respectively, *individual* with *downstream* and *population* with *upstream*, McMichael positions the distinction between *distal–proximal* and the distinction *individual–population* to two different planes. In particular he observes that upstream interventions could also be addressed to individuals, and downstream approaches could also be addressed to populations, but they need different strategies and are aimed at different contexts. In particular, upstream interventions at individual level especially involve lifestyle recommendations, while at population level the trends of the society and the distribution of resources need to be

proactively addressed through policies. It is probably this kind of strategies that the proponents of the 'distractions argument' advocate as the 'most urgent interventions': interventions involving policies at a societal level, addressing the environment and the societal structures rather than the bodies of individuals or of populations.

On the basis of this consideration, building on the models proposed by the relevant literature, and in particular on the clarification made by McMichael, we propose to describe the distinction underlying the 'distraction argument' as follows:

1. A downstream and mainly individual focused approach working across the scales of the biomedical domain, aimed at acting *on the patient* to assess the best treatment or prevention strategy: a *body centered* approach.

2. An upstream and mainly population focused approach working across the scales of the socio–political domain, aimed at acting *on the (social) environment* through social policies: a *(social) environment centered* approach.

The place of precision medicine

A clarification of the body–environment polarity as the discursive feature underlying the approaches posited as alternative by the 'distraction argument' opens up the investigation of the place of precision medicine within this polarity. This amounts to investigating the implicit presupposition of the 'distraction argument' according to which the reach of precision medicine is limited to the approach considered as least effective in terms of public health, namely the approach we portrayed as *body centered*, while distracting from the *(social) environment centered* approach. To discuss this assumption, we propose to analyze defining case studies.

In particular, we aim to focus on the 100K Genomes Project (hereafter 100KGP), a major initiative of genome sequencing conducted in the UK and already considered, in scholarly literature and public sphere alike, as a paradigmatic precision medicine project. Launched in 2012 by former UK Prime Minister David Cameron, the 100KGP aims at harnessing genomics knowledge to ameliorate the effectiveness of treatments in two areas, cancer and rare diseases. By sequencing patients' whole genomes the goal is to better understand the genetic causes of their disease predispositions, to provide more accurate diagnoses and, when possible, to deliver the most

effective treatments given the mutations found (genomicsengland.co.uk). In particular, in its cancer part, the project entails comparison of the patient's germline genome with that from the tumor cell, in order to unequivocally define the cancer–causing mutations and to predict treatment response accordingly. In terms of rare diseases, patients' genomes are compared with those of their closest relatives, in order to improve diagnoses by identifying causative mutations. The 100KGP is thus entirely focused on the genomic causes of diseases, and its treatment tailoring ambition wholly predicated on the most proximal, genetic source of variation/disease predisposition, leaving out the distal causes of the mutations, and the (social)environment in which genes are (un)expressed. In this sense, we argue that the 100KGP corresponds to a typical case of *body centered* approach: the project looks at the causes of the diseases *internal to the body* (the relevant genetic mutations), and aims at providing interventions *directed to bodies* (medical treatments). The (socio)environmental components of the diseases are not considered in this context, and no (socio)environmental interventions are planned.

   As a prototypical example of a *(social) environment centered* approach, we look instead at the Whitehall II Study, especially relevant since Bayer and Galea explicitly build on the results of this study for their 'distraction argument'. The Whitehall II Study is focused on the socio–environmental causes of diseases, explicitly aiming at exploring the relationship between socio–economic status, stress and cardiovascular disease (ucl.ac.uk/whitehallII). The Study was established by Professor Sir Michael Marmot and his team in 1985, as a follow up of the first Whitehall Study (1967). The analyses are conducted on a cohort of London civil servants, their clinical data being analyzed in relation to their social and occupational positions as they emerge from questionnaires filled by the participants. Through these analyses, the Whitehall studies have been instrumental to reveal the existence of a social gradient in health, uncovering how the circumstances in which people live and work can affect their health. In particular, the Whitehall II study has shown the importance of psychosocial factors such as work stress and work–family conflict (in addition to the contribution of unhealthy behaviors and traditional risk factors such as high blood pressure) in heart disease and diabetes. The aim of the study is not to provide effective treatments, but rather to highlight the policy implications at the societal level and in this light to provide informed guidelines for policy makers (VV.AA., 2004). In summary, in line with the *(social) environment centered* approach, the Whitehall II Study investigates the causes of disease

onset that are *external to the body*, with an explicit emphasis on the *social and environmental causes*. Moreover, the Whitehall II Study does not implement any body treatment innovation on the basis of its analyses, rather, specific societal and occupational interventions are proposed. We argue that this exclusive focus on the (socio)environmental component of health and illness, makes the Whitehall II Study a paradigmatic representative of the approach we described as *(social) environment centered*.

Finally, as a third counterpart in our comparison, a prominent place is dedicated to the Precision Medicine Initiative (PMI) launched by Barack Obama: it is apparently with the announcement of this initiative that the popularity of precision medicine started rising steadily, and even the popularity of the very rubric of 'precision medicine' seems arguably related to this initiative. Moreover, it was precisely in response to the PMI that the 'distraction argument' was expressed in the first place. The positioning of the PMI across the polarity of approaches we proposed is not as univocal as in the other case studies considered. The PMI proposes to build a cohort of one million or more American volunteers, and to collect, analyze and compare their data about their genomes, but also their habits and lifestyle and environmental exposures (nih.gov). This project is often assimilated to the 100KGP, since both initiatives propose massive whole genome sequencing efforts. Yet, while the 100KGP is exclusively focused on the genomes of cancer and rare disease patients (or of their closest relatives), the PMI proposes to sequence the genome of any category of people, aimed at detecting genomic influences related to any health or disease condition, in order to get a global understanding of disease predisposition and treatment response for the implementation of tailored therapies and prevention strategies. Moreover, the PMI also aims at collecting information about several kinds of socio–environmental exposures on the cohort participants, in order to probe the influence of lifestyle and the social environment on health and diseases. To this aim, the cohort participants will be requested to share their lifestyle and environmental data through questionnaires and through wearable devices. In this respect, we observe that the PMI also shows many similarities, at least prima facie, with features of the Whitehall II Study. Not only the genetic outfit, but also external conditions such as the social and occupational position, environmental exposures and the lifestyle are studied in relation to health/disease. With this attention to the distal, socio–environmental causes, the PMI includes all the elements to also highlight policy implications and suggest socio–political

interventions, similarly to Whitehall II. The univocal, mutually exclusive ascription to the *body centered* or to the *(social)environment centered* approach seems thus inadequate to capture the complexity of the PMI. On the one side, it focuses on genomes, thence on causes *internal to the body*, but on the other side it also leaves ample space to the exploration of *external, socio–environmental* causes by investigating lifestyle and environment. The PMI, at least in its current inception, promises thus to *combine* the two approaches, at least to some extent, questioning the assumption that precision medicine is limited to the *body centered* approach.

Along these lines, a new framework is also emerging around the notion of 'precision public health' (Khoury, Iademarco and Riley, 2016). The grounding concept of precision public health is that the precision achieved in understanding the individual causes of disease, and in delivering the most effective treatments and prevention strategies at an individual level, might be translated at a population level, with the promise to provide better health outcomes to whole populations, included the most disadvantaged populations. Yet, on the basis of the distinction of the two approaches we have analyzed above, we argue that precision public health, despite its promissory thrust in terms of addressing global health inequalities, does not entail a thorough integration of the two approaches to health at issue. What we observe is in fact a shift involving only one plane, following McMichael's terminology: a shift from individuals to population, which remains however anchored squarely to the biomedical without necessarily involving the other dimensions. In particular we observe that precision public health proposes to expand the focus from *the body* of the individual to *the bodies* of the population, while keeping within brackets much of the socio–environmental dimensions.

Conclusion

In our paper we have examined the implicit assumptions of what we term the 'distraction argument', questioning precision medicine as a distraction from social interventions addressing public health. Our analysis dissects the conceptual underpinnings of this argument, exposing the exceedingly narrow framing that it posits for precision medicine. This framing limits the reach of precision medicine largely to what we have called the *body centered* approach. Instead, once viewed through a broader angle, empirically grounded in the preliminary analysis of the PMI resources,

precision medicine is shown to articulate, and hopefully mobilize, resources that have the potential to contribute to, rather than distracting from, socio–political interventions addressing public health urgencies and health disparities. Indeed, unlike the emerging framework of precision public health, that mainly proposes to shift the attention from the individual *body* to the population *bodies*, we consider the potential of precision medicine to produce relevant knowledge through the intertwined analysis of socio–environmental and individual (chiefly genomic) factors, to be translated into social policies.

Needless to say, fulfilling the potential of precision medicine for public health through social policies depends on several outstanding issues, which we will analyze as they unfold in the three cases under study. These include the relevance of the knowledge actually produced, the commitment in translating this knowledge into policies and the values intrinsic to the initiatives. Indeed, especially as far as the PMI is concerned, the issues we have laid out become all the more relevant, and their concrete shape all the more open, with the transition to the new US administration, as seen in the very uncertainty voiced among the stakeholders about the framing of the PMI (Garde, 2016; Whitman, 2016).

References

Bayer, R. and Galea, S. (2015) Public Health in the Precision–Medicine Era. *New England Journal of Medicine*, 373 (6), 499–501.

Centers for Disease Control and Prevention (2013) *CDC Health Disparities and Inequalities Report – United States, 2013.* Technical Report. Morbidity and Mortality Weekly Report.

Coote, J.H. and Joyner, M.J. (2015) Is Precision Medicine the Route to a Healthy World? *The Lancet,* 385, 1617.

Garde, D. (2016) What Does Donald Trump's Win Mean for Science and Medicine? *STAT*. [Online] Available from: https://www.statnews.com/2016/11/09/donald–trump–win–science–medicine/ [Accessed: November 20th, 2016].

Khoury, M.J., Iademarco, M.F. and Riley, W.T. (2016) Precision Public Health for the Era of Precision Medicine. *American Journal of Preventive Medicine*, 50 (3), 398–401.

Marmot, M. and Wilkinson, R. (eds.) (1999) *Social Determinants of Health*, Oxford: Oxford University Press.

McMichael, A.J. (1999) Prisoners of the Proximate: Loosening the Constraints on Epidemiology in an Age of Change. *American Journal of Epidemiology*, 149 (10), 887–897.

National Research Council and Institute of Medicine (2013) *U.S. Health in International Perspective: Shorter Lives, Poorer Health* Washington (DC): National Academies Press (US).

Obama, B. (2015a) *State of the Union Address*. [Online] Available from: https://www.whitehouse.gov/the–press–office/2015/01/20/remarks–president–state–union–address–january–20–2015. [Accessed: November 20th, 2016].

Obama, B. (2015b) *Remarks by the President on Precision Medicine*. [Online] Available from: https://www.whitehouse.gov/the–press–office/2015/01/30/remarks–president–precision–medicine. [Accessed: November 20th, 2016].

Pearce, N. (1996) Traditional Epidemiology, Modern Epidemiology, and Public Health. *American Journal of Public Health*, 86(5), 678–683.

Rose G. (1985) Sick individuals and sick populations. *International Journal of Epidemiology*, 14 (1), 32–38.

Rothman, J.K., Adami, H.O. and Trichopoulos, D. (1998) Should the Mission of Epidemiology Include the Eradication of Poverty? *The Lancet*, 352, 810–813.

VV. AA. (2004) *Work, Stress and Health: The Whitehall II Study*. CCSU/Cabinet Office. [Online] Available form: http://www.ucl.ac.uk/whitehallII/pdf/wii–booklet [Accessed: November 20th, 2016].

Whitman E. (2016) Hopes for Precision Medicine Initiative, Cancer Moonshot rest with lame–duck Congress. *Modern Healthcare.* [Online] Available from: http://www.modernhealthcare.com/article/20161111/NEWS/16111998. [Accessed: November 20th, 2016].

Zimmern R. (2016a) *A commentary on Khoury & Galea Will Precision Medicine Improve Population Health. phg blog.* [Online] Available from: http://www.phgfoundation.org/blog/17389/. [Accessed: November 20th, 2016].

Zimmern R. (2016b) Precision Public Health: A Conversation. *phg blog.* [Online] Available from: http://www.phgfoundation.org/blog/17408/. [Accessed: November 20th, 2016].

Websites:

https://www.genomicsengland.co.uk/
https://www.nih.gov/research–training/allofus–research–program
https://www.ucl.ac.uk/whitehallII

Immagini laparoscopiche. Esplorazione e parcellizzazione del corpo della donna

Miriam RONCA[*][a]

[a] Université de Genève

Tra le attuali tendenze di esplorazione endoscopica, la laparoscopia è l'unica tecnica chirurgica che sfrutta un differente registro visivo. La pratica laparoscopica realizza, infatti, una nuova cartografia del corpo, che da superficie visiva si trasforma in superficie spaziale, ovvero in un territorio da esplorare e decodificare in rappresentazioni digitali. Per tracciare le vicende storiche dell'ingresso della laparoscopia in ambito medico, l'articolo esamina le prime immagini laparoscopiche presentate dai ginecologi Raoul Palmer e Henry Clarke. L'intento è quello di analizzare la profonda trasformazione operata da tali immagini, le quali richiedono l'elaborazione e l'affinamento di una serie di approcci d'interpretazione medica della materia organica: come la laparoscopia riconfigura il corpo, massimizzando l'effetto della sua frammentazione?

Per rispondere a tale interrogativo, l'articolo analizza, in secondo luogo, le pagine web dell'AOU Azienda Ospedaliera Universitaria Policlinico 'Federico II' di Napoli, l'unico ospedale universitario italiano a presentare, nel portale web GINEUNINA, una galleria d'immagini e video della pratica laparoscopica. Queste indagini saranno condotte attraverso l'uso di tecniche proprie della sociologia visuale, volte a investigare come le dinamiche della laparoscopia portano la corporeità femminile a rendersi accessibile allo sguardo clinico, fino a costituirsi come superficie visiva di sperimentazione.

Keywords: *Laparoscopia; medical imaging; GINEUNINA; corpo; donna*

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[*] Corresponding author: **Miriam Ronca** | e–mail: **mmronca@gmail.com**

1. Introduzione. Tecnologia biomedica e immagine corporea

Nel novembre 1895, la scoperta dei raggi X rivoluziona le modalità di visualizzazione interna del corpo umano. Questa tecnica di imaging prefigura il rapido sviluppo di nuove tecnologie mediche lungo tutto il XX secolo. Oggi, diversi settori della medicina hanno radicalmente tecnologizzato la biologia dell'uomo: differenti dispositivi medici sono, ormai, in grado di osservare le parti anatomiche più nascoste alla vista, realizzando immagini, ricostruite al computer, precise e dettagliate. Diversi autori (Cartwright, 1995; Panese, 2009; Van Dijk, 2005 ; Waldby, 2000), specialisti nel proprio campo di ricerca, rilevano come le tecnologie mediche sono profondamente correlate a quelle mediali e che questi strumenti sono essenziali per determinare un nuovo modo di concepire e di rappresentare il corpo. Alcuni autori focalizzano il loro interesse sugli strumenti ottici del XIX e del XX secolo, e suggeriscono che l'invenzione di questi dispositivi determina un nuovo modo di vedere e l'emergere di un nuovo soggetto che possiamo chiamare 'osservatore' (Balsamo, 1996; Crary, 1990; Kemp, 1999; Latini, 2007; Toffoletti, 2007). Le tecnologie di visualizzazione medica costituiscono, dunque, un terreno di esperienza, non solo specifico e ristretto dello sguardo clinico, ma anche a quella extra–scientifico –fuori del laboratorio o del luogo di produzione dell'immagine tecnica– nella sfera sociale, nello spazio della cultura. Per meglio comprendere le relazioni tra pratiche cliniche e processi di biomedicalizzazione della società (Clarke, 2010) è, allora, necessario rivolgere l'attenzione alle riflessioni condotte in ambito della sociologia della medicina, ormai sempre più tangente ai Social Studies of Scientific Imaging and Visualisation (Burri, 2012; Burri e Dumit, 2007). Tale convergenza sembra, infatti, offrire una giusta prospettiva per osservare come le pratiche di visualizzazione scientifica, svolte all'interno di specifiche organizzazioni professionali, siano incorporate in processi sociali e culturali che, coinvolgendo saperi costruiti e negoziati, creano precise modalità attraverso cui appropriarsi visivamente della corporeità (Crabu, 2014; Perrotta, 2012)**.** Tale assunto è sottolineato, seppur in modalità differenti, sia da De Lauretis (1999), che da Mulvey (1975), secondo le quali i dispositivi di visualizzazione nel loro complesso sono processi attraverso cui si definisce il coordinamento e la disposizione di differenti sguardi: quello dell'obiettivo dei dispositivi, quello dello spettatore e quello del corpo osservato. Questi s'incontrano e coesistono secondo una continuità relazionale che organizza la visione, finendo così con il costruire un campo

che, modificando il grado di visibilità del corpo, ne strutturano la sua configurazione. Misurare le dinamiche di inclusione, esclusione e attivazione della corporeità sia del produttore, sia del fruitore di immagini realizzate e visibili grazie a nuovi dispositivi, permette di verificare, legittimare, istituire e quindi mettere in essere le nuove pratiche della visione. Si tratta non solo di esaminare le aree e i saperi attraverso i quali le storie delle tecnologie presiedono alla formazione di una nuova visibilità, ma anche d'interrogarsi su come i diversi mezzi tecnologici influenzano la comparsa di differenti punti di vista nella storia della visualizzazione anatomica (Rose, 2001).

Le ricerche femministe che si focalizzano sull'immaginario clinico sostengono che questo processo sia il frutto di una costruzione sociale. L'immagine riflette le dicotomie di genere che si manifestano attraverso rappresentazioni stereotipate dei ruoli maschili e femminili, interiorizzate dalla società. Nel rapporto tra donne e tecniche di visualizzazione medica è l'intero processo di tecnologizzazione a essere considerato come tipo di costruzione non neutra, ma profondamente influenzata dalle relazioni di genere (Jordanova, 1989). Diverse autrici femministe, che si sono occupate del rapporto tra genere e scienza, quali Harding (1991), Fox Keller (1985), Donini (2000), mostrano come la tecnologia sia un processo in cui è possibile rintracciare la costruzione storica e culturale di dominio maschile. È all'interno di questo flusso relativo ai significati e agli usi delle tecniche e delle loro immagini che va investigato il processo di ingenerazione della tecnologia nella costruzione dei corpi femminili e delle loro identità (Demaria e Violi, 2008). In particolare, per chiarire la visibilità del corpo delle donne le analisi di Duden (1991), e di Petchesky (1987), si rivelano fondamentali. Entrambe le autrici sostengono che gli strumenti medico–visivo, applicati al corpo femminile, attuano un processo profondo di costruzione della rappresentazione corporea, tramite azioni di visualizzazione e di controllo.

Sulla base degli spunti teorici emersi dall'intersezione fra sociologia della medicina, Science and Technology Studies e comunicazione visiva, il presente articolo vuole mostrare come tale processo di ridefinizione dei corpi si massimizza nelle pratiche di laparoscopia ginecologica; campo emblematico in cui la scientificità clinica tenta di comprendere le dinamiche di produzione e condivisione dei saperi medico–scientifici contemporanei, fino a cogliere i processi biologici del corpo della donna con interventi tecnologici definiti mini–invasivi. Attraverso le applicazioni di tali trattamenti clinici s'instaura un completo svelamento dell'interno del corpo femminile, che perde la sua unità organica, si frantuma e accentua l'importanza di

ciascun organo, soprattutto di quelli sessuali e delle loro parti minime. In effetti, la laparoscopia è considerata la tecnica 'gold standard', vale a dire la migliore opzione diagnostica e operativa per diverse patologie del sistema riproduttivo femminile. Ovaie, cervice uterina, tube di Falloppio, sempre separati dal corpo originale, sono i soggetti privilegiati di queste operazioni tecniche.

In questo processo di 'tecnologia di generazione' – termini presi in prestito da De Lauretis per indicare come il corpo delle donne è 'generato nel genere'– l'obiettivo diventa quello chiarire come la tecnica della laparoscopia ha messo a disposizione dello sguardo clinico l'interno della corporeità femminile (De Lauretis, 1999, p. 99). Lo scopo principale di questa ricerca è quello, dunque, d'investigare le modalità attraverso cui il dispositivo laparoscopico stabilisce un modo di osservare e indagare il corpo della donna. In particolare, l'intento è esaminare le dinamiche della pratica laparoscopica che portano la corporeità femminile a costituirsi come oggetto di una serie di processi di ridefinizione di confini, limiti e possibilità, fino a divenire superficie visiva su cui è possibile decidere e intervenire.

2. Lo statuto delle immagini laparoscopiche. Un breve quadro storico.

Alla fine del 1800 l'ambito chirurgico e quello endoscopico s'incontrano e amalgamano poco a poco: accanto alla possibilità di osservare l'interno del corpo si sviluppa l'idea di una minimizzazione dell'invasività dell'accertamento diagnostico. Nel 1910, Hans Christian Jacobaeus, medico di Stoccolma, riporta la prima laparoscopia in un umano (Vecchio, MacFayden e Palazzo, 2000).

Benché siano numerosi i chirurghi che migliorano la tecnica e la rendono popolare, questa rimane limitata ad affezioni epato–biliari. Difatti, nella prima pubblicazione riguardante la pratica laparoscopica, *Instrumentation et technique de la coelioscopie gynécologique*, 1947, il ginecologo francese Raoul Palmer osserva che la laparoscopia:

'In ginecologia, non è stata utilizzata che per trattamenti ristretti o con dei risultati incompleti, a causa della disposizione particolare degli organi pelvici, i quali impediscono l'esplorazione dettagliata delle tube e delle ovaie senza alcuni artifici tecnici' (Palmer, 1947, p. 420, traduzione dell'autrice).

È l'utilizzo di tali artifici, quali l'impiego di un'ottica a visione laterale, e la posizione di Trendelenburg – in cui il paziente è supino, sdraiato in modo che la testa sia situata inferiormente a ginocchia e bacino – a fare della laparoscopia una valida metodica di esplorazione diagnostica (fig. 1).
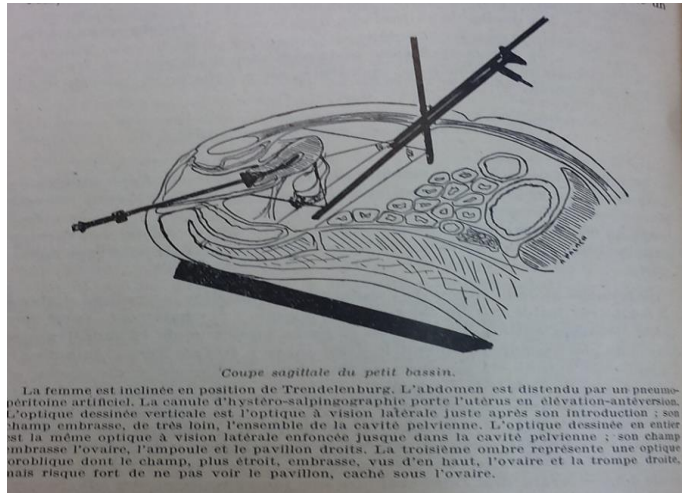
Figura 1   Instrumentation et technique de la coelioscopie gynécologique (Palmer, 1947, p. 426).
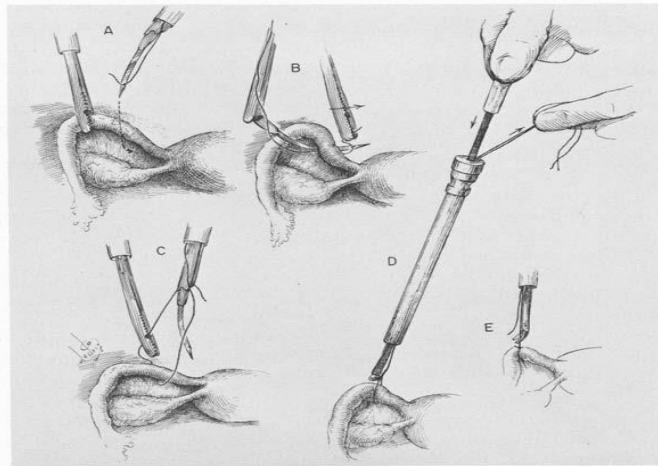
Figura 2   Laparoscopy. New instruments for suturing and ligation (Clarke, 1972, p. 275).

Nel 1972, il medico canadese Henry Clarke pubblica il resoconto del primo filmato laparoscopico nell'articolo *Laparoscopy – new instruments for suturing and ligation*. L'articolo racchiude due differenti livelli di testo: i risultati di visualizzazione della struttura intraddominale e la descrizione della tecnica sperimentale che permette tali esiti visivi. Il Dr. Clarke espone i principi e le modalità di esecuzione: la complessità del dispositivo si riflette nella tipologia delle illustrazioni, che certificano il corretto funzionamento dello strumento (fig. 2).
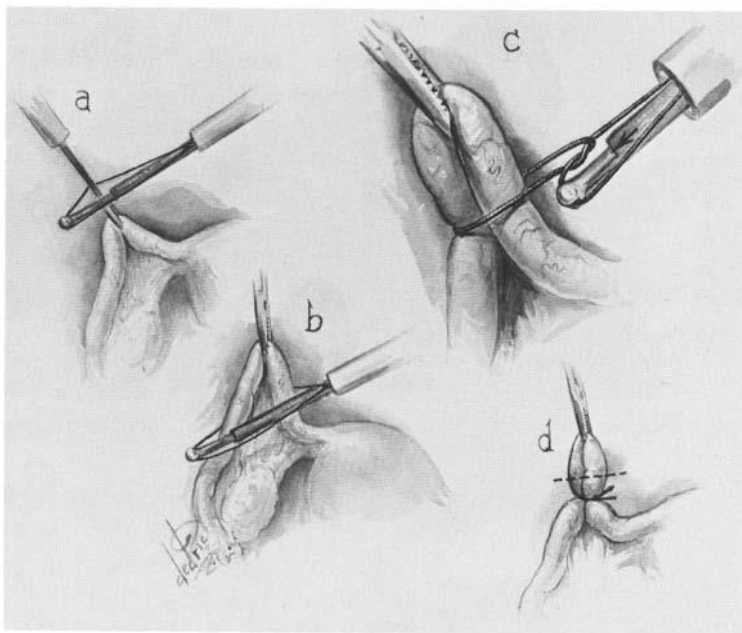
Figura 3   Laparoscopy. New instruments for suturing and ligation (Clarke, 1972, p. 275).

Si rivela fondamentale il movimento che l'osservatore non specialista deve compiere dalla didascalia alla figura e dalla figura alla didascalia: quest'ultima rappresenta una spiegazione ausiliaria capace di assegnare un significato alle pieghe e agli anfratti che attraversano le illustrazioni laparoscopiche, organizzandone il modo di lettura. D'altronde, l'intento di Clarke, non è necessariamente quello di rendere comprensibile ai lettori neofiti o inesperti in materia la morfologia anatomica interna, ma renderla solo più visibile. Oltre a definire lo spessore, la lunghezza, i diametri dei

tessuti corporei, il Dr. Clarke sottolinea come la pratica incrementa la possibilità d'individuare masse non percettibili o non palpabili. Ciò che si rivela interessante è il modo in cui è concepita la costruzione visiva delle immagini (fig. 2 e fig. 3), mostrate in serie, e quindi, destinate a confrontarsi per evidenziare contrasti e differenze. Per superare il problema della leggibilità, il medico sovrappone all'immagine delle indicazioni grafiche: le lettere alfabetiche, affiancate a una didascalia, permettono di comprendere le molteplici variabili della pratica; la struttura e la trama delle superfici anatomiche, la disposizione spaziale degli organi pelvici.

Alla fine degli anni 1980, la routine della pratica laparoscopica si accompagna a innovazioni tecnologiche atte a monitorare la rappresentazione degli organi interni, intensificandone la visione corporea. Da allora, il trasferimento delle immagini laparoscopiche sul monitor permette sia di eseguire tecniche chirurgiche sempre più complesse, sia l'intervento partecipato e attivo di medici e collaboratori. Difatti il monitor, derivato dal display delle tecnologie radar, consente di visualizzare in tempo reale un'informazione numerica, presentandosi come superficie in continua modificazione di stato (Gere, 2006). Anche secondo Manovich la superficie dello schermo si caratterizza per un'estrema 'temporalità' che aumenta le potenzialità di codifica, manipolazione e sviluppo dei dati:

> 'La novità di tale schermo è che l'immagine può cambiare in tempo reale, riflettendo le variazioni del referente, sia la posizione di un oggetto nello spazio (il radar), una qualsiasi modifica nella realtà visibile (la ripresa dal vivo) o la modifica dei dati nella memoria del computer' (Manovich, 2001, p. 133, traduzione dell'autrice).

Ad avere la funzione di trasmettere l'immagine a un monitor televisivo è la telecamera. Questa rappresenta l'occhio dell'operatore e, pertanto, le sue caratteriste qualitative sono fondamentali. La sua qualità è definita da 3 parametri: 1) sensibilità luminosa, 2) definizione, espressa dal numero di pixel che analizzano 3) risoluzione, numero di linee orizzontali per pollice. L'illuminazione, la differenza tra le aree più scure e quelle più chiare (il cosiddetto contrasto) e la nitidezza di un'immagine sono fattori che possono essere alterati o corretti attraverso la manipolazione dei pixel. L'immagine laparoscopica è, difatti, il prodotto di una codifica digitale su una superficie sintetica composta da un campionamento bidimensionale di pixel nello spazio, o secondo la definizione di Couchot, 'una collezione di numeri, ossia, di simboli prodotti sia da circuiti del computer che dai programmi' (Couchot, 1988, p. 192, traduzione dell'autrice). È questo corto circuito dell'immagine che non possiede un aspetto materiale (nemmeno quello del fascio di luce

proiettato sullo schermo, ma solo un fascio di pixel) a stabilire la relazione tra spazio dell'immagine e spazio della retina. Secondo Couchot (1988) l'immagine è, dunque, sottoposta a una duplice scissione, quella degli impulsi informativi visibili sullo schermo e quella delle operazioni tecniche di decodifica che le producono concretamente.

Un ulteriore e fondamentale indice di qualità dell'immagine laparoscopica è il rapporto tra segnale e disturbo, che è espresso in decibel: quanto maggiore è il suo valore tanto più pura è l'immagine. D'altronde già negli anni 1950, l'ingegnere Claude Shannon e il matematico Warren Weaver propongono un modello matematico e quantitativo della comunicazione, basato su un'idea fisica dell'informazione, nel quale si possono verificare delle inefficienze di codifica, sia a livello tecnico che semantico, generate da disturbi, frastuoni, 'sorgenti di rumore', che aumentano l'incertezza della ricezione (Shannon e Weaver, 1948, p. 381). Per ovviare a tali disturbi, un sistema digitale di elaborazione delle immagini si occupa di migliorare il contrasto e la nitidezza delle immagini video–laparoscopiche. Ciò permette una visualizzazione ottimale di strutture particolareggiate: il chirurgo può riconosce più facilmente gli organi, i loro limiti e contorni, e le strutture vascolari.

Se il momento della produzione e quello della ricezione non sono differenziati, perché lo stesso dispositivo può elaborarli contemporaneamente, la codifica delle immagini ha delle conseguenze sostanziali anche sul chirurgo, sopprimendo la distanza che separa l'immagine da colui che guarda sul monitor. Il requisito richiesto ad un monitor per poter essere utilizzato in chirurgia mini–invasiva è essenzialmente rappresentato da una buona definizione dell'immagine. È, dunque, la specifica morfogenesi della laparoscopia a fare di tale immagine un peculiare costrutto di rappresentazione esposto a dinamiche operative ben sottolineate anche dal teorico dei media Friedrich Kittler:

> 'A differenza del mezzo semi–analogico della televisione, non solo le linee orizzontali ma anche le colonne verticali sono risolte in unità di base. La massa di questi cosiddetti 'pixel' forma una matrice bidimensionale che assegna a ogni singolo punto dell'immagine una certa miscela di tre colori base: rosso, verde e blu. La natura discreta o digitale, sia delle coordinate geometriche che dei loro valori cromatici, rende possibile quell'artificio magico che separa la computer grafica dal cinema e dalla televisione' (Kittler, 2001, p. 32, traduzione dell'autrice).

Seguendo l'analisi condotta da Kittler, la laparoscopia è, piuttosto, un'immagine digitale discreta, i cui processi di codifica restano invisibili e sconosciuti al medico e al paziente. Più che sullo statuto dell'immagine e della sua trasformazione rappresentativa, l'accento di Kittler è posto sulla nuova possibilità operativa, resa possibile dalla specifica configurazione materiale e tecnica dell'immagine laparoscopica, dotata di una precisa predisposizione all'applicazione clinica. L'istanza su cui poggia l'immagine laparoscopica, qui presa in esame, è dunque la possibilità primaria di permettere di osservare o riguardare segni clinici fisiologici e patologici, alla quale si aggiunge la possibilità di visualizzare le proprietà di oggetti altrimenti invisibili all'osservazione diretta perché o troppo veloci, o troppo piccoli, in ogni caso, impercettibili all'occhio umano.

3. Laparoscopia e Web. Nota metodologica

Il riferimento al sostrato tecnico e visivo della laparoscopia costituisce certo un tassello fondamentale, ma ancora non consente di rintracciare chiaramente le dinamiche di questa pratica. In primo luogo, bisogna constatare che la tecnica laparoscopica si è diffusa anche grazie l'utilizzo delle recenti tecnologie di comunicazione, e tra queste la rete Internet; canale d'informazione medica (Medina, 2009). In particolare, sono i portali ospedalieri a diventare le principali lenti attraverso cui raccontare il nuovo scenario video–chirurgico (Hardey, 2004). Per rintracciare le direzioni cliniche del dispositivo laparoscopico e individuare come i siti web ospedalieri siano capaci di diffondere dati e immagini della nuova chirurgia mini–invasiva e le sue possibili evoluzioni, l'indagine ha scelto come luogo privilegiato di osservazione le pagine web dell'AOU Azienda Ospedaliera Universitaria Policlinico Federico II di Napoli. Caratterizzandosi per l'elevata qualificazione in campo ginecologico, l'ospedale universitario è, difatti, il più specializzato del Sud Italia ed è l'unico sul territorio nazionale a presentare, nel portale web GINEUNINA, una galleria di immagini e video, in cui i chirurghi del Dipartimento di Science della Riproduzione mostrano la pratica laparoscopica, diagnostica e operatoria.

Allo scopo di valutare la qualità comunicativa del sito, questa ricerca ha inteso utilizzare tecniche in sé proprie della sociologia visuale. Il primo modello proposto è quello delle 'Quattro I e Quattro C' del sociologo Giampaolo Fabris, strutturato in otto fasi, quali: identificazione, impatto, interesse, informazione, comprensione, credibilità, coerenza, convinzione

(Fabris 2007). Tale modello presenta le principali variabili che entrano in gioco nella definizione di un efficace atto comunicativo (Latini, 2007).

Un secondo livello di approfondimento è riservato alla dimensione testuale che, nella sua funzione ancillare alle immagini, consente una facile e reale consultazione del sito. Seguendo il paradigma di Peninou, lo studio semiologico del vocabolario è mirato all'individuazione del livello denotativo e connotativo del testo, consentendo la selezione e la classificazione dei segmenti testuali significativi (Peninou, 1970). Per massimizzare l'analisi del sito, è adottata, quindi, una strategia d'indagine fondata sulla 'triangolazione dei dati' (Denzin e Lincoln, 2000). In considerazione della combinazione tra montaggio del supporto verbale e messa in sequenza del codice visivo, si vuole descrivere come entrambi siano necessari per l'interpretazione complessiva della pratica laparoscopica. Le documentazioni testuali, oltre a fondamentale strumento di divulgazione e propaganda delle ricerche laparoscopiche, costituiscono un elemento indispensabile di ancoraggio per la polisemia e la complessità interpretativa del codice visivo della laparoscopia. La ricerca è, dunque, condotta attraverso l'interrogazione di un corpus eterogeneo, sia testuale sia iconografico. Tale percorso metodologico è, così, capace di mostrare come la rappresentazione del corpo presentato dal portale GINEUNINA e la retorica discorsiva che lo accompagna, palesa un modo stesso di intendere il corporeo e la costruzione di un suo nuovo tipo d'immaginario (Medina, 2011).

In coerenza con le finalità lavoro, e nello scopo di fornire uno strumento in grado di restituire dati, informazioni e contributi visivi chiari, sono stati tralasciati immagini e testi, tecnici e descrittivi, relativi alle altre tecnologie biomediche (stereoscopiche e oncologiche), presentate sul sito. Seguendo questo approccio, il perimetro del processo di raccolta dei dati è stato limitato in modo rigoroso.

4. Raccolta e analisi dei dati

Il portale GINEUNINA, nato per iniziativa del Dipartimento di Ostetricia, Ginecologia e Urologia, è stato completamente riaggiornato nel febbraio 2015. In primo luogo, si tiene conto dell'identificazione dell'Ospedale, valutata in termini di design del sito. L'analisi di web design di GINEUNINA è partita dal logo aziendale, collocato in alto a sinistra, poiché area maggiormente osservata in una pagina web. Si è rilevata, poi, la scelta del colore azzurro, nuance istituzionale dei servizi sanitari pubblici che permette

di avvalorare, a livello psico–cognitivo, la credibilità dell'istituzione ospedaliera (Colombo, 1989).

Parallelamente, si è proceduto a una selezione dei passaggi testuali più funzionali ed esplicativi.

Già sull'home page si può leggere che:

'I contenuti del sito hanno scopo informativo e non devono essere usati per diagnosi mediche o sostituirsi in alcun modo alla valutazione di un medico professionista' (Fonte: gineunina.it/dipartimento/).

Una tale premessa precisa fin da subito che lo scopo del portale GINEUNINA non si esaurisce nella semplice trasmissione di dati e immagini sulle strumentazioni ginecologiche. Il portale, infatti, enfatizzando le immagini mediche proposte, palesa l'interesse per la definizione dei processi tecnologici della laparoscopia prima ancora che dei risultati terapeutici.

In particolare, nella sezione 'attività' si può leggere che:

'La laparoscopia trova nella chirurgia ginecologica odierna sempre più indicazioni. La maggior parte delle patologie che in passato venivano trattate con la chirurgia tradizionale, oggi possono essere affrontate per via laparoscopica. Viene eseguita per giungere alla diagnosi in alcune condizioni cliniche che non si riescono a spiegare con altri metodi di indagine' (Fonte: gineunina.it/attivita/laparoscopia/).

Il sito evidenzia il ruolo assegnato alla tecnica, le evoluzioni della chirurgia mini–invasiva e le limitazioni sul fin dove spingersi: possibilità costantemente messe in discussione e mai stabilite in partenza, ma ridefinite nel corso di un procedimento clinico che si caratterizza sempre più come una sperimentazione tecnologica che procede per tentativi (Slatman, 2004).

Nell'intento di rintracciare i principi costitutivi della laparoscopia, in questa prima fase si è provveduto all'individuazione delle immagini, selezionate per le loro peculiarità documentative, nonché comunicative. Seguendo l'approccio proposto del modello 'Quattro I e Quattro C' di Fabris, si è operata un'analisi della vasta galleria presente sul portale, con lo scopo d'identificare quelle immagini che contribuiscono a chiarire come la lente della laparoscopia riconfigura il corpo e la sua interpretazione culturale e sociale. In tal senso, si è operata anche una selezione dei video che il portale GINEUNINA presenta sul canale di Youtube; account che oltre a permettere notevoli vantaggi a livello di visibilità, rappresenta un ancoraggio alle scelte terapeutiche da parte delle nuove fasce di pazienti.

Figura 4   Pratica Laparoscopica, GINEUNINA (Fonte: gineunina.it/gallery/).

Figura 5   Pratica Laparoscopica, GINEUNINA (Fonte: gineunina.it/gallery/).

L'attenzione posta sull'efficacia dell'esame e la rappresentazione panoramica di tutti i compartimenti pelvici è corroborata dai parametri figurati delle immagini laparoscopiche –quali accuratezza, specificità, nitidezza– che consentono di identificare le lesioni e di ridurre gli errori interpretativi (fig. 4 e fig. 5).

È interessante notare come le immagini laparoscopiche mirano a una descrizione visuale complessiva. Si tratta di un processo di visualizzazione in cui i tessuti corporei che si presentano sulla superficie dell'immagine sono appunto la traccia di un processo dinamico in cui si decide di mettere in luce alcuni aspetti a discapito di altri. Le immagini laparoscopiche, qui presentate, mostrano ciò che può essere realmente visto durante un

particolare stadio dell'operazione chirurgica da uno specifico punto di vista, cercando di rappresentare le forme corporee come dimostrazioni sintetiche di tessuti e porzioni, isolati dal resto. La pratica laparoscopica, infatti, potenziando le competenze del vedere in campo medico, trasforma i corpi, o meglio i suoi organi, in pura istanza rappresentativa. Attraverso questo strumento di ausilio medico, il corpo, oltre a divenire totalmente visibile, si fa, dunque, divisibile; le parti non sottoposte a interesse clinico vengono eliminate, aumentando l'effetto di parcellizzazione e trasformando la superficie corporea in elementi e in brandelli fisiologici. Il corpo è sezionato, disarticolato in una decostruzione d'immagini di differenti elementi organici staccabili; tasselli di composizione autonoma, ciascuno dei quali può essere preso contemporaneamente come principio, ma anche come fine. L'iconografia laparoscopica dà forza, allora, a uno sguardo continuamente nuovo sul corpo della paziente che si trova a somigliare sempre più a segni iconici non facilmente identificabili. In nome della crescente fedeltà dell'anatomia e della concretezza rappresentativa, la corporeità è ridotta nel perimetro di rappresentazioni frammentate. Si tratta di un lavoro di de–frammentazione –termine intenzionalmente preso in prestito dall'informatica– che consiste nel riorganizzare il corpo in smisurate superfici in cui lo sguardo dell'osservatore si smarrisce. Le immagini presentate sul sito costituiscono traduzioni di porzioni del corpo visto attraverso le particolari convenzioni tecniche della laparoscopia, mostrate senza mediazioni entro i limiti del medium.

Inoltre, sul sito di può leggere che:

'La laparoscopia è una tappa d'obbligo nell'iter diagnostico sull'infertilità. Infatti, solo con la laparoscopia è possibile documentare la normalità degli organi pelvici' (Fonte: gineunina.it/attivita/laparoscopia/).

Il sito enfatizza l'elevata capacità della laparoscopia di formulare una diagnosi precisa e al tempo stesso mirata a preservarne l'apparato genitale. Tuttavia, il corpo femminile esiste nelle immagini solo come entità digitale frammentata: si tratta, difatti, di un tipo di visualizzazione che penetra fino all'interno dei tessuti corporei della donna, privata della pelle e dei muscoli, per appiattirla in una riduzione metonimica (fig. 6 e fig. 7).
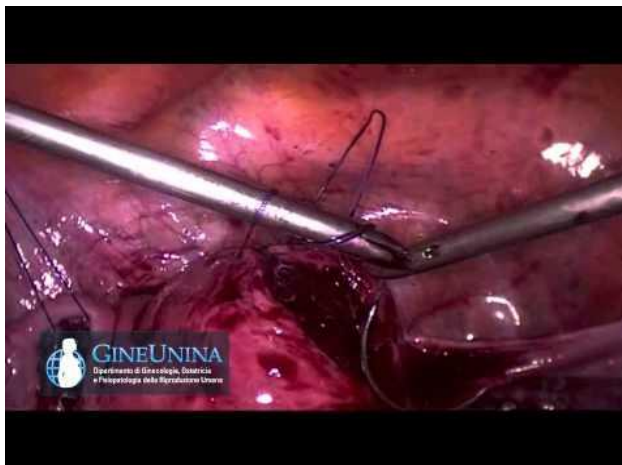
Figura 6   Pratica Laparoscopica, GINEUNINA (Fonte: gineunina.it/gallery/).

Quando si mostra il corpo della donna si visualizza soltanto la struttura di muscoli, mucose e tessuti fibrosi che rivestono l'utero, le salpingi e le ovaie. Sono gli interrogativi, posti da Anne Balsamo, a denunciare come il genere, pur non essendo collocabile negli organi genitali, s'incarna attraverso pratiche discorsive, tecnologiche e figurative che mettono in atto una specifica costruzione del corpo femminile:

> 'Quando il corpo è frammentato in organi, in fluidi e in codici genetici, cosa succede all'identità di genere? Quando il corpo è frammentato in parti funzionali e codici molecolari, dove si colloca il genere? Qual è il rapporto tra le parti del corpo ricostruite e l'identità di genere?' (Balsamo, 1996, p. 5, traduzione dell'autrice).

L'imperativo categorico della pratica laparoscopica, come presentata sul sito GINEUNINA, non potrebbe essere più evidente nella sua capacità di rafforzare la visione dualistica del sesso/genere. Attraverso le immagini mostrate sul sito, la laparoscopia diventa una tecnica, il cui ruolo principale è quello di cartografare in modo funzionale il corpo della donna. Corpo, che non è semplicemente visto, presentato in immagine e descritto, ma costruito secondo una modalità che influisce anche sulla maniera attraverso la quale esso è esperito. La tecnica laparoscopica, difatti, circoscrive e definisce la materia corporea in organi e apparati, attribuendo loro funzioni e significati riproduttivi. In questo senso, la laparoscopia applicata al corpo della donna palesa come la tecnologia traccia con precisione il processo

profondo di costruzione della rappresentazione corporea, tramite azioni di visualizzazione e di controllo.
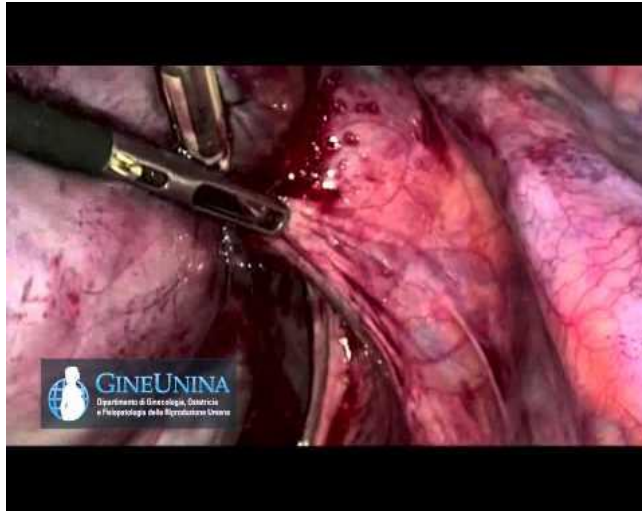
Figura 7   Pratica Laparoscopica, GINEUNINA (Fonte: gineunina.it/gallery/).

5. Conclusioni

Abbiamo visto come la laparoscopia rappresenta una delle principali evoluzioni della chirurgia mini–invasiva: attraverso i recenti avanzamenti tecnologici, essa è in grado di fornire informazioni inedite sulla configurazione e la struttura delle diverse realtà anatomiche, normali o patologiche. Tale pratica, infatti, realizza un nuovo registro cartografico del corpo, che si trasforma in un territorio da decodificare in rappresentazioni digitali. In primo luogo, la profonda trasformazione delle immagini sulle quali il medico si trova a operare ha richiesto l'elaborazione e l'affinamento di tutta una nuova serie di approcci all'interpretazione del corpo: se da un lato la trasformazione in pixel e l'assoggettamento ad algoritmi e a operazioni di tipo matematico sottopongono l'immagine corporea a una manipolabilità totale, dall'altro provocano una radicale destabilizzazione del corpo, sempre più frammentato dalla tecnologia.

In particolare, l'analisi del portale GINEUNINA ha permesso di osservare come le immagini laparoscopiche si pongono sia come un prodotto comunicativo che clinico. Nel primo caso, le retoriche visive negoziate dal portale contribuiscono a dimostrare l'eccellenza, in termini di efficienza e di

qualità delle prestazioni della pratica laparoscopica eseguita nel Dipartimento. Da un punto di vista clinico, invece, tali visualizzazioni non sono soltanto una rivelazione delle parti nascoste del corpo, ma una costruzione d'immagini fabbricate in funzione delle regole della tecnologia laparoscopica che contribuisce ad avvalorare un'ipotesi medica, conferendo all'accertamento sanitario un carattere esplicativo immediato. In tal senso, le immagini laparoscopiche acquisiscono una valenza fortemente diagnostica, oltre che chirurgica. L'immagine, oltre a mostrare la meticolosità della contemporanea anatomia del particolare e la necessità di sistematizzare nuove esperienze e conoscenze, presenta l'attuale transizione dalla rappresentazione all'intervento sui corpi, e palesa come la comprensione della paziente passa nel modo in cui la medicina tratta e raffigura il corpo. D'altronde, la volontà di adottare un approccio teorico basato sulla connessione tra la sociologia della medicina e gli studi sociali e culturali sulla scienza e la tecnologia è stata motivata dall'intento di cogliere le dinamiche che portano le conoscenze cliniche, i dispositivi tecnologici e le immagini da essi prodotti, a riconfigurarsi reciprocamente. Con tale ricerca mi sono, così, inserita nella continuità di questi fondamenti epistemologici, soffermandomi sulla ricorsività mimetica tra tecnologia e immagini laparoscopiche. In particolare, ho insistito su come il corpo, prima di essere un costrutto medico è, innanzitutto, una costruzione culturale. Tuttavia, ho cercato anche un distacco da tali assunti teorici, nell'intento d'inquadrare la pratica laparoscopica come mezzo capace di valicare la frontiera della conoscenza anatomica, producendo nuove corpografie. Di conseguenza, mi pare lecito pensare che la laparoscopia postula l'imprescindibilità dell'atto del vedere nell'acquisizione e nella comunicazione delle conoscenze relative a una corporeità trasparente, malleabile e frammentata. Queste tre ultime caratteristiche si fanno ancora più dense e istruttive nell'iconografia medica legate all'apparato riproduttivo: organi genitali, quali ovaie, cervice, tube di Faloppio, sono oggetto di ingrandimenti e esplorazioni. In questa situazione di continuo mutamento e ridefinizione mediale, l'osservazione laparoscopica del corpo della donna mi ha permesso di evidenziare come lo sguardo, oltre a frammentare il corpo, difficilmente riesce a sfuggire al retaggio di soggiogazione da parte di una visione clinica che considera la corporeità femminile al pari di un oggetto (Pizzini, 1999). È in tale contesto che uno degli interrogativi di base di questo lavoro: 'la pratica laparoscopica e le sue rappresentazioni sul sito GINEUNINA conserva ancora stereotipi di genere?' trova una risposta sicuramente affermativa. Pur traendo origine dalla volontà di predisporre uno strumento capace di render conto dei meandri

del corpo femminile, ho voluto mostrare come le immagini cliniche, qui analizzate, siano costruite secondo uno sguardo che incorre nell'errore di stabilire esclusive forme di costruzione identitaria. In questa visione, le immagini sono il risultato di una costruzione culturale che dà vita a un binarismo sesso/genere, rinforzando l'idea di un legame preferenziale fra la natura biologica del corpo femminile e la definizione dell'essere donna. Nonostante le nuove modalità tecnologiche di riscrittura del corpo fisico messe in scena dalla laparoscopia, la corporeità femminile è continuamente decodificata come fattore sessuale e l'utero continua a significare il genere femminile, inteso come eminentemente riproduttivo.

Bibliografia

Akrich, M. (1993) Les formes de la médiation technique. *Réseaux*, 11 (60), 87–98.

Balsamo, A. (1996) *Technologies of the Gendered Body: Reading Cyborg Women*. Durham: Duke University Press.

Burri, R.V. (2012) Visual Rationalities: Towards a Sociology of Images. *Current Sociology*, 60 (1), 45–60.

Burri, R.V. e Dumit, J. (a cura di) (2007) *Biomedicine as Culture. Instrumental Practices, Technoscientific Knowledge, and New Modes of Life*, London: Routledge.

Cartwright, L. (1995) *Screening the Body. Tracing Medicine's visual culture*. Minneapolis: University of Minnesota Press.

Clarke, A. (2010) *Biomedicalization: Technoscience, Health and Illness in the U.S*. Duhram: Duke Universitu Press.

Clarke, H.C. (1972) Laparoscopy. New Instruments for Suturing and Ligation. *Fertility and Sterility*, 23 (4), 274–277.

Colombo, F. (1989) *I persuasori non occulti*. Milano: Lupetti.

Couchot, E. (1988) *Images: de l'optique au numérique: les arts visuels et l'évolution des technologies*. Paris: Hermes.

Crabu, S. (2014) Nanomedicine in the Making: Expectations, Scientific Narrations and Materiality, *Tecnoscienza. Italian Journal of Science & Technology Studies*, 5 (1), 43–66.

Crary, J. (1990) *Techniques of the Observer: On Vision and Modernity in the Nineteenth Century*. Cambridge: MIT Press.

De Lauretis, T. (1999) *Soggetti Eccentrici*. Milano: Feltrinelli.

Demaria, C. e Violi, P. (2008) *Tecnologie di genere. Teoria, usi e pratiche di donne nella rete.* Bologna: Bononia University Press.

Denzin, N.K. e Lincoln, Y.S. (a cura di), (2000) *The Handbook of Qualitative Research*. Thousand Oaks: Sage.

Donini, E. (2000) La costruzione culturale delle scienze della natura. Generi, soggetti e fatti storici. In Porzio Serravalle*, E.* (a cura di), *Saperi e libertà. Maschile e femminile nei libri, nella scuola e nella vita.* Milano: AIE.

Duden, B. (1991) *Der Frauenleib als öffentlicher Ort. Vom Mißbrauch des Begriffs Leben*. Hamburg: Luchterhand.

Fabris, G. (2007) *La pubblicità. Teoria e prassi*. Milano: Franco Angeli.

Fox Keller, E. (1985) *Reflections on Gender and Science*. New Haven: Yale University Press.

Gere, C. (2006) Genealogy of the computer screen. *Visual Communication*, 5 (2), 141–152.

Hardey, M. (2004) Internet et société: reconfigurations du patient et de la médecine? *Sciences sociales et santé*, 1 (22), 21–42.

Harding, S. (1991) *Whose Science? Whose Knowledge?* New York: Cornell University Press.

Kemp, M. (1999) *Immagine e Verità. Per una storia dei rapporti fra arte e scienza*. Milano: Il Saggiatore.

Kittler, F. (2001) Computer Graphics: A Semi–Technical Introduction. *Grey Room*, 2, 30–45.

Latini, G. (2007) *Forme digitali*. Roma: Meltemi.

Manovich, L. (2001) *The Language of New Media*. Cambridge: MIT Press.

McLuhan, M. (1964) *Understanding Media*. New York: McGraw Hill.

McLuhan, M. (1969) The Playboy Interview: Marshall McLuhan. *Playboy Magazine*, 1–23.

Medina, P. (2009) La communication institutionnelle online dans les organisations hospitalières. Le cas des hôpitaux belges francophones. *Recherches en communication*, 32, 171–180.

Medina, P. (2011) La diffusion online de la marque hospitalière : le cas des hôpitaux français. *Quaderni*, 74, 97–104.

Mulvey, L. (1975) Visual Pleasure and Narrative Cinema. *Screen*, 16 (3), 6–18*.*

Palmer, R. (1947) Instrumentation et technique de la coelioscopie gynecologique. *Gynecology Obstetic*, 46 (4), 420–431.

Panese, F. (2009) Décrire et convaincre: rhétoriques visuelles de la cinématographie en médecine. *Gesnerus,* 66 (1), 40–66.

Peninou, G. (1970) Physique et métaphisique de l'image publicitaire, *Communication*, 15 (1), 96–109.

Perrotta, M. (2012) The Study of Technoscientific Imaging in STS, *Tecnoscienza. Italian Journal of Science & Technology*, 3 (2), 163–175.

Petchesky, R.P. (1987) Fetal Images. The Power of Visual Culture. *Feminist Studies*, 13 (2), 263–292.

Pizzini, F. (1999) *Corpo medico e corpo femminile*. Milano: FrancoAngeli.

Romeyer H. (2008) TIC et santé: entre information médicale et information de santé. *Revue tic&société*, 2 (1), 26–44.

Rose N. (2001) Biopolitics in the Twenty First Century: Notes For a Research Agenda, *Distinktion: Scandinavian Journal of Social Theory*, 2 (3), 25–44.

Shannon, C. e Weaver, W. (1948) A Mathematical Theory of Communication. *Bell System Technical Journal*, 27 (3), 379–423, 623–656.

Slatman, J. (2004) L'imagerie du corps interne. *Methodos*, 4, 2–13.

Terranova, T. (2006) *Cultura network. Per una micropolitica dell'informazione*. Roma: Manifestolibri.

Timmermans, S. e Berg, M. (2003) The Practice of Medical Technology. *Sociology of Health & Illness*, 25 (3), 97–114.

Toffoletti, K. (2007) *Cyborgs and Barbies Dolls. Femminism, Popular Culture and the Posthuman Body*. London: I.B. Tauris & Co.

Van DijK, J. (2005) *The Transparent Body. A Cultural Analysis of Medical Imaging*. London: University of Washington Press.

Vecchio, R., MacFayden, B.V. e Palazzo, F. (2000) History of Laparoscopic Surgery. *Panminerva Med*, 42 (1), 87–90.

Waldby, C. (2000) *The Visible Human Project: Informatics Bodies and Posthuman Medicine*. London: Routledge.

Wilgren, M. (2001) Health Discussion on the Internet: A Study of Knowledge Communication through Citations. *Library and Information Science Research*, 23 (4), 305–317.

SECTION III

Enacting Objects, Infrastructures, and Innovation

Enrolling and Translating: Experiences of Using ANT in an Educational Research Setting

Victoria M. GORTON[*][a]

[a] Lancaster University

In the thirty years since the introduction of Actor–Network Theory (ANT), there have been radical developments in its characterisation and scope. These changes have fractured ANT into numerous waves – ANT, Post–ANT, ANT–ish (Fenwick and Edwards, 2010) – each of which is self–identifiable yet nonetheless tied to a shared notion of ANT. This paper strips away the excess terms that each wave has developed focusing instead on the central common concepts of 'enrolment', 'translation', (both following from Callon, 1986) as well as 'actor' and 'network' (despite their problematization by Latour, 1999a).

Here these terms are examined from the position of an early–career researcher using ANT for the first time. Drawing on my own work looking into the actor–networks that are used to conceptualise and perform quantitative methods teaching–learning in UK Higher Education, I offer my experience of using these terms in an Educational Research setting. Within this research setting, ANT is rarely applied, giving a new arena upon which to re–evaluate the usefulness of these terms. I explore not only their potential to facilitate analysis for this research question but also ask how these terms can be applied to describe our own relationship with ANT.

***Keywords**: ANT; methodology; early–career researcher; educational research*

Introduction

'You're using Latour? I always think that's so old school STS.' I could start this paper with a glorified description of the 1980s; a time that saw the commercialisation of the personal computer and the development of the Internet, and onto this scene place the Center for the Sociology of

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[*] Corresponding author: **Victoria Gorton** | e–mail: **v.gorton@lancaster.ac.uk**

Innovation. Ending by drawing out the parallels between the development of Actor–Network Theory (ANT) and this time of networks and globalisation.

However, this is not my experience of using ANT. I did not choose to adopt early ANT based on a nostalgic harking back to the past. To be 'old school'– as one colleague put it – as within Educational Research settings ANT is still a relatively new and underused theoretical stance (incidentally I did not choose ANT for its newness either) (Fenwick and Edwards, 2010). Hence, I find myself oddly positioned as both out of date – to some of my STS colleagues – *and* avant–garde – to some of my Educational Research colleagues. Thus, I suggest we imagine retro–ANT not as a travelling back, but as a sampling/borrowing of the past into the present/future. Recycling. Reimagining. Re–evaluating.

Here I aim to explore several key ANT terms – actor, network, enrolment, and translation – from the position of an early–career researcher using ANT for the first time. Despite their importance in ANT, these are terms that I have grappled with throughout my own research. Instead of providing new or alternative definitions to these terms, I seek to give a relatable account of the experience of performing these terms, evaluating their ability not only to help deliver on research questions but to enrol us – the researchers – into ANT, and ANT into our research.

Exploring the actor–networks of quantitative methods

My research aimed to understand how quantitative methods are conceptualised and performed within UK Higher Education (H.E.) Social Science subjects. Within the UK an increasing number of jobs require advanced quantitative skills (Mason, Nathan and Rosso, 2015), yet there remains a shortage of quantitatively skilled workers (Winterbotham et al., 2014).

This skills deficit is often understood as being a problem of education and training provision across all levels (Department for Education, 2010; Mason, Nathan and Rosso, 2015; Tu et al., 2016; Vorderman et al., 2011). Within universities, quantitative content of courses is increasing (ACME, 2011) and increasing attention is being given to align skills taught within degrees to those skills desired by employers (Mistry, White and Berardi, 2009).

Improving the skills provision within H.E. has tended to focus around three key areas: GCSE Mathematics course content and the two–year gap

between compulsory mathematics education and university enrolment; mathematics/statistics anxiety (Onwuegbuzie and Wilson, 2003); and difficulties with the teaching–learning of the quantitative material itself (Garfield, 1995; Garfield and Ben–Zvi, 2007; Williams et al., 2008).

My research arose from dissatisfaction with several key assumptions made by this literature. Firstly, that there is a shared understanding of what quantitative methods are, and that this understanding is unified across disciplines and sectors. Secondly, the prioritisation of human actors in the narratives of the teaching–learning environments – often teachers are seen as the only characters able to create change. Learning is characterised as a non–problematic interaction between active teachers and passive learners, with little reference to the role of software, infrastructure, or the quantitative methods.

'Why ANT? What is it doing here?'

To begin to problematize these assumptions I turned to ANT. Despite repeatedly being asked incredulously 'Why ANT?' my choice has remained steadfastly simple. ANT offers a different stance on the world. It sees everything around us as being comprised of networks of actors, or actants. Actors can be anything, including conceptual or symbolic ideas (i.e. Mol, 2002), 'that acts or to which activity is granted by others' (Latour, 1990, p. 275). Critically, all actors, human or non–human, have the same potential agency over a network.

But actors are not only individual entities, as Callon, Law and Rip describe, 'the actor is both the network and a point therein' (Callon, Law and Rip, 1986, p. xvi). The agency of actors stems from their relations to other actors in networks and their ability to construct and manipulate the networks they are present within and constructed from (Callon and Latour, 1981). The network represents a shift away from previous hierarchical social theories. It is an arrangement that 'has no a priori order relation' (Latour, 1990, p. 4) nor which exists within an enclosing aether. It reimagines concepts of distance, borders, macro/micro divisions. As Latour puts it 'the only question one may ask is whether or not a connection is established between two elements' (Latour 1990, p. 4).

This application of Deleuze and Guattari's (1987) concept of the rhizome, has perhaps been one of the most criticised aspects of ANT. Drawing attention from feminist scholars who highlighted that in this imagining the ever–present other was erased (Lee and Brown, 1994), and that these accounts presented a grand narrative where the positionality of the

researcher was moved. In early ANT the network was all encompassing, however others have since drawn attention to the multiplicity and partiality of networks (Gad and Bruun Jensen, 2010).

Actor–networks form through a process of translation, whereby actors make connections and establish communication (Brown, 2002). As Callon (1986, p.28) describes 'to translate is to speak for, to be indispensable, and to display. […] Successful translation quickly makes us forget its history'. Here we see that translation is not only about the bringing together of actors, in networks, but that it is a process of transformation, where actors are changed though their movements (Gad and Bruun Jensen, 2010), where prior identities are manipulated, and broken. As such actors can be present in multiple networks in different ways, simultaneously being one and multiple.

While translation describes how entities relate to one another, actors are brought into and positioned in a network through enrolment (Law, 2000). Enrolment is a way of facilitating the growth of an actor–network, as Callon and Latour (1981, p. 296) explain 'in order to grow we must enrol other wills by translating what they want and by reifying this translation in such a way that none of them can desire anything else any longer'.

This is not a politically neutral activity. During enrolment actors own goals and interests may become displaced, as mutual concessions occur in order to reach a point of agreement (Callon, 1986). As Callon and Law (1982, p. 662) explain 'the theory of enrolment is concerned with the ways in which provisional order is proposed, and sometimes achieved'. This is a process whereby new political orderings are achieved or reinforced, and through which certain actors become seen as the cause of the network's effects (Murdoch, 1997). It is through this manipulation of order and prominence of other actors that actors are able to formulate their own space–times. In order to stabilise, or become black–boxed, actors must become enrolled in the network, with their goals being translated, mediated, and aligned in order to form stable actor–networks.

Overall, ANT is not just a theoretical language but a stance on how to understand the world around us (Gad and Bruun Jensen, 2010). Influenced by the sociology of scientific knowledge, ANT is a 'ruthless application of semiotics' (Law 1999, p. 3), encouraging us to follow and trace out the networks that are hidden or black–boxed within objects (Latour, 1994) or debated (Besel, 2011). It reimagines just who can have power in these networks, giving humans and non–humans equal agency, and understands

that these networks are dynamic, and constantly performed (Bleakley, 2012).

For my research ANT offered potential to bring a different stance to research into quantitative methods teaching, giving voice to the numbers, notation, tests, and worksheets that are involved in teaching–learning environments in H.E.. To bring the performative turn (Thrift and Dewsbury, 2000) to this field of educational research, which was populated by flat, caricatures of learners and teachers. ANT provided a mechanism for challenging and problematizing the pre–existing literature on Quantitative Methods teaching, which seemed to have ignored the central question of what quantitative methods are, and how they are enacted.

A note on ANT in educational research

Within Education Research, ANT has had a limited uptake. In the last thirty years, while ANT application has boomed in fields such as geography, design, and STS, there have been a handful of studies that have used ANT in education settings. These studies have tended to focus either on identifying key actors that are involved in educational settings (Hamilton, 2011; Vickers and Bailey, 2006) or in tracing out networks (Gorur, 2011; Kamp, 2012).

A key landmark study in the area was Nespor's (1994) ethnographic study of Management and Physics university programmes. Through following students' movements through these programmes Nespor illustrates how different time–spaces are created within each discipline. In Physics, the programme organised students' socio–material realities to create strong, and exclusive within course social bonds. In comparison, the Management course fractured students' academic spaces. The department building mimicked that of a corporate office and professors cultivated particular business dress codes and behaviours, distancing themselves from academia and prioritising the separated business world. Nespor's study represents one of the few applications of ANT into an educational research setting which foregrounds both the actors and networks as frameworks of power, not simply as components of a system.

Since Nespor's text, ANT has been gradually applied to a range of educational contexts giving rise to Fenwick and Edward's (2010) textbook. Despite Mlitwa's (2007) identification of the benefits of ANT over the more popular activity theory, Fenwick and Edward's remains the only introductory text to ANT in educational research.

For this research, I adopted a broadly ethnographic approach to understand the actor–networks comprising quantitative methods within

H.E. Social Science subjects. Data was gathered from four disciplines during the 2014–2015 academic year within a top–ten UK University. In total, 32 interviews and concept maps were completed with staff and students, to gain an understanding of the performances of quantitative methods within their disciplines. In addition, 59 hours of observation was completed of the formal teaching–learning environments (i.e. lectures, seminars/tutorials, workshops) of 16 different modules across the four different disciplines – economics, criminology, geography and psychology. Finally, a range of course documentation was gathered and analysed, including material from handouts, course descriptions, and course handbooks. All material was coded within Atlas.ti, with these codes being used to develop network diagrams to give a relational understanding of the codes. Alongside this, following Latour's (2005) four notebooks, writing trials were performed to develop and refine the understandings of quantitative methods in H.E.

Stage 1: labelling/identifying

Like Latour and Woolgar's 'observer' (1979, p. 41) or anthropologist (Latour, 1999b), I went out into the field, equipped with notebook, coloured pens, dictaphone, and identification key – ANT. In these early stages, ANT had told me what I should be trying to spot, and, at least theoretically, how to spot these things. The literature seemed clear that these actor–networks were there to be seen, traced, or followed.

I had my way into this network – the courses taught that contained quantitative methods. Given this starting point, I began struggling to recruit participants through email lists (Meho, 2006) – meeting those actors who would later become identified as spokespersons for the quantitative methods, and attending the sites of performance of quantitative methods. Yet all I was able to see was the interactions described by the very authors whose work I was so critical of. I could not see actors. I could just see lecturers and students.

I began interviewing staff and students, hoping that they would provide me with a fleeting image of these actors, or networks, I did not care which. During most of these interactions, I chose to explain my research aims without reference to ANT. At this point, I was still struggling to explain ANT to myself, and worried that describing ANT could lead my participants' responses. I was already aware of a distance between my participants and myself, who were often critical of my choice of qualitative methods and wary of my role as observer – was I secretly reporting on their performance?

Explaining that yes I did genuinely believe that the t–test, whiteboard, or handout, in that week's class had as much, if not more, power or agency over the teaching–learning environment as they did, seemed stretching their faith too far. However, in making that choice I widened the distance and became forced to constantly translate between the everyday world and the ANT world. To learn to see/speak/be in the ANT world.

Both while conducting my fieldwork and when focusing on my analysis, the easiest place to start had always seemed to be the actors. After all, so many studies had provided lists of them in educational research contexts (i.e. Fox, 2009), and in classic texts readers were advised to simply 'follow the network…or to follow the actors' (Ruming, 2009, p. 453). But my research had never sought to follow the central actor (Quantitative Methods) through time(–space) as these accounts often did, instead I aimed to travel across disciplinary space(–times). In doing this, instead of gaining insight into the interactions going on between actors I found myself surrounded by ever–growing lists of actors, skeptical of the power any of these actors really had in performances of quantitative methods. It did just seem to be teachers teaching, and learners learning.

Learning the language

At this point, ANT seemed like a inappropriate theory to apply in an educational research setting, after all it was developed to study scientists not education. My research had none of the usual STS accessories; there were no new or failed cyborg technologies in these lecture theatres. Apart from labeling things as actor and drawing sketches of possible ways these actors could be arranged in networks I had little to show for the glorious insights I had thought ANT was going to give me.

Of course these early problems were not just a result of my choice of theoretical framework. Researchers have long called attention to the difficulties of building rapport with participants (Clarke, 2006), of being an insider/outsider (Dwyer and Buckle, 2009), of acting the researcher (Mulhall, 2003), and of conducting research with more powerful elites (Campbell, 2003).

In working with ANT, however, I had to become enrolled into it. I had to displace my own prior understandings of the world to see and think not in terms of people, but of actors. I had to learn to follow its order of how the world is. To use its labels. To learn to translate into its language.

Here, we, as researchers, are ANT's researchers. We must become enrolled into it. It has the power over us by providing a language and

theoretical model of the world. But simply labeling the world as ANT sees it is not *doing* ANT. At this stage ANT was simply a tool for describing the world, but ANT is not just about describing the things in the world according to labels. After all, as Latour says, 'a good ANT account is one where all the actors do something' (2005, p. 128).

Stage 2: mapping power/action

By this point I had begun to identify human, and more importantly in my case, non–human actors. Yet I felt I was simply reproducing stories that had already been told. In one meeting when asked by my supervisors how I felt about the piece I had written I could only comment that it still 'wasn't ANT enough'. To try to remedy this, I started, in desperation, retracing my steps through the literature searching for what *was* ANT enough.

It was at this point, roughly two and a half years in, that I found other researchers uttering discontent with ANT (Hitchings and Jones, 2004). They clarified what I had begun to suspect while re–reading classic ANT texts, namely that these accounts were presented with almost no reference to methodology – in Laboratory Life (Latour and Woolgar, 1979) the reader is furnished with two paragraphs on the subject. But in contrast to those trying to critique ANT, Hitchings and Jones went further to hypothesize reasons for this methodological silence. Reasons included: a greater interest in the theoretical or philosophical contributions of the work; the use of ethnographic methods, which were commonly methodologically underdeveloped; and favoring narrative styles of reconstruction which foregrounded new entities and backgrounded the author.

Revisiting my own data I saw that the accounts I was producing were not 'ANT enough' because they were reproducing pre–existing understandings of the power dynamics within quantitative methods teaching–learning. I was ticking things off from the identification chart but doing no more. I was not translating or enrolling ANT, into my own research.

In focusing on what actors and networks there were, I had overlooked the power dynamics of these networks, or to use Latour's phrasing, I had overlooked 'the sort of action that is flowing from one [actor] to the other' (2004, p. 64). I began to trust that these actors did have equal potential agency over one another, and more importantly that non–humans could have more power than human actors. That quantitative methods were not always a passive actor there to be learnt. In certain situations quantitative methods were enrolling lecturers to talk about them in specific ways. In

others, worksheets were enrolling both lecturers and students into shared performances of *doing* quantitative methods (not simply learning), and that different disciplinary learning performances were (re–)producing different quantitative methods research ontologies. Points I was able to discuss with curious participants in later interviews, narrowing the distance I had created earlier in my research.

Learning to think in different directions

This shift was not, as is often presented in the literature, a clear seeing of the actor–networks. Instead this process involved a messy process of looking at my data in different directions. In my early writing/thinking I had started from the point of those actors that drew the most attention – the lecturing staff, the students, the computers – and worked my way around network diagrams linking actors together. But as Laurier and Philo explain ANT is about bringing other entities out from a 'shadowy domain' (1999, p. 1056). It is about making *all* the actors work, not just those that are the most visible.

One of my first moments of getting ANT to work for me was realizing that in the narratives I was producing, little reference was made by teachers, learners or in the teaching–learning interactions to the raw data that these quantitative techniques were applied to. The techniques themselves were controlling the teaching–learning environments and enrolling staff and students into producing understandings that these techniques were what quantitative methods were all about. Similarly, in considering that, as in Latour's (1993) Pasteur, actors often enroll other actors as spokespersons, I was forced to retrace my understanding of power in the classroom: What if teaching staff were not the ones in control? What if they were simply spokespersons for other actors, namely the quantitative methods?

In re–assigning power in the networks I had mapped I was enrolling ANT into my research setting. After struggling to learn the language I was now able to translate ANT into my own actor–networks, and to create an engaging narrative (Latour, 1988) that met my aims instead of reproducing the narratives of surrounding quantitative methods education literature or the narratives of ANT about the world around us.

Concluding thoughts

I started by stating that I did not want to travel back in time, that I had inadvertently become positioned as doing retro–ANT, whilst feeling I was

simply trying to do ANT. Yet there is something retro or vintage about this tale. An appreciation that the benefits of ANT remain unchanged no matter what the research setting. It has an ability to transform our understanding of situations in new and unexpected ways. These simple terms, actor, network, enrolment and translation, represent some of the theoretical standpoints/sensibilities ANT has given, and continues, to give us.

However, these terms, and ANT, do not do the research for us. As Latour (2004, p. 62) puts it: 'it does not say anything positive on any state of affairs'. This account has traced through the experience of a novice researcher applying ANT to a research setting for the first time. I have characterised two stages in my relationship working with ANT: one of translating and being enrolled *by* ANT and another of translating and enrolling *ANT*.

In writing this paper I have tried to provide a relatable account of working with ANT, including the difficulties of learning a new language and translating that language between different actors, which can be especially difficult with participants who are resistant to the agency of non–human actors. These are difficulties that, whilst almost universally experienced, are all too easily forgotten or excluded in the reporting of our research.

This process is not unique to working with ANT. However, few theories give a framework that can be reapplied to themselves to help understand the process of working with them. This potential re–application of ANT to its own research studies nonetheless remains limited. There are still few accounts of experiences of working with ANT, and in those that do the agency of ANT itself as an actor can be overlooked. Here I have drawn attention to the fact that at I – the researcher – was not the only actor in this research, that ANT – amongst other actors – were also active actors enrolling me into their own networks, often without my awareness.

While there is a growing sense of 'crisis' in STS and increasing awareness for the need to create change we should be careful not to abandon ANT as it continues to offer new insights across a range of research settings. Nonetheless this retro–ANT should be aware of the agency of other actors in its methodological discussions.

References

ACME (2011) *Mathematical Needs: Mathematics in the Workplace and in Higher Education*. London: Advisory Committee on Mathematics Education.

Besel, R.D. (2011) Opening the 'Black Box' of Climate Change Science: Actor–Network Theory and Rhetorical Practice in Scientific Controversies. *Southern Communication Journal*, 76 (2), 120–136.

Bleakley, A. (2012) The Proof is in the Pudding: Putting Actor–Network–Theory to Work in Medical Education. *Medical Teacher*, 34 (6), 462–467.

Brown, S.D. (2002) Michel Serres: Science, Translation and the Logic of the Parasite. *Theory, Culture & Society*, 19 (3), 1–27.

Callon, M. (1986) Some Elements in the Sociology of Translation: Domestication of the Scallops and the Fishermen of St. Brieuc Bay. In Law, J. (ed.), *Power, Action and Belief: A New Sociology of Knowledge?* London: Routledge.

Callon, M. and Latour, B. (1981) Unscrewing the Big Leviathan: How Actors Macro–Structure Reality and How Sociologists Help Them to Do So. In Knorr–Cetina, K.D. and Cicourel, A.V. (eds.), *Advances in Social Theory and Methodology: Toward an Integration of Micro and Macro–Sociologies*. Boston: Routledge and Kegan Paul.

Callon, M. and Law, J. (1982) On Interests and Their Transformation: Enrolment and Counter–Enrolment. *Social Studies of Science*, 12 (4), 615–625.

Callon, M., Law, J. and Rip, A. (1986) *Mapping the Dynamics of Science and Technology: Sociology of Science in the Real World*. London: The Macmillan Press.

Campbell, E. (2003) Interviewing Men in Uniform: A Feminist Approach? *International Journal of Social Research Methodology*, 6 (4), 285–304.

Clarke, A. (2006) Qualitative Interviewing: Encountering Ethical Issues and Challenges. *Nurse Researcher*, 13 (4), 19–29.

Deleuze, G. and Guattari, F. (1987) *A Thousand Plateaus*. Minnesota: University of Minnesota Press.

Department for Education (2010) *The Importance of Teaching: The Schools White Paper*. London: Department for Education.

Dwyer, S.C. and Buckle, J.L. (2009) The Space Between: On Being an Insider–Outsider in Qualitative Research. *International Journal of Qualitative Methods*, 8 (1), 54–63.

Fenwick, T. and Edwards, R. (2010) *Actor–Network Theory in Education*. Oxon: Routledge.

Fox, S. (2009) Context of Teaching and Learning: An Actor–Network View of the Classroom. In Edwards, R., Biesta, G. and Thorpe, M. (eds.), *Rethinking Contexts for Learning and Teaching: Communities, Activities and Networks*. Abingdon: Routledge.

Gad, C. and Bruun Jensen, C. (2010) On the Consequences of Post–ANT. *Science, Technology & Human Values*, 35 (1), 55–80.

Garfield, J. (1995) How Students Learn Statistics. *International Statistical Review*, 63 (1), 25–34.

Garfield, J. and Ben–Zvi, D. (2007) How Students Learn Statistics Revisited: A Current Review of Research on Teaching and Learning Statistics. *International Statistical Review*, 75 (3), 372–396.

Gorur, R. (2011) ANT on the PISA Trail: Following the Statistical Pursuit of Certainty. *Educational Philosophy and Theory*, 43 (5–6), 76–93.

Hamilton, M. (2011) Unruly Practices: What a Sociology of Translations can Offer to Educational Policy Analysis. *Educational Philosophy and Theory*, 43(s1), 55–75.

Hitchings, R. and Jones, V. (2004) Living with Plants and the Exploration of Botanical Encounter within Human Geographic Research Practice. *Ethics, Place & Environment*, 7 (1–2), 3–18.

Kamp, A. (2012) Collaboration in Education: Lessons from Actor Network Theory. In Nikolaeva, S. and Mulcahy, C. (eds.), *Towards Transformative Education*. Sofia: Sofia University.

Latour, B. (1988) The Politics of Explaination. In Woolgar, S. (ed.) *Knowledge and Reflexivity*. London: Sage.

Latour, B. (1990) On Actor–Network Theory. A Few Clarifications Plus More Than a Few Complications. *Soziale Welt*, 47 (4), 369–381.

Latour, B. (1993) *The Pasteurization of France*. Cambridge: Harvard University Press.

Latour, B. (1994) On Technical Mediation: Philosophy, Sociology, Genealogy. *Common Knowledge*, 3 (2), 29–64.

Latour, B. (1999a) On Recalling ANT. *The Sociological Review*, 47 (S1), 15–25.

Latour, B. (1999b) *Pandora's Hope: Essays on the Reality of Science Studies*. Cambridge: Harvard University Press.

Latour, B. (2004) On Using ANT for Studying Information Systems: A (Somewhat) Socratic Dialogue. In Avgerou, C., Ciborra, C. and Land, F. (eds.), *The Social Study of Information and Communication Technology: Innovation, Actors and Contexts*. Oxford: Oxford University Press.

Latour, B. (2005) *Reassembling the Social: An Introduction to Actor–Network–Theory*. Oxford: Oxford University Press.

Latour, B. and Woolgar, S. (1979) *Laboratory Life: The Construction of Scientific Facts*. Beverly Hills: Sage Publications.

Laurier, E. and Philo, C. (1999) X–Morphising: Review Essay of Bruno Latour's Aramis, or the Love of Technology, *Environment and Planning A*, 31 (1), 1047–1071.

Law, J. (1999) After ANT: Complexity, Naming and Topology. In Law., J. and Hassard, J. (eds.), *Actor Network Theory and After*. Oxford: Blackwell Publishing.

Law, J. (2000) *Objects, Spaces and Others*. Lancaster: Centre for Science Studies. [Online] Available from: http://www.lancaster.ac.uk/fass/resources/sociology–online–papers/papers/law–objects–spaces–others.pdf [Accessed: February 23rd, 2017].

Lee, N. and Brown, S. (1994) Otherness and the Actor Network: The Undiscovered Continent. *American Behavioral Scientist*, 37 (6), 772–790.

Mason, G., Nathan, M. and Rosso, A. (2015) *State of the Nation: A Review of Evidence on the Supply and Demand of Quantitative Skills*. London: The British Academy.

Meho, L.I. (2006) E–Mail Interviewing in Qualitative Research: A Methodological Discussion. *Journal of the American Society for Information Science and Technology*, 57 (10), 1284–1295.

Mistry, J., White, F. and Berardi, A. (2009) Skills at Master's Level in Geography H.E.: Teaching, Learning and Applying. *Journal of Geography in Higher Education*, 33 (1), 123–148.

Mlitwa, N. (2007) Technology for Teaching and Learning in H.E. Contexts: Activity Theory and Actor Network Theory Analytical Perspectives. *International Journal of Education and Development using ICT*, 3 (4), 54–70.

Mol, A. (2002) *The Body Multiple: Ontology in Medical Practice*. Durham: Duke University Press.

Mulhall, A. (2003) In the Field: Notes on Observation in Qualitative Research. *Journal of Advanced Nursing*, 41 (3), 306–313.

Murdoch, J. (1997) Inhuman/Nonhuman/Human: Actor–Network Theory and the Prospects for a Nondualistic and Symmetrical Perspective on Nature and Society. *Environment and Planning D: Society and Space*, 15 (6), 731–756.

Nespor, J. (1994) *Knowledge in Motion: Space, Time and Curriculum in Undergraduate Physics and Management*. London: The Falmer Press.

Onwuegbuzie, A.J. and Wilson, V. (2003) Statistics Anxiety: Nature, Etiology, Antecedents, Effects, and Treatments – A Comprehensive Review of the Literature. *Teaching in Higher Education*, 8 (2), 195–209.

Ruming, K. (2009) Following the Actors: Mobilising an Actor–Network Theory Methodology in Geography. *Australian Geographer*, 40 (4), 451–469.

Thrift, N. and Dewsbury, J.D. (2000) Dead Geographies–And How to Make Them Live. *Environment and Planning D: Society and Space*, 18 (4), 411–432.

Tu, T., Colahan, M., Hale, C., D'Souza, J., Mallows, D., Carpentieri, J.D. and Litster, J. (2016) *Impact of Poor Basic Numeracy and Literacy on Employers*. London: Department for Business, Innovation and Skills.

Vickers, D. and Bailey, A. (2006) *Strategy Building for the Future: Exploring the Impact of Buildings in Further Education using Actor–Network Theory*. Lancaster: Centre for Excellence in Leadership. [Online] Available from: http://hdl.voced.edu.au/10707/91651 [Accessed: February 23rd, 2017].

Vorderman, C., Porkess, R., Budd, C., Dunne, R. and Rahman–Hart, P. (2011) *A World–Class Mathematics Education for All Our Young People*. London: Department for Education.

Williams, M., Payne, G., Hodgkinson, L. and Poade, D. (2008) Does British Sociology Count?: Sociology Students' Attitudes toward Quantitative Methods. *Sociology*, 42 (5), 1003–1021.

Winterbotham, M., Vivian, D., Davies, B. and Kik, J. (2014) *The UK Commission's Employer Skills Survey 2013: UK Results*. Rotherham: UK Commission for Employment and Skills.

Semiotic Machines: Portrait of an Actor–Network as a Pushdown Automaton

Francesco GALOFARO[*]

Free University of Bozen–Bolzano

We will apply the notion of script – Akrich and Latour (1992) to the design of a pushdown automaton representing the relation between a network of both human and not human actors in two different restaurant cars, analysed on the basis of their ethnographic description. The language computed by the automaton will be the program of the network. Thus, an actor network will appear as a semiotic machine, made of both organic and not–organic apparata. However, one should ask what kind of algorithms govern social life (finite, indeterministic, stochastic automata…): the pushdown automaton is only a particular case of semiotic machine, a form of rationality superimposed by the analyst to a largely undetermined object with the goal of explaining the articulation of its meaning. This naturally poses the question of the relation between an actor network and the observer–analyst. Values matter only in front of an instance according to which they matter – Marsciani (2013).

***Keywords**: Script; semiotics; abstract machine; crisis; program of action*

Introduction

To what extent ANT can be considered useful nowadays? According to Mattozzi (2006) there are two ways in which ANT could be improved. ANT should be applied to the interaction between technical objects, human and not human actors in everyday life, not only to the reconstruction of the social and cultural conditions which explains their development and diffusion. Furthermore, the dialogue between ANT scholars and semioticians should be kept alive, since Akhrich and Latour derived many notions and their relational epistemology from generative semiotics.

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[*] Corresponding author: **Francesco Galofaro** | e–mail: **francesco.galofaro@polimi.it**

For these reasons, we will apply some ANT kernel concepts to a case study – the restyling of a restaurant car in fast trains – to represent conflicts and solutions which emerge when an object is observed in the world of life (*Lebenswelt*). In this perspective, the complex of the technical object and its script can be seen as a semiotic machine, producing meaning, whose peculiar program is reconstructed by the analyst when describing a technical artefact. By doing so we hope to show how ANT can be useful to establish a fruitful relation between generative semiotics and the machinic turn in post–structuralism – Deleuze and Guattari (2004b).

Kernel notions

During the analysis we will refer to some ANT notions which are defined in Akrich and Latour (1992). We start from the notion of 'Crisis': any dispositive prescribes or forbids something to other actors (prescription; proscription; affordances; allowances). The identification of a crisis is the condition which allows the authors to reconstruct the 'script' inscribed into an object: every object implies a conflict with human and not human actors, which react subscribing or de–inscribing themselves from the programmed relations of the dispositive. The conflict opens a space (a meaningful space) for mediation and tactics. The 'script', inscribed in the object, consists of the possible roles, actions, and rules of interaction between the technical object and the network of human and not human actors in which it is inserted. We will describe this script as a hierarchical, indented list of programs of action, using the notation proposed by Marsciani and Zinna (1992), slightly simplified to our purposes. In this perspective, the technical device plays often the role of an (anti–)sender in an (anti–)program of action: the technical device is responsible for the conjunction/disjunction between the subject and one or more modal values which modify the action – on the same line, cf. Deni (2002). These modal values can enter into conflict – Greimas (1983) – along four dimensions: what the subject wants do (will), what the subject has to do (duty)*;* what the subject knows how to do (knowledge); what the subject can do (power). The result can be the failure of the action, because every program of action can be seen as a canonical chain of modal presuppositions: if the subject wants to do something, then the subject must be able to do it; if the subject is able to do something, then the subject must have acquired knowledge on how to do it; finally, if the subject has acquired knowledge on how to do something, the subject must have wanted to do it or must have been obliged to do it (fig.1). Let us say that a certain technical artefact does not transfer to its user the proper

knowledge on how to operate. Then there will be a conflict between what the user has to do to properly interact with the object, and what it knows about the object (duty/knowledge). Consequently, there will be a second conflict which involves power, because a lack of knowledge will not allow the user to be able to perform the action. Finally, the performance fails.
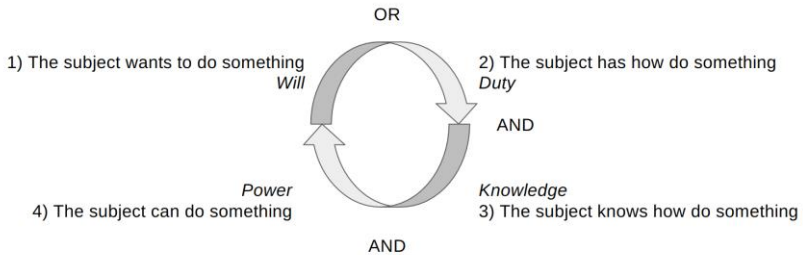
Figure 1   The canonical chain of modal presuppositions of a program of action.

How to describe an actor–network?

Many studies in ANT represent actor networks as graphs whose nodes identify actors, linked by a relation of 'proximity'. Such kind of representation is somehow misleading for different reasons. First, it gives the impression that the nodes of the net have a positive, independent existence, whereas, according to ANT, both the technical object and the actors are created by the relations established in the network. Second, the relation of 'proximity' seems static: it does not consider the transformations which are typical of Latour's ontology of becoming. According to Latour's perspective, we can't take for granted the stable identity of object through time – Latour (1998). It is important to notice how technique is a 'regime of enunciation', or, later, the 'meta–mode of existence' – Latour (2013) – which confers endurance to other regimes. Consequently, there will be a moral technique, a legal technique … Finally, this kind of graph does not take in account conflicts (crisis), inscriptions, subscriptions, de–inscriptions. In other terms, we need to work on the representation of scripts. For this reason we will use Greimas' notation to formalize programs of actions in a precise way, so that this formal language can be interpreted by an automaton, a notion we borrow from formal language theory. This could be useful for both theoretical and practical goals, which we are going to discuss later on. First we need to test this research program on a complex technical object: the restaurant car in fast trains.

Fast trains

The introduction of fast trains in Italy changed the usual interior design of the passenger cars, with interesting consequences on the sub–programs of action which compose the main program 'train ride'. Many of these have been analysed in a seminal work by Michela Deni (2002), which compared the old Espresso train with newer models such as the ETR 480 and the ETR 500. Basically, the space of the Espresso passenger cars was subdivided in compartments, allowing up to six persons to sit down, connected by a corridor. In newer fast trains, the space is open and connected by a central corridor. Deni describes the opposition between the two morphologies as /closed//public/ space Vs. /open//private/ space. As a matter of facts, in a compartment the six passengers can speak and interact because they can look at each other and the environment is quite, whereas the new disposition make uncomfortable to turn toward the neighbour and the environment is very noisy. The change could be seen as a turn from the stagecoach to the airplane model. At the same time, the old model, which presented many advantages according to Deni, survives in the 'salotto' formula, at the executive level of service of NTF train 'Italo' offering four seats per compartment. Many issues affected the 'airplane' design of fast trains: the elimination of the pedal–mechanisms that allow users to avoid the use of the hand in the toilets; the institution of new codes – Eco (1976) – aimed to explain how to open the doors and to use the toilet devices, which had been solved with a redundant and even misleading use of icons, buttons and writings. Furthermore, it worth noticing how a train ride could be really boring: in those trains there was no individual electrical sockets, since electronic devices were not still widespread. After the publication of Deni's work, some issues were fixed: in newer trains we can observe the stabilization of the code of the icons; the radio sockets disappeared and were substituted with electrical sockets, involving conflicts between different programs of action – to phone; to work; to hear some music; to watch a movie; to sleep. Quiet cars were instituted to differentiate the functions of the train spaces. They are disappearing in Italy, where the service is offered at the executive level of service, but they are still in use in other European countries: for example, in Poland user can choose the quiet car at the business level. New cognitive spaces appeared in form of displays, providing information such as the actual speed, the next station, some news, and corporate advertising. Obviously, the institution of programs of actions involve new crisis and conflicts. In order to analyse this dynamics, we will focus on the evolution of the restaurant car, basing on ethnographic

observation and using the instruments of ANT and Semiotics as a set of research questions to pose to the observed service.

Restaurant cars

Unfortunately, Michela Deni did not analyse the restaurant car of the ETR 500 in the late '90. We have been able to find only some photographs, which do not allow us to use an ethnographic method. However, in those years, the space was subdivided into two zones (bar and restaurant). The restaurant car was accessible only during meal times. It was necessary to book and the service was organised in two turns. The choice of the menu was narrow and expensive. In the bar zone there was the presence of some dedicated spaces, in which customers could eat standing on foot. Later on, as we will see, the service evolved in the direction of the bistro: comparably cheaper, featured by moderately priced simple meals and by the continuity of the service. In the present paper we will consider two different fast trains: the ETR 485 (Frecciargento) and the ETR 610, both designed by Giugiaro. The first is a restyling of the ETR 480, dating back to 2005; as the second is concerned, we observed the polish version, dating back to 2007.

ETR 485

The restaurant car of the ETR 485 frecciargento offers two services: bar and bistro. To keep separate the two programs of action, the inner space shows a topological opposition /centre//periphery/ (fig. 2) Considering the car as a segment, the two extreme regions are occupied respectively by the bistro zone and by the bar zone; the central part of the car is occupied by the kitchen and by a narrow corridor which links the bar and the bistro. A door allows the waiters to enter the kitchen from the corridor. There are not tables in the bar zone: customers can eat their meals standing on foot at the bar counter. In theory, during meal times the tables of the bistro are reserved to bistro customers; in practice, as we will see, this does not happen due to a crisis of the two programs of action. A huge crowd comes into view in the small spaces of the bar zone: ordering dishes becomes difficult since the bar counter is occupied by people consuming their meal. Since the bistro zone is usually less crowded, the barman invites customers to occupy those tables. A risky operation when carrying food and drinks, since the two zones are linked by a long, narrow corridor which is used by the waiters too. This way, the rule which forbids the bistro zone to the customers of the bar is violated. Furthermore, the described topology forbids the cooperation between the barman and the waiters, separated by

a long corridor. Ethnographic observation shows how customers that want to eat at the bistro have to order meals at the bar zone, even if there are menus in the bistro zone.

Figure 2   The structure of the space in the ETR 485 restaurant car (Frecciargento). The picture has been generated with Sketchup (www.sketchup.com).

ETR 610

The restaurant car of the ETR 610 presents a reversed disposition of the corridor and the bar: the bar becomes central, and it communicates with the bistro zone (fig. 3). Furthermore, the bar has its own tables, that allow customers to eat standing on foot. The bistro zone is smaller in comparison to the one in use in the Italian ETR 485. The reversed position of the bar counter allows the cooperation between the barman and the waiters, and customer sitting in the bistro zone can order meals directly to the waiters. The spaces are not crowded. The disposition of the space is more functional, but there is also a cultural element which has to be considered: in Polish culture it is not a rule to eat at 'meal time': since restaurants are always open during daytime and customers can eat when they prefer to do it. From a deontic point of view, we could formulate the different programs of action in this way: (IT) it is compulsory to eat at mealtime; (PL) it is allowed to eat outside of mealtime. To resume the connection between topology and functions with an homology, we can write:

/connectedness/ : /not–connectedness/
= /programmed actions/ : /not–programmed actions/

In other terms, the connections between the bar and the bistro zone in the ETR 610 allows to execute the programmed interactions between the involved actors, while the not–connected topology of the ETR 485 causes the formation of crowds, the violation of usual rules, and eventually allows the regimes of interaction called 'accident' and 'adjustment' by Eric Landowski (2006).
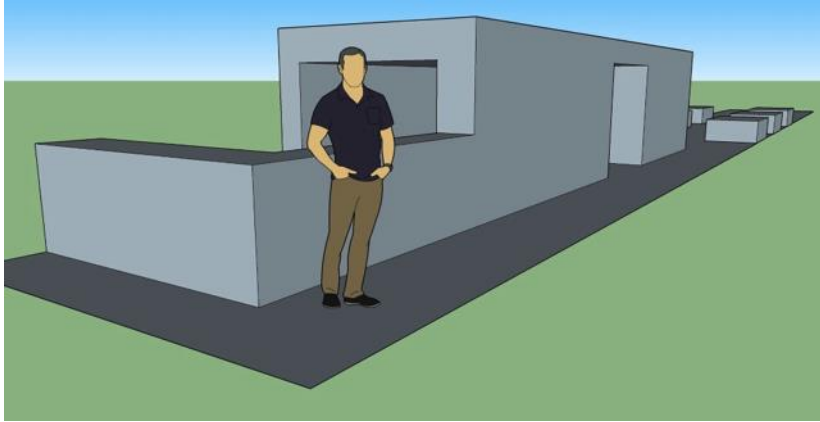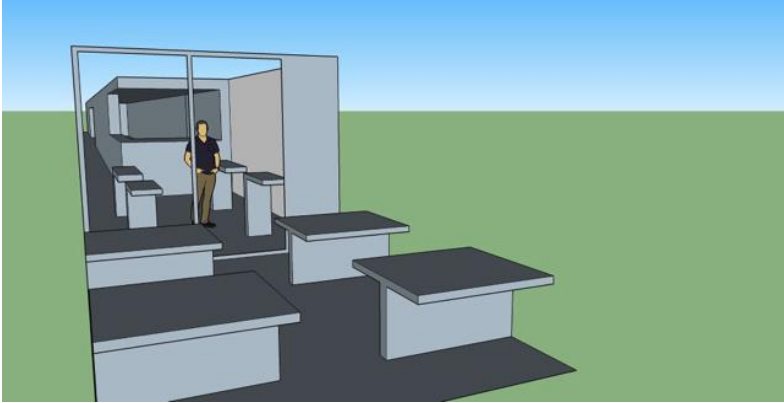

Figure 3   The structure of the space in the ETR 610 restaurant car (Polish version). The picture has been generated with Sketchup (www.sketchup.com).

The program of action of the restaurant car

Mattozzi and Piccioni (2012) demonstrated how Greimas' notation can be useful to action programs inscribed in technical objects. We consider an enunciate (E) in a program of action (AP) as state of conjunction (+) or disjunction (–) between a Subect (S) and an Object in which a positive (euphoric) or a negative (disphoric) value is invested (Ov). The junction is realized by a Sender (D).

$$E_i : D_i \rightarrow (S_i \pm Ov_i);$$

The index (i) identifies the position of the enunciate in the hierarchy of a complex program of action, consisting of base–enunciates which can be analysed in simpler use–enunciates. The conjunction or disjunction can be realised by an anti–Sender (Đ) when we represent an anti–program of action – Akrich and Latour (1992):

$$E_j : Đ_j \rightarrow (S_j \pm Ov_j);$$

We can represent the AP 'to eat at the restaurant car' in the two situation of the ETR 485 and 610 as follows (table 1–2). In the ETR 485 (table 1), the topology of the space let the traveller be in disjunction from power (E_1) because of two reasons: ($E_{1.1}$) the absence of tables let the traveller be part of a crowd; ($E_{1.2}$) the access to the bistro area is forbidden. An accessory enunciate ($E_{1.2.1}$) shows how the same topology also disjoints the waiters from the power (e.g. to serve properly the bistro area).

Table 1   ETR 485 (at meal time).

$E_1{:}\cancel{D_1} \rightarrow (S_1 - Ov_1);$

$\quad\quad E_{1.1}{:}\cancel{D_{1.1}} \rightarrow (S_{1.1} + Ov_{1.1});$

$\quad\quad E_{1.2}{:}\cancel{D_{1.2}} \rightarrow (S_{1.2} + Ov_{1.2});$

$\quad\quad\quad E_{1.2.1}{:}\cancel{D_{1.2.1}} \rightarrow (S_{1.2.1} - Ov_{1.2.1});$

$D_1 = D_{1.2.1} =$ Space topology (+/– connected);
$D_{1.1} =$ presence/absence of tables;
$D_{1.2} =$ bistrot area;
$S_1 = S_{1.1} = S_{1.2} =$ traveller;
$S_{1.2.1} =$ waiter and barman;
$Ov_1 = Ov_{1.2.1} =$ /power/;
$Ov_{1.1} =$ /crowd/;
$Ov_{1.2} =$ /prohibition/;

If we have a look at the modal values involved, it becomes clear that there is a conflict between duty (the prohibition to access the bistro area) and power (the subject can't eat). We expect that a different solution can solve the conflict. In fact, in the ETR 610 (table 2), the reversed topology of the space acts as a change of sign: the anti–program of action becomes a program of action, disjunctions become conjunctions and vice–versa, and every anti–sender turns into a sender.

Table 2   ETR 610 (Polish version).

$E_1{:}D_1 \rightarrow (S_1 + Ov_1);$

$\quad\quad E_{1.1}{:}D_{1.1} \rightarrow (S_{1.1} - Ov_{1.1});$

$\quad\quad E_{1.2}{:}D_{1.2} \rightarrow (S_{1.2} - Ov_{1.2});$

$\quad\quad\quad E_{1.2.1}{:}D_{1.2.1} \rightarrow (S_{1.2.1} + Ov_{1.2.1});$

The program of action and its formal language

If we consider the enunciates which compose the program of action of the restaurant car and the corresponding anti–program, they share the same structure (tables 1 and 2). Since we deal with enunciates of two kind (conjunctive/disjunctive), we can assign a letter to each enunciate of the program of action, as it is shown in the next table:

Table 3   The table assigns a letter of the alphabet to each enunciate, distinguishing between conjunctive and disjunctive ones. See tables 1–2.

Enunciate	Conjunctive	Disjunctive
E_1	a	b
$E_{1.1}$	c	d
$E_{1.2}$	e	f
$E_{1.2.1}$	g	h

The structure of the program of action represents a syntax which allows us to combine the symbols: we deal with a simple formal language, which consists of two allowed strings: 'b–c–e–h' and 'a–d–f–g'. Each symbol represents a transformation between couples of states (disjunction, conjunction). Each transformation changes the sign of the state or leaves it unchanged. The set of the states represents the semantic space of the restaurant car.

Introducing *Galaxy,* the pushdown automaton

We can represent the action program as a particular abstract machine: a pushdown automaton provided with a simple form of semantic memory – see Quillian (1968); Eco (1976: 121–125) – in form of a stack which allows the automaton to memorize the sign (conjunction, disjunction) of the last transformation. Every new information is memorized on top of the stack starting from the initial symbol Z, which simply marks the beginning of the memory. We will call it 'Galaxy' (fig. 4 and table 4).

Given a string of symbols belonging to the language L, starting from the initial state q0, Galaxy:

1) reads a symbol of the language;
2) reads the last symbol stored into the semantic memory;
3) effectuates either one of these operation on the memory or both:
3.1) it pushes (i.e. adds) a symbol on the top of the stack;
3.2) it pops (i.e. wipes out) a symbol from the top of the stack;

4) changes its internal state.
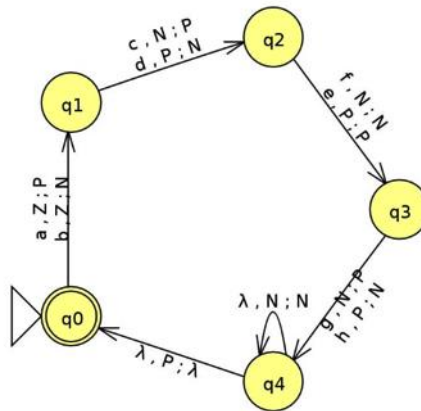
Figure 4   The pushdown automaton Galaxy accepts the string corresponding to the program of action of a restaurant car (a–d–f–g), while it gets into the trap state q4 while it reads the corresponding anti–program of action (b–c–e–h). The automaton has been designed with JFLAP (www.jflap.org).

Table 4   The symbolic repertoire of the pushdown automaton Galaxy.

Language L: {a, b, c, d, e, f, g, h};– see table 3.
Semantic memory M: {Z, P,N};
Z = initial symbol;
P = conjunction;
N = disjunction;
Empty string: {λ}
Space of the states S: {q0, q1, q2, q3, q4}; initial and final state: {q0};

Each enunciate of the program of action is represented by an arrow connecting two states and by a triplet of symbols:

x, Y; Z

This means: if the symbol that Galaxy is currently reading from the input string is x, and the current element memorized on the top of the stack of the semantic memory is Y, then Galaxy has to replace Y with Z before moving in the next state pointed by the arrow. In particular, if Z = λ, Galaxy simply pops the last symbol Y from the memory; if Z = P, Galaxy pops the last symbol Y from the memory and pushes the new symbol P (it replaces Y with

P). If, at the end of the input string, Galaxy reaches the final state with an empty memory stack, then the string is accepted.

Let us see how Galaxy interprets the input string is 'a–d–f–g', corresponding to the program of action of the ETR 610. Beginning from q0, the first instruction of Galaxy is an arrow connecting q0 and q1. On the arrow there is the instruction:

a, Z; P

This means: if the current symbol of the string is a, and the symbol stored in the memory is Z, then pop Z, push P, and move into the state q1. The first symbol of the string is in fact a, and the symbol which marks the beginning of the memory is Z, so the automaton substitutes Z with P in its memory and enters the state q1.

Thus, (table 3) Galaxy reads E1: D1 → (S1 + Ov1) and interprets it as a conjunctive enunciate. In q1 the input symbol d matches the symbol currently stored in its memory (P), as it is required by the instruction:

d, P; N

Thus, Galaxy replaces P with N, interpreting d as a disjunctive enunciate, then enters in the state q2. The next symbol is f, and it matches the instruction:

f, N; N

Galaxy recognizes f as a disjunctive enunciate, and leaves the memory unchanged. Now it is in q3 and it reads the symbol g, which matches the instruction:

g, N; P

Thus, Galaxy reaches the state q4. Now the input string is over, i.e. the input corresponds to the empty string λ. In memory Galaxy finds the symbol P: so the automaton pops P without substitutions, and reaches the final state with an empty memory stack: the string is accepted. The reader is invited to see how Galaxy interprets the string 'b–c–e–h', and to verify how it reaches the state q4, entering a loop. The state q4 acts as a trap state: this way we represent the result of the anti–program of action.

Discussion

A descriptive approach in terms of automata theory seems promising: automata are flexible graphs, and can be extended – if needed – to describe subprograms in detail. Though our automaton shows a really limited semantics, it can be extended – enriching its semantic memory – to other values, such as the modal dimensions of conflict (will, duty, knowledge, power). In this discussion, we will address some basic questions on the relation between our automata and generative semiotics, with Deleuze and Guattari's work on abstract machines, and on the practical goals of the proposed formalism.

Automata and generative semiotics

It is possible to ask to what extent our formalism is coherent with the post–structuralist approach typical of both ANT and semiotics. First, it is theoretically founded in Greimas and Courtès (1979). If we consider the entry 'Algorithm', the authors write that 'complex narrative programs […] can already undergo an algorithmic formulation'. According to them, the kernel notion of 'Transformation' (of meaning) can be algorithmic, and the 'Automaton' is simply the neuter subject of the algorithm:

> 'The automaton is then a semiotic domain constructed like a simulacrum of the programmatic doing and can be used as a model either for the human subject carrying out a reproducible scientific activity, or for the construction of a machine.'

These semiotics foundations have been proven useful to build–up new sociological perspective on technical artefacts, such as ANT.

The machinic turn in post–structuralism

Recently, different semiotic scholars draw a relation between semiotics and Deleuze's philosophy. As Design theory is concerned, we already named Alvise Mattozzi. To quote only some authors, Federico Montanari (2012) proposed to renew the interest of semiotics toward matter; Alessandro Zinna (2012) founded its notion of 'semiotic formation' on Deleuze and Guattari's (1994) classification of knowledge; in Cinema theory Nicola Dusi (2015) found a relation between figurality and Deleuze and Guattari's (2004b) notion of diagram. What we are proposing is a different link betweeen generative semiotics and the machinic turn in post–structuralism. In particular, we make reference to the notion of Desiring machine – Deleuze and Guattari (2004a) and to the one of Abstract machine – Deleuze

and Guattari (2004b). The chain of transformation of a desiring machine, which produces subjects as waste products, can be compared to the canonical, algorithmic transformations of Greimas and Courtès' narrative trajectory – see Galofaro (2016). The notion of 'abstract machine' defined by a 'diagram', is opposed to concrete 'devices' and their 'program'. The author's example concerns Chomsky's generative grammar, which is not enough general to be considered an abstract machine. According to the present paper, every social object and every network which can be described in terms of programs of action and scripts can be considered as a 'concrete device'. On the other hand, the formal means we use to describe these programs, the relational oppositions Sender/Reviewer; Subject/Object; conjunction/disjunction; relation/value; the conflict between modal dimensions; state/transformation; automaton/algorithm; recording head/semantic memory represent 'the condition of possibility' of social devices and of their programs: they are the clockwork of the abstract machine. In the notion of abstract machine and diagram we see the potential of a new kind of transcendental foundation of meaning, because it is completely anti–subjectivist. Working on Husserl's cartesian meditations, Marsciani (2012) concludes that the transcendental conditions of meaning are not the categories of a kantian subject, but an intersubjective network of relations. We propose to compare these interubjective relations to Deleuze's 'machines'.

The principle of observation

Our pushdown automaton shows many limitations. Galaxy is finite and deterministic, it has a weak computational power, it does not take in account every activity allowed by the train restaurant, from work relations to flirts, from chess games to murders and so on. However, we want to propose a 'principle of observation': it is not possible to describe mechanically every action allowed by a particular object without observing it. Description implies observation through ethnographical means. It is not possible to foresee a complete, finite list of the virtual programs inscribed in a space whatsoever. All meaning is observed meaning. This is a consequence of the principle of inherence, proposed by Marsciani (2013), according to which 'meaning' is always in view of an observation point, a position, a not–necessarily human instance.

Observation and semio–technique

Obviously, when describing complex objects such the restaurant cars, we are superimposing this form of rationality to them: a 'semio–technique' which consists of Greimas' metalanguage, Latour notions, and automata theory. However, even applying a different model of machine, such as a Turing machine, an analogic machine, a stochastic automaton, we'd have the same superimposition of a (more complex) form of rationality. If we choose a simpler automaton, this is only for reasons related to an evaluation of relevance. Relevance is never an objective feature; it expresses a relation between the object and an observer, which does more than 'describing' the object in a neutral way, By answering to a research question through its categories, by actualising some virtual qualities of the object and by neutralising some others, the analyst determines its meaning applying his conceptual instruments as a 'semio–technique'. According to our principle of observation, this cannot be avoided: before observation, meaning is undetermined.

Further researches

A scientific improvement comes for sure from a formal, precise notation of the transformations. Considered as the program of an automaton, the script and the crisis become clearer and can be criticised and modified by the scientific community. Besides that, a second advantage is represented by the possibility to work on the scripts of conflicting objects, such as the case of the ETR 485, modifying their programs in an analytical way. This will be useful to those designers who aim to solve the conflicts related to objects to improve them, finding new solutions.

References

Akrich, M. and Latour, B., (1992) A Summary of a Convenient Vocabulary for the Semiotics of Human and Nonhuman Assemblies. In Bijker, W.E. and Law, J. (eds.) *Shaping Technology / Building Society*. Cambridge: MIT Press.

Deleuze, G. and Guattari, F. (1994) *What is Philosophy.* New York: Columbia University Press.

Deleuze, G. and Guattari, F. (2004a) *Anti–Œdipus: Capitalism and Schizophrenia.* London and New York: Continuum.

Deleuze, G. and Guattari, F. (2004b) *A Thousand Plateaus.* London and New York: Continuum.

Deni, M. (2002) *Oggetti in azione.* Milano: Franco Angeli.

Dusi, N. (2015) *Contromisure: trasposizioni e intermedialità.* Udine: Mimesis.

Eco, U. (1976) *A Theory of Semiotics.* Bloomington: Indiana University Press.

Galofaro, F. (2015) Programmare e punire: semiotica del rapporto uomo–macchina. *La Deleuziana*, 1, 91–106.

Galofaro, F. (2016) Schizofrenia meccanica: come de–programmare le macchine sociali. *Etica & Politica/Ethics & Politics*, 18 (3), 201–220.

Greimas, A.J. (1983) *Du sens. 2.* Paris: Seuil.

Greimas, A.J. and Courtés, J. (1979) *Sémiotique: dictionnaire raisonné de la théorie du langage.* Paris: Seuil.

Landowski, É. (2006) Les interactions risquées*. NAS, Nouveaux Actes Sémiotiques*, 101–103.

Latour, B, (1998) Piccola filosofia dell'enunciazione. In Corrain, L. and Basso, P.L. (eds.), *Eloquio del senso: dialoghi semiotici per Paolo Fabbri*. Milano: Costa & Nolan.

Latour, B. (2013) *An Inquiry into Modes of Existence: An Anthropology of the Moderns.* Harvard: Harvard University Press.

Marsciani, F. (2013) Soggettività e intersoggettività tra semiotica e fenomenologia. In Leone, M. and Pezzini, I. (eds.), *Semiotica delle soggettività*. Roma: Aracne.

Marsciani, F. and Zinna, A. (1992) *Elementi di semiotica generativa.* Bologna: Esculapio.

Mattozzi, A. (ed.) (2006) *Il senso degli oggetti tecnici.* Roma: Meltemi.

Mattozzi, A. and Piccioni, T. (2012) A Depasteurization of Italy? Mediations of Consumption and the Enrollment of Consumers within the Raw–Milk Network. *Sociologica*, 3. [Online] Available at: http://www.sociologica.mulino.it/doi/10.2383/72702 / [Accessed: February 10th, 2016].

Montanari, F. (2012) Between Trees, Webs and Mirrors. Dimensions of Immanence and a Critical Poststructuralist Proposal. *E/C.* [Online] Available at: http://www.ec–aiss.it/ [Accessed: December 10th, 2016]

Quillian, R. (1968) Semantic Memory. In Minsky, M. (ed.), *Semantic Information Processing*. Cambridge: MIT press.

Zinna, A. (2012) Les formations sémiotiques. *Versus,* 114, 127–147.

Engaging with the Concept of the 'Script' in Industrial Innovation Studies – or how Retro–ANT is Perfect but not 'Enough'

Judith IGELSBÖCK[*][a]

[a] Technische Universität München

This paper engages with the concept of the script to make sense of the ways in which industrial innovation is performed. The starting point is the impression that companies in different sectors innovate in a similar fashion. The organization of innovation processes thus seems to follow specific recipes, suggesting who is supposed to innovate, when, where, and how. Drawing on the concept of the 'script' as developed by Akrich, these recipes are analytically captured as 'innovation scripts'. The paper argues that empirically carving out 'innovation scripts' in a variety of industrial organizations and fields, allows for an understanding of a potential isomorphic character of innovation across diverse industries. It also provides insights on where the ideas of how to innovate come from, how they circulate, and how they manifest – or put differently – how contemporary industries learn to innovate. In a subsequent section, this paper lays out how retro–ANT is a perfect starting point for making sense of the dynamics of homogenization and normalization in contemporary industrial innovation but wants to be complemented by modes of 'intervention' that deal with questions of 'responsible innovation' in a way such that prevalent ideas of innovation can be challenged, and alternative innovation scripts brought into existence.

Keywords: *Innovation scripts; isomorphism; intervention; agents of change; industrial innovation studies*

Introduction

Innovation is one of the key terms describing change in contemporary societies (also beyond the spheres of industry). Innovation is more than

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[*] Corresponding author: **Judith Igelsböck** | e–mail: **judith.igelsboeck@tum.de**

descriptive, however. It has turned into an imperative: desired, wanted, needed (see e.g. Hutter et al., 2005). Back in 1984, *Der Spiegel* anticipated that innovation would 'develop into a miraculous power' (Der Spiegel, 1984). It has not always been like that, however. Historically, the meaning of innovation has undergone a transformation process, as Godin (2015, p. 223) points out: 'Innovation is no longer seen as subversive to the social order, but simply opposed to traditional ways of doing things. While sociologists of the early twentieth century still define innovation as negative, the representation changes completely in a few decades. The deviant is now the conservative.'

Nowadays, every industrial organization seemingly wants to be constantly innovating. But not only that. Also, the ways of innovating are very similar. No matter which branch, which organization – it does not even have to be industry – there seems to be a rather constant ensemble of (human and non–human) actors that come into play. As related to innovation governance, there is a bunch of buzzwords repeatedly used, such as 'agile', 'lean', 'open innovation', and not to forget 'disruptive innovation'. Similarly, Silicon Valley seems to widely act as *the* place to get inspired by when seeking innovation. How is this possible despite different challenges that lie ahead of industries, the places in which they are located, or the kind of innovation intended?

We could relate this impression to what has been framed as 'institutional isomorphism', as developed by a group of scholars in organization studies to make sense of the dynamics of homogenization with regard to the establishment of organizational structures and cultures, such as forms of bureaucracy within organizational fields (see e.g. DiMaggio and Powell, 1983). Institutional isomorphism is regarded as a practice of dealing with uncertainty and considered to be effective with regard to an organization's legitimacy, stability, and survival prospects (see e.g. Meyer and Rowan, 1977). DiMaggio and Powell identify three modes of isomorphism: coercive, mimetic and normative. Since innovation is not only characterized by a high level of uncertainty, but also closely related to creativity and originality, or to the idea of 'breaking routines' (see e.g. Reckwitz, 2016), institutional isomorphism might be surprising in the context of innovation processes. Enrique Dans (2014) would even suggest that 'isomorphism is the greatest enemy of innovation.' Put less dramatically, to standardize and normalize innovation in an isomorphic manner, seems to contradict its very idea. I want to take this tension as a

starting point for a systematic empirical study of the ways to innovate. And this is where the retro–ANT concept of the 'script' comes in.

Turning to innovation scripts

I tentatively define 'innovation scripts' as recipes that suggest who is supposed to innovate where, when and how – or by means of which 'innovation tools'. Employing 'innovation scripts' is a way of making sense of innovation performances, or put differently, innovation 'in the making'. I thus follow the call from Akrich, Callon and Latour (2002a, p. 191) to 'open the way to a theory of innovation which is closer to the actors' by 'restor[ing] innovation in the making without intervening in the explanation of those elements which are unknown until the end of the process.' In so doing, this framework contrasts with the bulk of management literature, which tends to walk into the 'trap of retrospective explanation'(ibidemem).

I build on what Akrich (1992) has characterized as the 'prescriptive' dimension of scripts: innovation scripts prescribe who is to be considered a relevant actor or which tools should be used to innovate. '[Scripts] define a framework of action together with the actors and the space in which they are supposed to act' (Akrich, 1992, p. 208). In this sense, scripts can be understood as normalizing and standardizing innovation processes, and operate as 'ordering devices' (Suchman, 1987). 'Emerging as endogenous resources for ordering 'from within', plans, scripts and other ordering devices are woven intricately into the fabric of everyday activity' (Suchman, 1987, p. 295). This definition is not fundamentally different from Barley's (1986) conception of scripts as 'behavioral grammars that inform a setting's everyday action' (p. 84) and his idea that scripts lie in between '[f]lows of ongoing action and a set of institutionalized traditions or forms that reflect and constrain that action' (p. 80).

Akrich, however, leads us to yet another characteristic of scripts, namely their 'incompleteness'. Applying a script necessarily requires the effort of improvisation which in turn attributes power to the actors performing a script. 'To adopt is to adapt', as Akrich et al. (2002b, p. 208) suggest. Akrich (1992) calls the adoption process of a script 'de–scription'. This can be related to the fact that scripts can never be more than heuristics or 'proto–scripts' (see e.g. Gioia and Poole, 1984). As compared to other sorts of scripts, innovation scripts might be specific regarding their de–scription processes. 'Innovation by definition is created by instability, by unpredictability which no method, however refined, will manage to master

entirely' (Akrich et al. 2002a, p. 195). In order to qualify as innovation scripts, they can be expected to carry unscripted elements or even 'counter scripts' with them as a very part of the scripts. We can thus differentiate between the kind of adoption or 'de–scription' as related to the indeterminacy of scripts, and forms of 'deviancy' – such as the breaking of routines – as making innovation to innovation. This differentiation could add to an ongoing discussion about how much 'agency' can be attributed to institutional actors in organizations. Lawrence, Suddaby and Leca (2011) point out that actors are usually described either as 'cultural dopes' – trapped by institutional arrangements – or as 'hyper–muscular institutional entrepreneurs'. My hope is that my analysis of innovation scripts might not only contribute to a qualification of the relation between scripted and unscripted dimensions of innovation performances, but also to an understanding of how forms of improvisation, contestation and non–conformism are prescribed as integral parts of innovation scripts.

Akrich introduces a further dimension of script, which might be rather underexplored in many organization and innovation studies: their materiality. The notion of the inscription indicates that scripts get inscribed into bodies and devices (Latour and Woolgar, 1979). Akrich pays attention to the scripts that are inscribed into technical objects (by designers). As for the case of innovation scripts, it does not seem so clear where they come from, how they travel, how they manifest, or who the 'designers' of the scripts are. Accordingly, it is technically impossible to perform one of the classical 'from prescription to de–scription' approaches – as also Lavén (2008) did, when operating with the very same notion of the 'innovation script'. While Lavén investigated how policy–scripts get implicated, and are translated in doing so, performing a 'reverse study' seems in my case: In this 'reverse study' I will start by carving out innovation scripts in innovation performances of diverse types of industries and industrial organizations, to then compare them in terms of certain categories of actors starring in scripts (more on that below), and finally conceive an idea of where the scripts come from, how they manifest, and how they circulate.

Getting hold of innovation scripts

In related works, we find the idea that scripts are frequently performed 'quasi–automatically' (Zucker, 1977) or even 'mindlessly' (Ashforth and Fried, 1988). Innovation scripts might not even be acknowledged as such, lie in the tacit, be taken for granted, applied without being reflected on. This

should not make us worry though. We can get hold of scripts, even if they are 'silent', as 'Jim Johnson' reassures us:

> 'There exist many states of affairs in which [scripts] are explicitly uttered. […] I have already listed several entries: user manuals, instruction, demonstration or drilling situations, practical thought experiments. To this should be added the innovator's workshop where most of the objects to be devised are still at the stage of projects committed to the paper. […] The analyst has to capture these situations in order to write down the scripts' (Johnson [Latour] 1988, p. 306).

When searching for innovation scripts, we can thus ask for the performance of such 'practical thought experiments', look for user manuals, and so forth.

Basically, deploying a 'prototyping phase', in which the concept of the 'innovation script' is iteratively defined and refined, seems promising. This means to operate within a hybrid phase in which the researcher will be already 'in the field' but also re–conceptualizing 'innovation scripts'.

I have tentatively defined innovation scripts as recipes suggesting who is supposed to innovate, when, where and how. Innovation scripts can be described as manuals outlining the acts to be performed when pursuing innovations. They prescribe a certain way of standard behavior in a certain situation. Barley (1986) refers to scripts as 'standard plots'. Scripts also co–define the actors and the roles they are supposed to play. Schank and Abelson (1977, p. 83) write that 'scripts are outlines of recurrent patterns of interaction, that define in observable and behavioral terms, the essence of actors' roles.' The sort of agency attributed to actors does not comply with many of the basic assumptions of ANT scholars. Still, Schank and Abelson make clear how the acts of performing innovation are prescribed by innovation scripts, but – with it – also the actors. And this corresponds very well to Akrich's proposal of scripts '[defining] a framework of action together with the actors and the space in which they are supposed to act' (Akrich, 1992, p. 208).

Against this background, paying analytical attention to the ensemble of (human and non–human) actors starring in innovation scripts, as well as the interplay between those actors, seems promising. This means focusing on 'the (human and non–human) innovators' or 'agents of change', as Godin (2015) framed it, such as figures and myths of innovation (see e.g. Cameron, 2016; Carlsen, 2016). Starting from the proposition of epistemological and

ontological co–constitution, we should not neglect the power that can be attributed to scripts as prescriptive and political means. Innovation studies have often taken the actors as made responsible for the art of creating innovation (such as the 'entrepreneur') for granted, and have mostly been interested in innovation as outcome. Innovation studies have put great attention to 'understanding innovation as the driving force behind economic and social change', 'the factors affecting success or failure in R&D and innovation', or 'the micro–foundations of economic growth', as Fagerberg and Verspagen (2009, p. 220) point out. In contrast to these studies, I aim to focus on the human and non–human actors considered relevant for innovation. Attention shifts from economic performance to forms of being and 'ontological politics' (Mol, 1999) as involved in innovation performances.

This focus on the ensemble of actors as part of innovation scripts, as well as the interplay between them, allows to qualify on two forms of tensions which are normatively tied to contemporary innovation. One tension regards the relation between the individual and the organization. While the scientific chorus suggests that innovation is increasingly performed by a network of many people and organizations – which is sometimes captured by the term 'distributed innovation' (see e.g. Baecker, 1994; Rammert, 2003) – the figure of the heroic entrepreneur seems more present than ever. The analysis of innovation scripts leads us to political questions which are often silenced in innovation management literature: In a process of distributed innovation, who is taking the risk that goes along with it? Who is earning the credits in case of successful innovation? Who is blamed in case of failure? The analysis of innovation scripts seeks to provide an understanding of how contemporary innovation is tied to specific rewards systems. When we speak of the need for an establishment of a so–called 'culture of failure', how does it correspond to the distribution of responsibility und risk?

Another tension lies between organizations and their environment, and the tricky question of how and when to open the boundaries of an organization (Keyword 'open innovation', see e.g. Chesbrough, 2006). The concept of the innovation script is sensible to ways in which the boundaries between an organization and its environment are reset against the background of the normative pressure to perform innovations openly. In accordance to Akrich and colleagues (2002a, p. 211), the concept of the script operates 'far from the simplistic biological metaphors which talk about innovations being selected by their environment without recognizing

that the environment is produced at the same time as the innovation that it is going to judge.' Innovation scripts can provide us with insights on the renegotiation of the boundaries between organizations and their environment, since they carry ideas about how organizations need to be entangled with and disentangled from their environment with them.

The focus on the ensemble of actors as starring in innovation scripts, and the interplay between them can also contribute to an understanding of the materiality of innovation. How are ideals, such as creativity and originality connected to the use of specific innovation tools? The community of innovation– and organization studies has tried to catch up with the recent obsession with materiality in the social sciences (see e.g. Scott and Orlikowski, 2002), the materiality of innovation seems rather underexplored so far, however.

Next to the 'agents of change', the concept of 'innovation scripts' urges us to analytically attend to the settings, in which innovations are supposed to be created. Inspired by the sociology of place (see e.g. Gieryn, 2000), innovation settings can be captured in (at least) three – partly overlapping – dimensions: a symbolic, a material, and a geographical dimension. An example for a such a setting is the outlaw zone Night City, as featuring in the novel *Neuromancer* by Gibson (1984, p. 71), and presented as 'deliberatively unsupervised playground for technology itself.' Other prominent innovation–setting are the 'R&D department', or also 'hotbeds of innovation', such as the Silicon Valley. Bringing the setting into focus allows to specifically address the geopolitical dimensions of innovation. The analysis gives some indication of the spaces and places we identify as innovative ones and allows us to draw some innovation maps highlighting both, the 'hotspots' and 'blank spots' of innovation.

The goal of the analysis of innovation scripts is a detailed description of different ensembles of actors as starring in innovation scripts including specifications about the settings in which innovation processes are located. A comparison of 'casts' as mobilized in innovation scripts in different organizations across diverse branches and fields, will allow to qualify on modes of homogenization and normalization in contemporary industrial innovation. Moreover, the study should also encourage us to think about the societal implications of current ways of performing innovation in industry (and beyond).

How retro–ANT is perfect but not 'enough'

I entitled this paper 'how retro–ANT is perfect but not enough'. This part is devoted to the 'not enough'. As shown above, the retro–ANT concept of the script should very well equip me to lay out how innovation is normalized and homogenized – by focusing on the ensemble of actors as mobilized in innovation scripts. Also, it sheds light on ideas about the adequate distribution of responsibility and risk when it comes to innovate. However, I think that 'carving out' and analyzing innovation scripts is not 'enough'. My intension is to add a phase of 'intervention' in which we get the chance to challenge prevalent ideas of innovation and bring alternative innovation scripts into existence. In doing so, I wish to follow a tradition in science and technology studies of listening and giving voice to those at the margins, and of caring for 'responsible innovation' (see, e.g., The Maintainers, available from http://themaintainers.org). To do so, describing and analyzing innovation scripts and the actors as starring in them by means of retro–ANT concepts is an important first step. Can the generated knowledge be used to shed light on the 'blind spots' of our contemporary innovation landscapes, bring in 'counter–figures' of innovation, and, more broadly speaking, innovate innovation? How could such a turn to intervention look like?

I cannot deliver a satisfying answer to these questions by now, but only some ideas and potential sources of inspiration. We can find great sensibility for the restrictions that lie in the disciplinary conventions of science and technology studies and social sciences more broadly. 'Perhaps it is time for the long march through the institutions: the laboratory (as creative scientists, not just observers), politics, art galleries and the ashram,' Pickering (2002, p. 424) promotes his take on anti–disciplinarity. Law (2016, p. 19) alludes to the fact that '[a]cademic ways of knowing bracket, forget, and conceal much'. He presents a list of 'modes of knowing' are usually not a part of academic knowledge production. While there are many encouraging calls for opening up towards new forms of 'representing and intervening', concrete suggestions of how to perform these have remained rare.

The boundaries between what counts as 'mere' description and what as 'intervention' seem rather fuzzy, anyway. Following the understanding of Hacking (1983), any business of representation can and should be understood as 'intervention' in so far as representations are forming the realities we describe. But certainly, it makes sense to differentiate between the kind of intervention as inherent to any kind of representation and more 'deliberate' forms of intervention. Law and Hetherington (1998) have

introduced the idea of 'interference' as specifically political economy of representation. Beck, Knecht and Klotz (2012, p. 307) take up this idea and claim that '[m]aking interferences is about writing in a way, that does not merely describe, replicate or reflect. It is about placing politics and power at the center of social scientific practice of writing.'

But how to realize such attempts? I'm currently in search of role models as developed in other disciplinary and anti–disciplinary backgrounds. And I could find a few. There is 'Modelling Headless' (Cameron, 2015) – an example of 'imaginary economics' (Velthuis, 2005) in which a 'quasi–model' of offshore finance is created. Another type of intervention could be 'fictocriticism' – an experimental form of writing as Rhodes (2015) wants to be used in organization studies. 'Without gaiety, the science that calls us has no exuberance, it cannot dance', he suggests (Rhodes 2015, p. 289). Yet another prototype is *The Conduit* as designed by the Society for cultural optimism (see http://culturaloptimism.org). The Conduit is both performance and interactive installation. As such it is designed to explore forms of social engagement and the societal impacts of distinct technological and political arrangements.

No matter how I will eventually realize the outlined turn to 'intervention', I will come across the question of what social sciences are, what they are allowed to do, what is part of their responsibilities, and what is not. Most definitely, the turn is not about 'getting real' or 'demonstrating usefulness' – as problematized in a special issue on intervention (Zuiderent–Jerak and Bruun Jensen, 2007). Rather I wish to open up for the question of what social scientists can do as compared to other protagonists who interfere with social orders, power, and responsibilities. Designers self–confidently inscribe their visions of societal orders into our material environments, computer scientists' codes reorganize our social lives. Can social sciences keep up with such forms of insistence? And should they?

Acknowledgments

I presented this paper at the 6th STS Italia conference as part of a session called 'Let's do Retro–ANT!' organized by Alvise Matozzi and Annalisa Pelizza. It can be read as a conceptual paper outlining how the ANT–concept of the 'script' can be used to empirically make sense of contemporary industrial innovation processes. The insights on industrial innovation are meant to lay the foundation for dealing with questions of responsible

innovation, and more broadly, the societal implications of contemporary dynamics in industrial innovation.

References

Akrich, M. (1992) The De–Scription of Technical Objects. In: Bijker, W. and Law, J. (eds.) *Shaping Technology/Building Society: Studies in Sociotechnical Change*. Cambridge: MIT Press.

Akrich, M., Callon, M. and Latour, B. (2002a) The Key to Success in Innovation Part I: The Art of Interessement. *International Journal of Innovation Management*, 6 (2), 187–206.

Akrich, M., Callon, M. and Latour, B. (2002b) The Key to Success in Innovation Part II: The Art of Choosing Good Spokespersons. *International Journal of Innovation Management,* 6 (2), 207–225.

Ashforth, B.E. and Fried, Y. (1988) The Mindlessness of Organizational Behaviors. *Human Relations*, 41 (4), 305–329.

Baecker, D. (1994) *Postheroisches Management: Ein Vademecum*. München: Merve–Verlag.

Barley, S. R. (1986) Technology as an Occasion for Structuring: Evidence from Observations of CT Scanners and the Social Order of Radiology Departments. *Administrative Science Quarterly*, 31 (1), 78–108.

Beck, S., Knecht, M. and Klotz, M. (eds.) (2012) *Reproductive Technologies as Global Form: Ethnographies of Knowledge, Practices, and Transnational Encounters*. New York: Campus Verlag.

Cameron, A. (2015) Modelling 'Headless': Finance, Performance Art, and Paradoxy. *Journal of Critical Globalisaton Studies*, 1 (7), 102–121.

Cameron, A. (2016) Money's Unholy Trinity: Devil, Trickster, Fool. *Culture and Organization*, 22 (1), 4–19.

Carlsen, A. (2016) On the Tacit Side of Organizational Identity: Narrative Unconscious and Figured Practice. *Culture and Organization,* 22 (2), 107–135.

Chesbrough, H.W. (2006) *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston, Massachusetts: Harvard Business School Press.

Dans, E. (2014) *Innovation and Isomorphism*. [Online] Available from: https://medium.com/enrique–dans/innovation–and–isomorphism–e5812a31532c#.asc4abaeh [Accessed: February 10th, 2016].

Der Spiegel (1984) *Innovation wird zur Wunderkraft*. [Online] Available from: http://www.spiegel.de/spiegel/print/d–13510564.html [Accessed: December 10th, 2016].

DiMaggio, P. and Powell, W.W. (1983) The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields. *American Sociological Review,* 48 (2), 147–160.

Fagerberg, J. and Verspagen, B. (2009) Innovation Studies: The Emerging Structure of a New Scientific Field. *Research Policy*, 38 (2), 218–233.

Gibson, W. (1984) *Neuromancer*. New York: Ace Books.

Gieryn, T.F. (2000) A Space for Place in Sociology. *Annual Review of Sociology*, 26 (1), 463–496.

Gioia, D.A., and Poole, P.P. (1984) Scripts in Organizational Behavior. *Academy of Management Review*, 9 (3), 449–459.

Godin, B. (2015) *Innovation Contested: The Idea of Innovation over the Centuries*. London: Routledge.

Hacking, I. (1983) *Representing and Intervening: Introductory Topics in the Philosophy of Natural Science*. Cambridge: Cambridge University Press.

Hutter, M., Knoblauch, H., Rammert, W., and Windeler, A. (2015) Innovation Society Today: The Reflexive Creation of Novelty. *Historical Social Research*, 40 (3), 30–47.

Johnson, J. [Latour, B.] (1988) Mixing Humans and Nonhumans Together. *Social Problems*, 35 (3), 298–310.

Latour, B. and Woolgar, S. (1979) *Laboratory Life: The Social Construction of Scientific Facts*. Beverly Hills: Sage.

Lavén, F. (2008) *Organizing Innovation. How Policies are Translated into Practice*. PhD Thesis [Online]. Available from: https://gupea.ub.gu.se/handle/2077/17314 [Accessed: December 10th, 2016].

Law, J. (2016) Modes of Knowing: Resources from the Baroque. In Law, J. and Ruppert, E. (eds.) *Modes of Knowing: Resources from the Baroque*. Manchester: Mattering Press.

Law, J. and Hetherington, K. (1998) *Allegory and Interference: Representation in Sociology*. Centre for Science Studies, Lancaster

University. [Online] Available from:
http://www.lancaster.ac.uk/fass/resources/sociology–online–
papers/papers/law–hetherington–allegory–interference.pdf [Accessed:
December 10th, 2016].

Lawrence, T., Suddaby, R. and Leca, B. (2011) Institutional Work: Refocusing
Institutional Studies of Organization. *Journal of Management Inquiry*, 20
(1), 52–58.

Meyer, J.W. and Rowan, B. (1977) Institutionalized Organizations: Formal
Structures as Myth and Ceremony. *American Journal of Sociology*, 83 (2),
340–363.

Mol, A. (1999) Ontological Politics. A Word and Some Questions. *The
Sociological Review*, 47 (1), 74–89.

Pickering, A. (2002) Cybernetics and the Mangle: Ashby, Beer and Pask.
Social Studies of Science, 32 (3), 419–437.

Rammert, W. (2003) *Innoversity. Innovation and Diversity in a Knowledge
Society: Towards a New Regime of Distributed Innovation?* Antrag für
Konferenz. [Online] Available from: http://archiv.pressestelle.tu–
berlin.de/pi/2003/pi188.htm [Accessed: December 10th, 2016].

Reckwitz, A. (2016) Das Kreativitätsdispositiv und die sozialen Regime des
Neuen. In Hutter, M., Knoblauch, H., Rammert, W. and Windeler A. (eds.),
Innovationsgesellschaft heute. Wiesbaden: Springer.

Rhodes, C. (2015) Writing Organization/Romancing Fictocriticism. *Culture
and Organization*, 21 (4), 289–303.

Schank, R.C. and Abelson, R.P. (1977) *Scripts, Plans, Goals, and
Understanding: An Inquiry into Human Knowledge Structures*. Oxford:
Lawrence Erlbaum.

Scott, S.V. and Orlikowski, W.J. (2012) Great Expectations: The Materiality
of Commensurability in Social Media. In Leonardi, P.M., Nardi, B.A. and
Kallinikos, J. (eds.), *Materiality and Organizing: Social Interaction in a
Technological World*. Oxford: Oxford University Press.

Suchman, L.A. (1987) *Plans and Situated Actions: The Problem of Human–
Machine Communication*. Cambridge: Cambridge University Press.

Velthuis, O. (ed.) (2005) *Imaginary Economics: Contemporary Artists and the
World of Big Money*. Rotterdam: NAi Publishers.

Zucker, L.G. (1977) The Role of Institutionalization in Cultural Persistence.
American Sociological Review, 42 (5), 726–743.

Zuiderent–Jerak, T. and Bruun Jensen, C. (2007) Editorial Introduction:
Unpacking 'Intervention' in Science and Technology Studies. *Science as
Culture*, 16 (3), 227–235.

Intermateriality and Enunciation: Remarks on *The Making of Law*

Giuditta BASSANO[*a]

[a] Università di Bologna

In 2002, Latour faced the problem of the constructing legal arguments. He published a study based on the ethnography of the Council of State, the French court of final appeal for administrative law. That project undertook a comparison of the world of science and the world of law. Among the many different aspects of the everyday practices at the Council, Latour focuses on the problem of legal instruments. He develops a very 'far out' analytical perspective on legal files, folders, and documents as crucial tools of the judge's work. Here, I deal with some issues concerning that study and contemporary actor network theory (ANT): the idea of there being different enunciational regimes in science and law; the usefulness of Latour's definitions of 'shifting out' and 'shifting in' to describe the inner organisation of a legal file; the importance of material tools, in order to describe how law is produced; and finally, the possible relationship between intermateriality and the concepts of delegates and technique in theorising enunciational regimes or 'modes of existence'.

Keywords: Intermateriality; shifting out; enunciation of law

Introduction

In 2002, Latour wrote a quite–eccentric book, *The Making of Law: An Ethnography of the Conseil d'État*. Here, he takes an interest in a kind of 'enunciation regime' (1999) different from those to which he more frequently devoted himself. *The Making of Law* is the result of a considerable body of field work that Latour had undertaken regarding French administrative law. He spent more than two years at the Council of State (*Conseil d'État*), which serves as both the headquarters and exclusive authority of France's final decisions in administrative law. In the French legal

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[*] Corresponding author: **Giuditta Bassano** | e–mail: **gbf.mu2@alice.it**

system, most claims against the national or local governments – as well as claims against private bodies that provide public services – are handled by administrative courts, which use the Council of State as a 'court of last resort' for both ordinary and special courts.

The field work behind this book shows many issues worthy of investigation. Latour sat in the tribunal room where the public audiences are given, but also behind the closed door, where the cases are discussed by the counsellors. In this way, he was able to analyse what was *in* the debates of the judges of the Court. He also focuses on office paraphernalia as indispensable material tools of cases: it is this aspect in which I am particularly interested.

Law and science

We need now to go back to two further and more general issues, both of which align with Latour's overall reflection. The first is the relationship between law and science. On this, he conceives the Council of State as a kind of 'laboratory of objectivity' that can be compared to scientific ones; in the preface to the English edition, he writes: 'I have done much field work to define the scientific way of establishing connections: what I called reference. This book is the laboratory life, not for the construction of facts, but for the construction of legal arguments' (Latour, 2010, p. ix). An entire chapter of the book is dedicated to a comparison of scientific laboratories and the Council of State, and the reason behind this comparison is also explained in the preface:

'Whatever I tried to do, religious and political enunciations seemed always to lament and repent for not being scientific enough […]. Only law has maintained a sturdy confidence in the validity of its own felicity conditions quite independently of what has happened to science. It is this unique feature that allowed me to have confidence in the project of systematically comparing the felicity and infelicity conditions of the different regimes of truth production that define the hard core of our cultures' (Latour, 2010, p. x).

Actually, in this sense, *The Making of Law* lies at the interface of earlier and later discourses, and it is here that Latour deals with law and science as regimes of enunciation. In 1999, he published a small text identifying nine regimes; there he introduces the difference between 'quasi–objects' regimes – the triplet of science, fiction, and technology – and those that

centre on 'quasi subjects' (i.e. law, politics, and religion). In 2013, Latour came to an extended version of the previous theory and started referring to the regimes of enunciation as 'modes of existence'. In what was anticipated as his *magnus opus*, he refines the ontological status of science and law, at any rate maintains what he had asserted in 1999. Science, then, could be characterised by 'proof'; he states that, 'for example, between a yeast culture, a photograph, a table of figures, a diagram, an equation, a caption, a title, a summary, a paragraph, and an article, something is *maintained* despite the successive transformations […] a sort of bridge that others can cross in turn. This bridge is what researchers call 'supplying the proof of the existence of a phenomenon' (Latour, 2013, p. 39). This is also the reason why science, together with fiction and technology, give shape to 'objects', to something continuous through different spaces and times. In the domain of law, differently, everything happens thanks to the miracle of proceedings as thought, by particular linkages, we were held to what we say and what we do. 'What you have done, signed, said, promised, given, *engages* you. […] With law, characters become assigned to their acts and to their goods. They find themselves responsible, guilty, owners, authors, insured, protected. And this authorized us to say that without law, utterances would be quite simply *unattributable*' (Latour, 2013, p. 370). Law is so centrifugal to objects: as with politics and religion, it treats objects only in what is an occasion for judging (or assembling, or praying). Law gives rather roles, functions, figurations to those who use or fabricate objects.

For the problem I wish to outline, the modes of existence of technology and of organisation are also crucial. Indeed, in *Inquiry into Modes of Existence*, law is considered also in relation to its technological aspects (Latour, 2013, p. 228) and to its function of concatenating organisational scripts (Latour, 2013, p. 397). The issue is, however, whether Latour is or is not implicitly including legal office paraphernalia in these functions that work to connect law to other modes. This will be the topic of the final paragraph.

Shifting out/shifting in

The second problem to which we need to return is Latour's idea of enunciation. It was by insisting on this notion and on those of 'shifting out' and 'shifting in' that he started exploring the idea of different modes of existence. Indeed, in 1988, he gave a very innovative account of Einstein's physics theory. Following semiotics, he introduced various concepts, like

'cotexts' instead of contexts, science as a specific form of narration, 'inscriptions' in scientific texts, and 'subscription' to an internal reference responsible for the effect of realism in such texts. His goal was to demonstrate that scientific papers are not mere reports of a science activity; on the very contrary, they build up frames of reference, and they delegate observers in others spaces and times and include precise strategies by which to 'call them back'. There, he writes that

> 'what we call 'meaning' is whatever is preserved in the movement through stories, and not *one* of the repertories obtained after reaching at last one final story. […] Operations like thinking, abstracting, building pictures, are not *above* other practical operations like setting up instruments, arraying devices, laying rods, but are *in between* them' (Latour, 1988, p. 35).

So, according to Latour, Einstein did not discover something that he *then* explained, but rather he wrote a book creating the validity of his theory of relativity, thanks to a set of displacing and recalling semiotic tools. He shifted out a first character (i.e. the author), who talks to another delegated character (i.e. the reader). This character then 'shifts out' again by creating a 'man on the embankment' who does various things – including, among them, a third 'shifting out', by imaging what 'a man in the train' would do and see. Later, each of the characters shifts back in. Latour's position had an unruly power, since he refused to consider on two different levels scientific practice and scientific literature; no longer would there be things on one side and words on the other: no longer would it be 'objectivity versus subjectivity'. What I also find very interesting is the fact that four years later, in 1992, he extended the concept of shifting out and shifting in to artefacts. It is seen in the description of what door hinges do in terms of human and nonhuman roles, around the task of managing what gets into and what gets a place. Humans – Latour argues – 'shift out' to the hinge of the activity of closing and opening the wall–holes we usually call doors (Latour, 1992, p. 229). In the same book, he repeats that

> 'a *shifting out* structures any displacement to another frame of reference that allows an actant to leave the ego, hic, nunc. [...] For narratives there are three shiftings: actorial, (from I to another actor and back – *shifting in*); spatial (from here to there and back – *shifting in*); temporal (from now to then and back – *shifting in*)' (Akrich and Latour, 1992, p. 260).

Mattozzi (2006) underscores how Latour distinguishes technical enunciation from enunciation in *verbal texts*. Indeed, Latour notices that

'if engineers constantly shift out characters in other spaces and other times, devise positions for human and nonhuman users, break down competences that they then re–distribute to many different actors, […] the technical shifting–out inscribes the words into another matter and forces the reader to choose between frames of reference. Instead of allowing enunciators and enunciatees a sort of simultaneous presence and communion to other actors, techniques allow both to ignore the delegated actors and walk away without even feeling their presence' (Latour, 1992, p. 169).

We can now return to Latour's ethnography, armed with two problematic remarks. 1) In both 1999 and 2013, Latour seemed to somehow overlook the technical–material aspects of law, but at the same time pay considerable attention to them while studying the Council of State. 2) His ideas of 'shifting out' and 'shifting in' are modelled on scientific literature, but he successfully extended it to artefacts: what then about objects that comprise both verbal texts and material actors? I hope to contribute to the discussion of these points through making the observations that will follow.

'Files, more files, nothing but files'

With respect to writing activities, Latour examines the difference between laboratories and the Council. For both scientists and judges (or lawyers), writing is an activity central to their work, but while judges write judgments so as to close a discussion definitively, researchers dream only of reopening discussions – or, if they are the ones to bring the discussion to an end, to do so to their own advantage. Another consideration regards addressees: when scientists write, they do it for other researchers, and sort of constrain invisible readers in every each line. Judges, on the other hand, write firstly for the claimant's lawyers, then secondly for their colleagues, and thirdly for the writers of legal doctrine. Laboratories and the Council also differ in terms of documents where activities are recorded. Scientists have protocol books in which they note what they propose to do, the raw results they obtain, and the provisional hypotheses suggested by those results. Such records have no less than a quasi–legal status in cases of fraud and patents.

The files of the Council, however, contain cases referred to the council. The file, he observes,

'has the closed, round and polished form of a grey cardboard folder [...] in which everything is held and which forms the small world to which the judge has to restrict himself, on pain of penalty. [...] There must be something in the file itself, in its closure, that supplies an essential reason's to law difference from the sciences' (Latour, 2010, p. 211).

In this way, the file becomes the keystone for a further statement about legal instruments:

'One can climb from the cellars of the Palais Royal, in which linear kilometres of archives lie in hibernation, to the attics, finding any real difference between the various objects that are essential to each branch of the work of the Council. Files, more files, nothing but files, to which one should add varying number of books and a profusion of elastic bands, paperclips, folders and rubber stamps. [...] All these tools have an intimate connection with textual matter' (Latour, 2010, p. 202).

Each file is unique, but they all consist of different 'layers of documents'. As an example, Latour chooses the case of a sad casualty: a young man who had been killed while skiing at a ski resort during a heavy snowfall. His father, the claimant, asked the Mayor (of the ski resort) for a sum, as reparations for his moral and material damages. The father is compelled to prove that the Mayor had committed an error by not closing the ski resort during the heavy snowfall. Hence, the particular folder of that case contains a number of different documents, produced by different institutions: reports by policemen and witnesses, letters from doctors, a disposition by the father, a certificate from the family doctor, documents of preliminary inquiry from the police, a map prepared to show the relevant locations, and a confirmation from the national meteorological institute about the bulletin for the fatal day. Furthermore, therein one finds a certificate of heredity that proves the relationship between father and son, invoices from the funeral director and from the parish priest, and the response from the district insurer. Latour then points out the importance of the file's route inside the Council premises: from secretaries to subsection offices, and from offices back to the claimants and defendants of the implicated parties. Potentially, other documents will arrive, even if a party does not answer

questions in the 'right' way, or replies after a statutory time limit has passed, or does not answer at all.

The most original thing Latour offers is with respect to the crucial physical/material means by which files are processed: once one specific folder passes the protocol reception, it is 'closely watched over, like milk that is put on to boil' (Latour, 2010, p. 111). From this point, all file operations must be adequate: each failed or successful operation can constitute a grievance, and could give rise to new litigation. Losing a document, forgetting to ask for the statement of defence, failing to raise the means of public order, and the like can influence and change the layers of the file, which so rapidly fill up.

Towards the idea of intermateriality

According to what was said about 'shifting out', I argue that it is not only useful to describe what the Council's judges do, as we all do, when we speak and write. We can also say that the documents held in the file constitute a set of sheets where specific actors, times, and spaces are 'shifted out'. As a general rule, the primary document of every file is an introductory claim in proceedings, which has been posted to the Council of State or sent by fax. Latour is very sensitive to the stage of claim reception, and writes that

> 'when the first appeal arrives at the Palais–Royal, it has already undergone a long history [...] whose traces can be recognized from the type of letterheaded paper, from the presence and name of some famous and expensive lawyer's firm, from the manner of writing and from the greater or lesser display of legal knowledge, texts of law and decrees' (Latour, 2010, p. 73).

Here's the movement quite opposite to 'shifting in': some traces *send* back from the actors, including the time and the space *in* the claim to the frame of reference of its production (i.e. the circumstances at the time of writing by someone, at a certain time and in a certain lawyer's firm, or in a police station, or in the house of a simple citizen). Upon acceptance, the claim is enveloped in a carton folder and given a number it will bear forever. The number is the only thing that the claimant receives at the very beginning: it signifies a place in a queue of files.

Then comes the moment when 'productions' are compared – namely, all the documents I spoke of that quote the accident of the young skier, and which must support the legal evidence of a claimant's request. The file is

now passed to an office that integrates it into ordering categories, according to its general character: degree of urgency, nature of litigation, and submission to court. It must then be filled with any sort of missing documents (e.g. confirmation of powers). At this moment, the time comes to generate a computer–formatted card of the claim, which will be the ID card of the case. Finally, the file is ready to be examined and linked to the vast corpus of Council judgments and to innumerable codes, decrees, and regulations. For many files, the journey ends here, with a rejection or annulment. However, for cases allowed to 'follow their course' (Latour, 2010, p. 89), there is a long way to go, because they still need to be opened by the judges of the court.
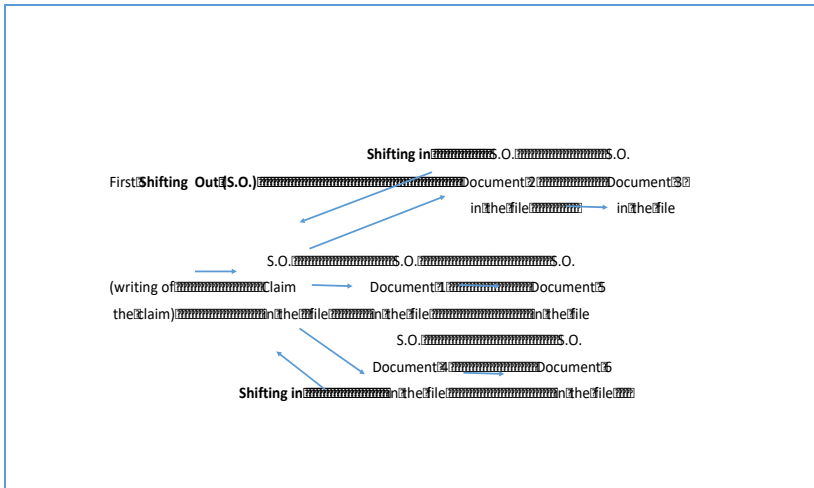
Figure 1   The structure of the inner frames of reference in a legal file.

With respect to all these details, Latour studied the 'slow fabrication of a file' (Latour, 2010, p. 83), and he allows us to see how 'shifting out' is made not only by humans. In dealing with doors in the extended notion of 'shifting out', it is possible to say that the device of door–closers impose back on humans some 'prescriptions'; nonetheless, it is a short step to say that legal nonhuman actors can shift out frames of reference. The idea that there is a somehow inescapable agency of the objects in terms of 'shiftings out' and 'shiftings in' is today accepted in semiotics (Landowski and Marrone, 2002; Mattozzi, 2006), and it does not seem to dumbfound the same Latour (1994). If we assume a preliminary 'shifting out' of the initial claim – wherein someone, a human, put into writing an appeal – in the moment the letter is

opened or the fax is transmitted, it starts to 'shift out' a frame of reference (i.e. concerning actors, time, and space) that constrains the council staff to verify its accuracy and to handle it. At this point, the file starts to serve as the frame of reference of successive inner 'shiftings out', which are produced by the connections among the documents that, little by little, fill it. Each of them, at the same time, will include elements that shift back into one or more of the previous layers (fig. 1).

In such a network of verbal actors, signatures, verbs, and the names of codes and people all hold the same relevance, as nonverbal actors. A folder unifies the documents, there are elastic bands that help the folder to enclose itself, there are paper clips that allow close readings of sheets of different characters, there are rubber stamps that fix the file's age since its entrance to the Council, and it has a unique number that distinguishes the file from all the others. There are also material actors (e.g. highlighters, correction fluid, adhesive note papers). They illuminate incontestable proofs, correct intolerable mistakes, and invalidate or readdress documents. It is possible, then, to consider the physical parts of the file not as mere supports and accessories. Along with its function of as a frame of reference for the progressive 'shiftings out' of its successive layers, the file drives its legal use in terms of prescriptions, allowances, proscriptions, and affordances. An argument connects a document in the file with another, but not in the way that paper clips do; a rule concerning deadlines invalidates a report included in the folder, as the bulk of the mass of sheets hides the relationship between one layer and another (figg. 2 and 3).
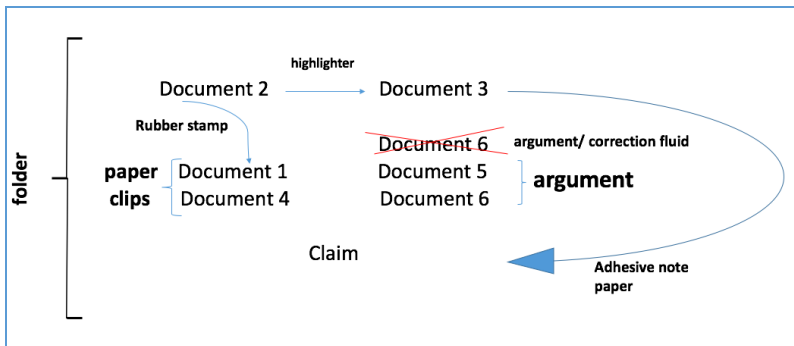
Figure 2   Actors in legal 'shiftings out' and 'shiftings in'.

Figure 3   A collection of legal files, both as cases and as masses of sheets.

The legal enunciation regime, and legal tools

Following what has been said, we still need to respond to the aforementioned problematic remarks. The proposition of analysing a legal intermateriality level as having the same importance as one of a legal intertextuality level (Latour, 2010, p. 92) turns out to be very faithful to some of Latour's assertions, while somehow questioning some others. At first, it seems to me that sustaining the importance and trying to define the roles of nonhuman actors in theorising law are things that align with the general project of an ANT. Secondly, I tried to take into account Latour's considerations of urgency, to reformulate the relationship between practice and the literature: the ideal passage from facts to words – in law, as it is in science – is found to be one of pure illusion, as shown when describing an architecture of supports and frames through which a legal decision necessarily passes.

However, it is also true that the idea of a legal–technical enunciation poses three problems. The first relates to Latour's conception of 'shifting out'. Indeed, to consider something a legal file complicates enormously passage from one frame of reference to another: here, there is no longer an actor (i.e. an artefact delegated by a human, or a verbal fictional subject 'shifted out' from another), but rather a swarm of actors that are

simultaneously sent and recalled by a multiplicity of levels, both verbal and material. The second one concerns the idea of 'subscriptions' in science, and it allows us to illuminate a very specific aspect of the production of law. Latour says that the reader of an astronomy paper believes that he or she could be permitted to return to the astronomer's observatory to superimpose the traces of the stars read with traces present in the lab, but this cannot work with law. Here, 'facts' no longer exist; they cannot be replicated. One could object that this is precisely why law is a mode of existence based on subjects, while science is based on objects: I would definitively agree, but it also changes the status of material tools in law, in respect of the material tools in science.

This is how I come to the third point. Looking at the modes of existence of technology and organisation, is it possible to say that the material elements of law work as if they would be borrowed from other modes – namely, those of technology and organisation? I assume that the answer must be 'no', since the material elements of law – both in terms of supports and texts – are more similar to the proteins or to the planets that scientists notoriously do not 'include' in their papers. Not one professional working in law could ever ignore a legal file, as it represents a useful gathering of technical devices – nor could anyone freely reorganise it, as would be expected in the mode of organisation. It is clear that there is the possibility of establishing an entire material anthropology of the law.

References

Akrich, M. and Latour, B. (1992) A Summary of a Convenient Vocabulary for the Semiotics of Human and Nonhuman Assemblies. In Bijker, W. and Law, J. (eds.) *Shaping Technology–building Society: Studies in Sociotechnical Change*. Cambridge: MIT Press.

Bijker, W. and Law, J. (eds.) (1992) *Shaping Technology–building Society: Studies in Sociotechnical Change.* Cambridge: MIT Press.

Landowski, E. and Marrone, G. (eds.) (2002) *La società degli oggetti. Problemi di interoggettività*. Roma: Meltemi.

Latour, B. (1988) A Relativistic Account of Einstein's Relativity. *Social Studies of Science*, 18 (1), 3–44.

Latour, B. (1992) Where Are the Missing Masses? The Sociology of a Few Mundane Artifacts. In Bijker, W. and Law, J. (eds.) *Shaping Technology–building Society: Studies in Sociotechnical Change*. Cambridge: MIT Press.

Latour, B. (1994) Une sociologie sans objet? Remarques sur l'interobjectivité. *Sociologie du travail*, 36 (4), 586–607.

Latour, B. (1999) Piccola filosofia dell'enunciazione. In Basso, P. and Corrain, L. (eds.) *Eloquio del senso. Dialoghi semiotici per Paolo Fabbri*. Milano: Costa&Nolan.

Latour, B. (2010) *The Making of Law. An Ethnography of the Conseil d'Etat*. Cambridge: Polity Press.

Latour, B. (2013) *An Inquiry into Modes of Existence. An Anthropology of the Moderns*. Cambridge and London: Harvard University Press.

Latour, B. and Woolgar, S. (1979) *Laboratory Life: The Construction of Scientific Facts*. London: Sage.

Mattozzi, A. (ed.) (2006) *Il senso degli oggetti tecnici*. Roma: Meltemi.

Infrastructuring is the New Black: Challenges and Opportunities of a Fascinating Intellectual Tool

Teresa MACCHIA [*a]

[a] Digital Catapult

During the last twenty years, the notion of infrastructure evolved towards the notion of infrastructuring. This transition has happened since Information and Communication Technologies (ICTs) became gradually more complicated and linked to one another. The development of interlinked ICTs called for identifying the implication of this new technologies into the society.

This paper analyses the core steps of the evolution of the notions of infrastructure and infrastructuring by providing a definition of their adoption. Hence, the paper clarifies the condition in which the notion of infrastructuring takes place and can be apply for describing implication and use of ICTs.

In the process of unfolding the complex concept of infrastructuring, the paper articulates and unpacks the different employments in the current literature related to infrastructure and infrastructuring. However, the argument is built on a European project related to IoT technologies that can be defined as an example of an ongoing process of infrastructuring. The focus of the project is of stimulating interoperable environments dotted by a constellation of empowering relationships.

Keywords: Infrastructure; infrastructuring; Internet of Things; standards; interoperability

Introduction

Yoko Akama challenging described the notion of infrastructuring as the 'New Black' since it has been discussed by several scholars in different subject areas. However, notion of 'infrastructuring' in a juxtaposition of 'infrastructure' adopted across STS literature calls for reflections on the *how* and *why* these notions received an extensive use in the literature. While the

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notion of infrastructure roots on features that refer to local practices that integrate technologies into a functioning system (Star and Ruhleder, 1996), the notion of infrastructuring explains the persistency and the evolution in time of a sociotechnical phenomenon (Karasti and Syrjänen, 2004). Thus, drawing upon on the transition from the notion of infrastructure to the notion of infrastructuring, this paper analyses the notion of infrastructuring in terms of a participatory mediated action.

The discussion is built on activities related to Unify–IoT, an H2020 project meant to connect seven other European projects that explores the issues and the opportunities of interoperable Internet of Things (IoT). The question of interoperability poses the issue of mediating mechanisms for defining new and mutual recognized frames of action. Hence, the definition of new frames of action is a process that grows and expands in time. For examining and describing the gradual process of the definition of standards related to IoT technologies suggests the adoption of the notion of infrastructuring.

The notion of infrastructuring was shaped from the one of infrastructure, which firstly highlighted features of information systems as parts of a sociotechnical environment. Both, the notion of infrastructure and infrastructuring help to picture, represent, and embrace the complex and articulated nature of the overloaded society (Bowker, 2005).

To address this topic, the paper is organized as follows: the next section aligns the IoT discussions within the frame of infrastructuring as tool for approaching complex phenomena. The third section presents the Unify–IoT project in combination with notion of infrastructuring. While, the forth section describes the four principles employed to study a specific phenomenon by employing the concept of infrastructuring. The paper concludes by elaborating how the concept of infrastructuring helps the definition of Internet of Things technologies as vehicles of interactions and social activities.

IoT technologies for interconnecting society: an infrastructuring impression

This section introduces how we can look at IoT technologies through the lens of STS, more specifically through the notion of infrastructuring.

With the expansion of connected and connecting sensors, we are able to monitor and enhance the environment around us (Wortmann and Flüchter, 2015). As Wortmann and Flüchter summarised in their paper (2015, p. 221),

IoT technologies are making 'smart' many different contexts and settings in homes or building areas by developing 'intelligent thermostats and security systems [and] smart electricity, gas and water meters'. Cities become 'smart' by technologically enhancing transport solutions with 'vehicle fleet tracking and mobile ticketing' and by adopting real–time monitoring solutions for 'parking spaces availability and intelligent lighting of streets'. Additionally, the healthcare sector expands with new technologies for 'patients' surveillance and chronic disease management' (Wortmann and Flüchter, 2015, p. 222).

In the context of sophisticated information technologies and hyper–connected spaces, our experience on the environment evolves through and together with the infrastructures (Bowker, 2016). Facing and understanding that our experience of the environment is evolving, means that we need to reframe the way we look at the effects of new information technologies on people communicating and interacting activities. Moreover, IoT technologies have been reasonably perfected and expanded upon during the last five years and (hyper)connect people, organisations, things, and the environment. However, the definition of IoT is relatively recent and describes objects and devices that are connected with, and communicate through the internet (Evans, 2011).

In relation with Star and Ruhleder's (1996) definition of infrastructure, the IoT technology happens to be an intriguing example. The nine features of infrastructure seem to fit the characteristics of the IoT technology: embeddedness, transparency, reach or scope, learned as part of membership, links with conversations of practice, embodiment of standards, built on an installed base, it becomes visible upon breakdown, and it is fixed in modular increment, not all at once or globally. Hence, IoT technology, with its system of devices, networks, and managing applications stimulates and engages a new standard of interpretation and perception of interactions. Moreover, IoT technology follows the inclination of the 'traditional' internet that positions 'into place a set of agreements' that includes and embeds physical and protocol levels (Bowker, 2005).

Transactions, communications, and negotiations are embodied in a formal procedure that creates a recognised standard not only from a technical perspective but on a *social* perspective. IoT technologies are impacting the circulation and the use of data through different assessments affecting people's daily life. Looking at IoT through the notion of infrastructure increases the number of questions and challenges on the way we can look and study its impact on people's interactions as a set of 'values,

norms, rights and the social fabric' (Guimarães Pereira, Benessia and Curvlo, 2013).

IoT technology is a complex, multi–layered, and in–time example of creating, 'storing and manipulating, and presenting information' (Bowker, 2005). The morphology of IoT technology combines input and output with the surrounding environment highlighting the intense effects that come together with it. Hence, the notion of infrastructuring (Macchia, Poderi and D'Andrea, 2015) can help to understand and configure IoT technology as a combination of strategies, locus, and standards.

It is within this growing IoT scenario that a new paradigm of interaction is settling down. There are new issues to understand and to face in the context of socio–technical interactions. Thus, this paper builds upon the understanding of the concept of infrastructuring, focusing on different layers of human–to–human, technology–to–technology, and human–technology interactions. New criteria of communication and interactions are settled down by the access to the scene of IoT technologies which change the conceptual structure of the human–technology interaction. The IoT interaction includes and emphasised the position of things connected and communicating together for activating the environment and allowing people's independent action. It is in this scenario that the notion of infrastructuring helps to put light on how our interconnected society operates, interacts, and negotiates.

Making infrastructure a moving notion: infrastructuring

As mentioned earlier in this section, the notion of infrastructure contributes to providing an initial understanding of the IoT features. However, that notion fails to provide a set of features related to the interconnecting and evolving nature of IoT. This sub–section describes the evolutionary steps that brought the notion of infrastructure to the current notion of infrastructuring.

The concept of infrastructure is quite a challenging one. It has been adopted and investigated and adapted by various scholars and is useful for highlighting the impact of information systems on the interaction with human and non–human (fig. 1). Moreover, evoking the notion of hypertext (Bowker and Star, 1999), the concept of infrastructure reveals the association and standardisation of the features of the infrastructures. It is together with the notion of ecology and of the redefinition of the information experience that the changing and evolving aspects rise and encourage the adoption of the –*ing*.

Figure 3   From infrastructure to infrastructuring an evolution process.

Since Star and Ruhleder (1996) introduced the concept of infrastructure, it has been recalled and discussed in a variety of ways: for tracing guidelines and directions for reviewing Information Systems (Bowker and Star, 1999); for disentangling the 'intricacies involved in the collaborative development of scientific information infrastructures' (Karasti, Baker and Millerand, 2010); for proposing an explanatory understanding of socially related commons (Marttila, Botero and Saad–Sulonen, 2014). Moreover, the notion of infrastructuring has been broadly investigated since it was first introduced in the academic language by Helena Karasti and Anna–Liisa Syrjänen (2004) to highlight the 'embedded, ongoing, and multi–relational activity' in Participatory Design. In their paper, Karasti and Syrjänen combine two core aspects of the relationship among technology and human–being: artful integration and infrastructure. The meaning of 'artful integration' is the one of expanding consciousness on 'the existence of hybrid systems composed of heterogeneous devices' (Suchman, 2002).

Hence, the core feature of the *–ing* lays on the suggestion of a network of relationships, processes, actions and dynamics of the *infrastructure* that happens to be a changing and evolving *thing*. Infrastructuring highlights 'strategies for making' things of public domain that is relevant to people's experiences (Ehn, 2008). In addition to the concept of infrastructure, infrastructuring informs the analysis and the design of collaborative and relational experiences that involve people and technologies. However, the adoption of this concept evolved and exploded through complementary research areas and investigates disparate subjects: from knowledge (Karasti, Baker and Millerand, 2010; Macchia, 2016) to design (Light and Akama, 2015; Simonsen, Hertzum and Karasti, 2015). In relation to the adjustment from infrastructure for describing the complex nature of the human/non–human relationship (Bowker and Star, 1999; Karasti and Syrjänen, 2004) to

infrastructuring as 'opposed to project' (Karasti, 2014; Björgvinsson, Ehn and Hillgren, 2010). The concept of 'infrastructuring' continues with the consideration that the 'success of a technology depends on the strength and size of the groups that take it up and promote it' (Sismondo, 2008, p. 16). Hence, the core of the notion of infrastructuring is the evolution in time of interactions existing in the environment. To the degree at which environment affects the relationship of interaction components, to that degree components are exposed to sudden changes.

This is a rather relevant understanding in respect to the way we look at IoT technologies as this means that interactions evolve in time rather than being preserved as they are. IoT technologies radically change our approach to think, collect, and analyse data, and the way we consider the output of the interaction itself.

Thus the notion of infrastructuring can help to approach the current situation and the progress of the over–connected environment. Nevertheless, little exploration has been dedicated to describing how the notion of infrastructuring is helpful and what the challenges would be. In this perspective, the revision of infrastructuring concept, makes the latter not simply an analytical tool but an approach to analyse a specific phenomenon (Macchia, Diaz and D'Andrea, 2014; Macchia, Poderi and D'Andrea, 2015). Specifically, infrastructuring can be employed as a guideline for looking at a technology that is embedded in the environment is changing and affecting the way to communicate and interact. Thus the notion of infrastructuring comes as support for unpacking and translating interactions into a self–explanatory narrative.

To summarise, the notion of infrastructuring highlights the evolutionary dynamics that bring interactions into a different level. Thus, this notion may be effective for recognising features that trigger a change an interaction on a technological and social level.

Learning from Unify–IoT: the case of supporting interoperability

Unify–IoT aims at improving understanding of potential employments of IoT technologies. Hence, Unify–IoT works in association with Coordination and Support Actions (CSAs) and Research and Innovation actions (RIAs) that consist of seven research and innovation projects (please visit the following link for further information on the IoT– EPIs: http://iot–epi.eu/projects/). Each project focuses on different IoT sectors from designing, implanting, and

testing IoT platforms for Smart cities and Smart mobility to Environment/Energy monitory and recycling; and from Smart retail to Smart healthcare and Quantified Self.

For achieving an effective understanding on IoT, the Unify–IoT focuses on IoT platforms development for identifying a 'common language' related to the Internet of Things (IoT). One of the core challenges of the project is to support communication and to enable interoperability among parties. Interoperability means to develop solutions that while covering different aspects of daily life, allow data to be exchanged across different domains creating a condition for developers to create new and innovative applications. Thinking and developing a shared IoT architecture need to focus on a set of various parts of the technology from 'model, specifications, requirements, features and functionality'. Overall, an interoperable framework is relevant for synchronising with the constant and challenging improvement of IoT technology.

In this framework, one of the core objectives for Unify–IoT is to address the interoperability issue among IoT technology. The project aims 'to overcome the increasing market fragmentations by delivering solutions for IoT platform interoperability and demonstrating the benefit of the resulting interoperability in different real world pilots.' (Gluhak et al., 2016, p. 6). Moreover, the focus on interoperability issues aims to overcome technical problems for the user adoption and management, as well as to improve reliability of devices overall in respect to cross–domain operation. Furthermore, as one of the processes for helping the establishment of an interoperable approach, such project is developing and supporting the creation of 'a vibrant IoT ecosystem, which can pave the way for significant scale–up of IoT solutions thanks to the interoperability with other platforms and services' (Delgado et al. 2016, p.13). For stimulating the ecosystem and by this supporting further interoperable practices, Unify–IoT is stimulating and encouraging by providing different activities, the other seven European projects to adopt a framework of actions that rise awareness and understanding on dealing with interoperability. To create an IoT community, Unify–IoT aims to improve the promotion, communication, and sharing information plan of RIAs, introducing appropriate tools such as hackathon, conferences, and workshop. These activities support the communication and connection among developers, end–users, and other stakeholders. The overarching objective of the project is to address value–cocreation, business strategies, innovation, and standardisation while identifying interoperable outcomes. Therefore, high level of interest for interoperability in the IoT

ecosystem is fundamental to the future success of such technology. Principal concern for IoT technologies is the ability of devices to communicate and work through platforms defined as 'set of enablers and tools that abstracts service creation from data generators and actuators' (Juan Rico, https://twitter.com/j_rico_/status/790861272132816896).

It is in this scenario of willing for stimulating and encouraging interoperability, and creating a common language among IoT projects that I found myself interrogating how the notion of infrastructuring help to portrays the issue of interoperability; why such notion can assist the discussion related to interoperability; how this notion can be (or not be) applied for understanding and strategically shape socio–technical phenomena crossing our path.

The following section discusses in what terms the experience of looking for a standard definition and construction of IoT technological environment can be approached through the notion of infrastructuring. Simonsen and colleagues describe infrastructuring as a set of activities that 'does not simply happen; it must be supported' and provide a list of needs that allow and support infrastructuring (Simonsen, Hertzum and Karasti, 2015). The authors highlight the need for general orchestration, interconnection, cooperation, reconfiguration, and intervention among different parties in an organisation. Moreover, their definition of infrastructure embeds the notion of time and describes infrastructuring in hospitals as a 'longitudinal activity intertwined with ongoing and clinical work'.

When talking about infrastructuring

In line with Simonsen and colleagues' interpretation of infrastructuring, I agree with grounding the definition on the ongoing and relational features of activities. Besides, infrastructuring highlights transformations and describes changes and reconfigurations of power relationships. By adopting this description of infrastructuring, I look at the Unify–IoT project tasks and components to understand which are the factors that can characterise a process under the line of infrastructuring.

What participating in Unify–IoT taught to me

IoT platforms can be supported by a vast variety of technologies, differently combined with/to one another, from semiconductors and sensors to operating systems and analytical services; from communication hardware and developer tools to complete devices and protocols.

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Moreover, IoT platforms together with these technologies support and cover a variety of different market segments that are 'consumers' or 'business' oriented and that serve and assist health and home care, lifestyle, mobility, city and manufacturing management, and diverse public sectors. The Unify–IoT is not an exception in this panorama. Among partners and RIAs, the project includes groups who aim to develop platforms and technologies that fit in a variety of segments. An aspect that requires itself a different language.

Internet of Things integrates people's lives – as *all* of other technologies do – and it noiselessly incorporates people's spaces. However, because these technologies can cover multiple functionalities from collecting data for informing, to collecting data for activating interactive devices, the construction of a common language happens to be feeble in the absence of a careful negotiation and exchange of information. For instance, the conversation and the actions for performing the project tasks were pushed to support and stimulate equal discussion among parties providing spaces and occasions for everyone to add value and support in building a combined language. The negotiation for the establishment of a common language among parties, a language that was there to explain how 'this' platform suits 'this' application, while 'that' other platform suits this other at its best. It is not only about compromising. It is about negotiating the advancement of functionalities of IoT technologies. For each negotiating experience, there is a change. For each change, there is a new interoperable discussion to be opened.

The negotiation is about instructing parties on the limits and the potentials encountered by developing and using a connected device. Thus, the compromise brings the development of the IoT technology towards another level in which functionalities are increased and improved for opening spaces for future technologies. Hence, the process of building a shared understanding and language related to IoT platforms is about mutually giving permissions to access to new and different competences for addressing new shapes. The instance in the interoperable discussion is about knowing where the IoT technologies currently are, so to ensure the appropriate information to progress to the next level.

Conclusion

IoT interoperability is the result of a common and shared interpretation of technologies. The evolution of the technology is an accommodation and

elaboration of the implication the technology has into a particular context instead of another.

Discussions related to IoT technologies focus on the formulation of interoperable frames among platforms and devices, for facilitating developers and end users use of technologies. Hence, the elaboration of a common definition of categories/features/descriptions of the platform is rather a continuous and elaborated negotiation of interpreting the technology. The adoption of an infrastructuring approach for defining IoT interoperability is an approach for opening towards the advancement of the technology, rather than providing analytical answers. In line with this description, adopting this notion as an approach to technology development is rather providing a negotiation space.

For a negotiation and technological change to happen, people participating in the definition of the technology need to be *experts*, which means to be participating in the process of understanding the features of the technology or be willing to image how technology can be changed. Hence, infrastructuring is about orchestrating and stimulating changes for bringing technology into a different condition. It is a work of negotiation and conflict. For this purpose, the environment has to leave the space for the 'infrastructurer' to be able to interact, to have the opportunity to modify, calibrate, and reframe the negotiation. Adopting an 'infrastructuring approach' is opening towards an opportunity of change that can happen when a technology is mature enough to be reinterpreted and placed differently by infrastructurer. Infrastructurer act within a common space of discussion and unshared requirements. So far 'infrastructuring' implies empowerment of inexistent interactions. Thus, by its means, infrastructuring implies changes. Changes mean the ability to introduce a breaking component, concerning a service or technology.

Describing the notion of infrastructuring as the new black was meant to provoke and stimulate further reflections on its use. It is an operational method that focuses on changes, accommodation, and reconfiguration of technologies which are active in space and in time. The reason for adopting this notion for looking at socio–technical phenomenon is to help researchers as well technologists and designers. Developing technology is a continuum of different interpretation and negotiations that bring to the reconfiguration of external technologies. Therefore, the notion of 'infrastructuring' allows us to look at the process of implicitly and informally recognised standards with an inch of expectation of changes stimulated and brought by different parties involved in the 'definition' of technology.

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References

Björgvinsson, E., Ehn, P. and Hillgren, P. (2010) Participatory Design and Democratising Innovation. In *Proceedings of the 11th Biennial Participatory Design Conference.* New York: ACM.

Bowker, G. (2005) *Memory Practices in the Science*. Cambridge and London: MIT Press.

Bowker, G. (2016) *The Data Citizen – New Modes of Being in the emergent Internet of Things*. [Online] Available at: https://ethos.itu.dk/2016/01/21/public–talk–geoffrey–bowker–on–the–data–citizen [Accessed: March 5th, 2017].

Bowker, G. and Star, S.L. (1999) *Sorting Things Out: Classification and Its Consequences*. Cambridge and London: MIT Press.

Delgado, M.T., Osella. M., Pastrone, C., Spirito, M., Tringale, A., Vermesan, O., Bahr, R., Gluhak A., Clari, F., Hoeer, H. Bösenberg, F., Senigalliesi, M. and Barchetti, V. (2016) *D01.01 Value Co–Creation Mechanisms*. [Online] Available at: http://www.unify–iot.eu/wp–content/uploads/2016/10/D01_01_WP02_H2020_UNIFY–IoT_Final.pdf. [Accessed: March 5th, 2017].

Ehn, P. (2008) Participation in Design Things. In *Proceedings of the Tenth Anniversary Conference on Participatory Design.* New York: ACM.

Evans, D. (2011) *The Internet of Things. How the Next Evolution of the Internet Is Changing Everything*. CISCO White paper. [Online] Available at: http://www.cisco.com/web/about/ac79/docs/innov/IoT_IBSG_0411FINAL.pdf. [Accessed: November 7th, 2016].

Gluhak, A., Vermesan, O., Bhar, R., Clari, F., Macchia, T., Delgado, M.T., Hoeer, A., Bösenberg, F., Senigalliesi, M. and Barchetti, V. (2016) *D03.01 Report on IoT Platforms Activities*. [Online] Available at: http://www.unify–iot.eu/wp–

content/uploads/2016/10/D03_01_WP02_H2020_UNIFY–IoT_Final.pdf
[Accessed: March 5th, 2017].

Guimarães Pereira, A., Benessia, A. and Curvlo, P. (2013) *Agency in the Internet of Things*. Joint Research Centre Institute for the Protection and Security of the Citizen*.* [Online] Available at: http://publications.jrc.ec.europa.eu/repository/bitstream/JRC87270/lbna26459enn.pdf. [Accessed: November 7th, 2016].

Karasti, H. (2014) Infrastructuring in Participatory Design. In *Proceedings of the 13th Participatory Design Conference Research Papers. Volume 1.* New York: ACM.

Karasti, H. and Syrjänen, A. (2004) Artful Infrastructuring in Two Cases of Community PD. In *Proceedings of the 8th Conference on Participatory Design. Artful Integration: Interweaving Media, Materials and Practices. Volume 1.* New York: ACM.

Karasti, H., Baker, K.S. and Millerand, F. (2010) Infrastructure Time: Long–term Matters in Collaborative Development. *Computer Supported Cooperative Work*, 19 (3), 377–415.

Light, A. and Akama, Y. (2014) Structuring Future Social Relations: The Politics of Care in Participatory Practice. In *Proceedings of the 13th Participatory Design Conference: Research Papers. Volume 1*. New York: ACM.

Macchia, T. (2016) Design Exhibition through Technological Infrastructuring. In Bruni, A. (ed.), *Designing Work, Technology, Organizations and Vice Versa*. Willington and Malaga: Vernon Press.

Macchia, T., Diaz, L. and D'Andrea V. (2014) *Participating in Infrastructuring. The Active Role of Visitors and Curators in Museum*. Paper presented at the 5th STS Italia Conference, Milan (IT).

Macchia, T., Poderi, G. and D'Andrea, V. (2015) Infrastructuring Knowledge in Cultural Infrastructure: Informal Example of Participatory Design for Museum Exhibition. *International Journal of Sociotechnology and Knowledge Development*, 7 (1), 16–32.

Marttila, S., Botero, A. and Saad–Sulonen, J. (2014) Towards Commons Design in Participatory Design. In *Proceedings of the 13th Participatory Design Conference: Short Papers, Industry Cases, Workshop Descriptions, Doctoral Consortium Papers, and Keynote Abstracts. Volume 2.* New York: ACM.

Simonsen, J., Hertzum, M. and Karasti, H. (2015) *Supporting Clinicians in Infrastructuring*. Paper presented at the 5th International Workshop on

Infrastructures for Healthcare: Patient–centred Care and Patient–generated Data, Trento (IT).

Sismondo, S. (2008) Science and Technology Studies and an Engaged Program. In Hackett, E. (eds), *The Handbook of Science and Technology Studies*. Cambridge and London: MIT Press.

Star, S.L. and Ruhleder, K. (1996) Steps Toward an Ecology of Infrastructure: Design and Access for Large Information Space. *Information Systems Research*, 7 (1), 111–134.

Suchman, L. (2002) Located Accountabilities in Technology Production. *Scandinavian Journal of Information Systems*, 14 (2), 91–105.

Wortmann, F. and Flüchter, K. (2015) Internet of Things: Technology and Value Added. *Business & Information Systems Engineering*, 53 (7), 221–224.

Changing Complex Sociotechnical Infrastructures: The Case of ATM

Roberta CUEL[a], Giusi ORABONA[a] and Diego PONTE[*a]

[a] Università di Trento

The aim of the paper is to analyse the decision processes that are taken to implement a planned change, in a complex ecosystem. As described by various authors in the so called second–generation development of STS theory, decisions are obligatory passage points of any change that affects the evolution of infrastructures. In this work decisions processes are not discrete decisions, but are considered as patterns of exchange and communication which reduce the equivocality of a problematic issue. In particular, we analyse the decision processes carried on by experts in Air Traffic Management (ATM) system and we sketch out whether and to what extend different decision making practices come into play in the adoption of an ATM changes and in the construction of the correlated socio–technical system.

As depicted in literature, we take advantage of the case study analysis which allow us to identity the main building blocks trough which infrastructures change.

Keywords: *Infrastructure; invisibility; decision processes*

Introduction

In this paper, we analyse decision processes used to implement changes in Air Traffic Management (ATM) systems. ATM systems are complex infrastructures aimed at assisting aircraft flights through distinct activities, such as air traffic control, air traffic flow management and other information services. Thanks to the ecological approach, we studied the complex interrelations among heterogeneous elements using both intra– and inter–organizational perspectives.

When a change needs to be implemented in the ATM, different and complex relationships occur and may underline some practices embedded in

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[*] Corresponding author: **Diego Ponte** | e–mail: **diego.ponte@unitn.it**

the socio–technical infrastructure shared by the actors. The relationships involved in decision processes affect the practices of actors making (in)visible ATM infrastructure that can be seen as an ecology constituted by interrelated elements that are continuously negotiated.

In this paper we analyse these relationships and their visibility. The analysis is conducted through the interpretation of semi–structured interviews with stakeholders involved in decision processes. In our conclusion, we sketch out whether and to what extend different decision making practices come into play in the adoption of an ATM change and in the construction of the correlated socio–technical system.

The paper is structured as such. The second section describes the notion of infrastructure and its (in)visibility. The third section discusses about invisibility and decision processes. The fourth section introduces the case study. The fifth sketches out some conclusions.

Infrastructures and (in)visibility

Sociotechnical infrastructure might be defined as a robust network of people, artefacts, and institutions that generate, share and maintain specific knowledge about the human and natural worlds (Edwards, 2010). A large body of literature spanning from interactionism to the workplace studies about infrastructures, emphasizes the importance of infrastructure's human elements such as work practices, individual habits, and organizational culture (Bowker and Star, 1999; Edwards, 2003; Heath and Luff, 2000; Mongili and Pellegrino, 2014; Star and Ruhleder, 1996; Schmidt and Bannon, 2013). These elements stress on the importance of the relations in an infrastructure. Two important characteristics (Bowker and Star, 1999; Bowker et al. 2010; Neumann and Star, 1996; Star, 2002; Star and Ruhleder, 1996) of the socio–technical infrastructure should be underlined:

- The infrastructure is the result of negotiation among heterogeneous actors.
- Within an infrastructure, people are connected to activities, structures and cognitive elements.

Infrastructure is embedded in stable work practices and become visible when work within or across communities breaks down (Star, 1999; Star and Ruhleder, 1996). Therefore, various studies have analysed the evolution of socio–technical infrastructures. Among others, Edwards et al. (2009) focused on two moments that seem to mark the evolution of the largest infrastructures:

1. Transition: it is the moment in which technical, social innovations and policies previously separated, will bind together to form a new, larger and 'powerful network'.
2. Adjustment: it is the moment in which an infrastructure fits and remodels, without aggregating previously separated elements, but only 'adjusting' them according the organizational needs.

In this line, STS studies have analysed the infrastructure starting from the invisibility concept. This means that the infrastructures are typically embedded in practices, embodied in routines. Therefore, they exist in the background, are invisible and are taken–for–granted by actors who perform routines (e.g. Bowker and Star, 1999; Bowker et al. 2010; Neumann and Star 1996; Star, 1999, 2002).

Socio–technical infrastructure becomes visible when it breaks. For instance, when a server goes down, a bridge washes out, or when a power blackout occurs, the infrastructure becomes very evident for the actors that use it. Therefore, they attempt to create and implement ex–ante and ex–post procedures (such as back–up mechanisms or other emergency procedures) which tend to fix breaks and bugs (Star and Ruhleder, 1996). In very complex systems, it may happen that a change is required by an actor in the system. The actor may push the others to plan changes of their own practices and/or infrastructures according to this new aim. This 'planned change' makes the infrastructure visible allowing actors to take decisions about its evolution. In this paper, we focus our study on this latter situation, in which actors take decisions to change the current ATM complex systems.

(In)visibility and decision processes

From an organizational point of view, decisions that have consequences on an entire ecosystem are usually made by groups (Huber, 1980; Robbins, 1992; Vroom and Jago, 1988). The essence of each organization is to coordinate diverse contributions and accomplish a goal that could not have been achieved by any of the group members working alone (Maznevski, 1994). A planned change of an infrastructure involves a multitude of decisions about:

1. the infrastructure as the result of negotiation among heterogeneous actors and
2. the interconnections among people, activities, structures and cognitive elements.

As such, the change of an infrastructure is a very complex set of processes, it and implies various phases and involves many actors. In other words, it is not an instantaneous process, it requires time and reiterative development. Since the infrastructure supports and is, in turn, inhabited by social and technical elements and relationships, the changes cannot refer only to the technological sphere; rather, they are the result of actors' negotiations on practices, routines, and all the socio–technical elements that compose the infrastructure itself. Among others, Pava (1983) in a second–generation development of STS theory, argued that decision processes are patterns of negotiations used to reduce the uncertainty of a problematic issue. Moreover, decision processes are not individual activities and are not discrete decisions, they are embedded into a cyclic and continuous development.

This implies that the infrastructures tend to be aligned with the planned changes, new practices, culture, embedded knowledge, etc. (Hanseth and Lundberg, 2001).

In the specific case of planned changes, actors take decisions on their interpretations of the infrastructure. In order to do that, they first analyse the infrastructure they see/perceive; secondly, they foresee/plan a change and finally they crystallize the moment in which the individuals enact the direction and shape a change trajectory.

According to Corbin and Strauss (1988) the key elements of this decision process are enclosed in the concept of 'crystallization', which is defined as a process made of two stages. At the beginning actors identify the performances that are not achievable later (where the infrastructure brakes), then they design new practices/infrastructures (Neumann and Star, 1996).

The way in which the foreseen future can be realized depends on the characteristics that the decision process assumes. These can be human and non–human relationships intertwined among heterogeneous elements, and negotiation processes related to power, reputation and trust. In detail, the trajectories of practices and decisions converging to the crystallization point allow the identification and implementation of new changes (Neumann and Star, 1996).

In this work, our focus is to study how the infrastructure is made visible, changes are planned, and decision are taken, in the specific case study of the Air Traffic Management.

The case study: the sectorless Air Traffic Management

Air Traffic Management (ATM) is the whole ecology of systems that assists the flight of an aircraft: departing, cruising, and landing at an airport (Duong et al., 2002). According to the European Organisation for the Safety of Air Navigation (EUROCONTROL) – the international organisation managing and controlling air traffic across Europe – ATM is made of three distinct activities:

- *Air Traffic Control*: the process by which aircrafts are safely separated in the sky as they fly en route and at the airports where they land and take off.
- *Air Traffic Flow Management*: the activity done before flights take place. Any aircraft using air traffic control files a flight plan and sends it to a central repository. All flight plans for flight into, out of and around Europe are analysed and computed.
- *Aeronautical Information Services*: the services responsible for the compilation and distribution of all aeronautical information necessary to airspace users. These include information on safety, navigation, technical, administrative and legal matters.

Since it has to deal with flights safety, the ATM is driven by strict national and international regulation. Furthermore, technical competence of the actors plays a strong role in the sector, as security of flights must be guaranteed.

ATM is a complex ecology of actors such as:
- civil and military experts in airspace design,
- European Civil Aviation Conference member states,
- air navigation service providers (e.g. DFS in Germany and ENAV in Italy),
- passengers and airspace users,
- flight planner organisations,
- relevant international bodies.

Traditional air traffic control is based on geographical partition of the airspace, indeed control sectors. Each airspace passing through a sector is controlled by a specific organization. Figure 1 shows an example of the traditional sectored control system applied to Germany (DFS, 2016).

In order to assess the feasibility of this concept, scholars have focused on several operative aspects of the sectorless scenario over the last decade, such as changes in the controllers' tasks, the procedures of aircrafts

assignments, the priority rules and the safety assessments routines (Biella et al. 2011; Birkmeier and Korn, 2014; Korn et al., 2009).
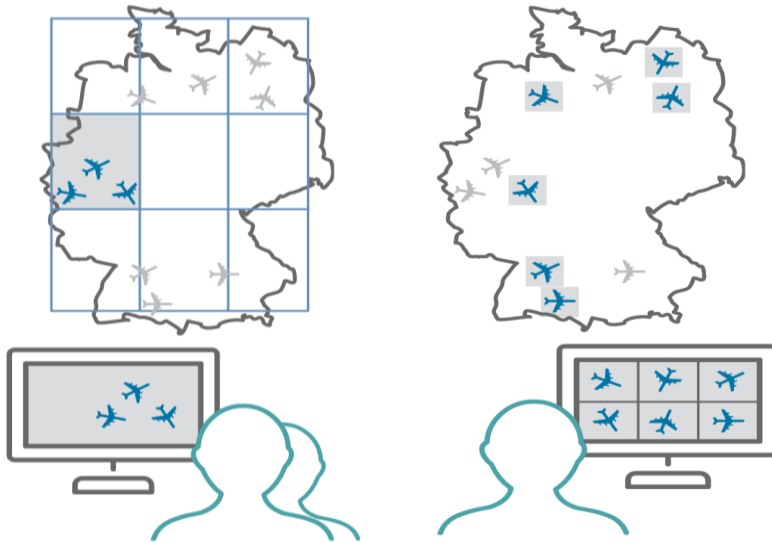
Figure 1   Sectored control scenario
(Source: DFS, 2016).

Figure 2   Sectorless control scenario
(Source: DFS, 2016).

The sectorless scenario is said to offer significant improvements while addressing the main bottlenecks of the traditional sectored approach. The main improvements are (Birkmeier, Tittel and Korn, 2016):

- Higher number of traffic. The system is able to control a bigger number of flights.
- Less workload. Controllers face less workload and also less handovers.
- Efficiency in terms of costs and time. Sectorless allows for more linear flights meaning less fuel and less travel time.
- Single point of contact for pilots. When entering a sectorless area, pilots have a unique controller to talk with.

Since the sectorless scenario is a complex innovation, its implementation lasts for several years: its real implementation is set to become gradually operational from 2020/2021, meaning more ten years since the initial exploration of the notion by a national control provider. The technical and procedural innovations of the scenario bring many changes within the sector; in this sense, actors should take decisions in order to plan and

implement the changes of the infrastructure and its interconnected practices.

Research method and discussion

To study the introduction of this change we performed semi–structured interviews and a workshop with international experts during Spring– Summer 2016 (PACAS, 2016):

- 1st phase: interview with 3 experts in May 2016;
- 2nd phase: workshop with 5 experts in July 2016.

The goal of this activity was to identify the most important categories of an ATM decision process. The analysis of the interviews allowed us to identify four emergent categories:

1. the type of activities and information in decision process;
2. the actors involved;
3. how to solve conflicts during the decision processes;
4. the types of decisions.

In the following, we briefly describe the most interesting evidences for each category.

Evidence 1. Activities and information in decision processes

The actors of the ATM face the need to clean the information from contaminations. In other words, the information should be represented and reported in the most objective and comprehensive way. The analysis of the interviews shows that this is necessary for three main reasons.

This excerpt of expert person n. 1 summarizes the most significant activities and type of information that characterize a decision process:

EP1: '[…] first of all the presentation of the problem. It must be presented in a way *as objective as possible*, because usually the problem comes *contaminated*. […]'

First, knowledge has to be cleaned to clearly represent a problem or an issue at stake. Usually decision makers represent situations from their point of view. This might not represent or over–represent a problem issue.

Second, decontaminated information allow to better identify possible alternatives. Indeed, knowledge which is represented from one of the points of view of the decision makers, might not be useful to represent all available alternatives.

Third, objective information allows to better evaluate the impact of the alternatives on the infrastructure while preventing political games or interests to affect the decision.

Evidence 2. Actors in decision processes

Interviewed persons state that the impact on all types of actors is being considered when taking decisions.

All the actors play a role in the decision process depending on:

- the position they have within the ATM (are they actors directly involved in the decision process? Do they have a powerful position? Are they able to impose a choice to the others?);
- the situation they encounter while participating (are they actors indirectly involved in the decision process? Do they suffer the decision process?).

From our interviews it emerges that two types of actors are very relevant in any decision for ATM:

- Actors that are actively involved in the decision processes are also responsible for the changes of the infrastructure;
- Actors that are passively involved in the decision because they are affected by it (e.g. passengers).

Whenever actors make a change, they have to take into consideration the effects on all other actors.

Evidence 3. How to solve conflicts during decision processes

Conflicts may happen during decision processes because of different reasons. A reason described by an interviewee is referring to the 'contaminated information' which may push actors working in an 'interested' way. As said, above, this may also shape the definition of alternatives and the evaluation of their impact. The conflicts may be solved in a political or operational manner. For instance, EP1 says that:

EP1: '[…] when you cannot act on the human being because he is stubborn, then *you must act on procedures* and then negotiate a common position.'

Interviewed persons state that, in case of conflict about a change, the decision makers have to consider various elements while reaching a common decision:

- the actors themselves: decisions may affect actors when this does not imply much conflict;

- the procedures: decisions may affect the flow of the procedures as a way to bypass conflict and force innovation;
- the artefacts: the design and choice of new artefacts may also be an option to minimize or bypass conflict.

Evidence 4. The types of decisions

Information, actor and conflicts spread over various decision levels. These are three:

- The operational level deals with the real management of any air traffic action, and decisions are made in real–time on an emergency basis.
- The managerial level deals with all the technical changes that may occur during a revision of ATM procedures, such as the introduction of new technologies, protocols etc. The changes are usually planned and are based on an in depth technical and specialized knowledge shared in national and multinational projects.
- The strategic practices deal with the adoption of policies, norms and regulations at national and international levels.

The analysis of the decision processes allows us to understand how the infrastructural change spread all over the system by focusing on all the elements that compose the organization itself (human, non–human, environment and context). Furthermore, the analysis of the decision process allows reconstructing the role of different elements, object and actors in shaping the trajectory of the planned change.

Findings and future work

The adoption of a sociotechnical approach has two main implications in terms of organizational change and decision process analysis. First, this approach allow us to understand the organizational change focusing on all the elements that compose the organization itself (human, non–human, environment and context). Second, the decision process could be analysed as a process by reconstructing the different trajectories among different elements, object and actors and focusing on the relationships among these elements (Star and Griesemer, 1989).

In particular, the analysis of the case study allowed us to identify that changes of an infrastructure are highly intertwined with decision processes. Changes, also, are discussed during the decision processes and the results are crystallized in facts that shape the change itself. Actors involved in the

decision processes, attempt to 'clean' the information from contaminations in order to share the most objective and comprehensive information which is crystallized in facts (Evidence 1).

Moreover, the relationships that forms the ecology of sociotechnical system emerges as a result of negotiations among actors and the role they play (even in term of power) in the decision processes (see Evidence 2 and Evidence 3). In the sectorless scenario, the innovation was initiated by DFS (Deutsche Flugsicherung GmbH), the German control provider and its real implementation is set to become gradually operational from 2020/2021. This imply the involvement of other actors that directly or indirectly take decisions in order to implement the innovation. Time is also required to reduce conflicts (Evidence 3).

Decisions about infrastructures go through three levels of decision (strategic, managerial, operational) that have different scopes (Evidence 4). As soon as an actor introduced the innovation and strategically shared the idea with other policy makers, managerial and operational levels get involved in decision processes and infrastructure changes.

Since the research project is still in progress, this work needs further improvements. Activities are in place in order to have a more in depth analysis of the interconnection between the infrastructure and each decision level; in particular, research is focusing on refining the insights about authority, influence and power on the decision levels.

Acknowledgments

References

Biella, M., Birkmeier, B., Korn, B., Edinger, C. and Kügler, D. (2011) Operational Feasibility of Sectorless ATM. In *Proceedings of the International Conference of the European Aerospace Societies CEAS 2011*. Venice: CEAS.

Birkmeier, B. and Korn, B. (2014) Five Transition Strategies for Sectorless ATM. In *Proceedings of 33rd Digital Avionics Systems Conference.* Colorado Springs*:* IEEE/AIAA.

Birkmeier, B., Tittel, S. and Korn, B. (2016) Controller Team Possibilities for Sectorless Air Traffic Management. In *Proceedings of Integrated Communications Navigation and Surveillance (ICNS, 2016).* Herndon: IEEE*.*

Bowker, G.C. and Star, S.L. (1999) *Sorting Things Out: Classification and Its Consequences.* Cambridge: MIT Press.

Bowker, G.C., Baker, K., Millerand, F. and Ribes, D. (2010) Toward Information Infrastructure Studies: Ways of Knowing in a Networked Environment. In Hunsinger, J., Klastrup, L. and Allen, M. (eds.), *International Handbook of Internet Research*. Dordrecht: Springer.

Corbin, J.M. and Strauss, A. (1988) *Unending Work and Care: Managing Chronic Illness at Home*. San Francisco: Jossey–Bass.

DFS (2016) *The Sectorless ATM Concept: Flight–centred ATC* [On–line]. Available from: http://www.dlr.de/fl/Portaldata/14/Resources/dokumente/veroeffentlic hungen/Sectorless_ATM_flyer_web.pdf [Accessed: December 19th, 2016].

Duong, V., Gawinowski, G., Nicolaon, J.P. and Nguyen, H.N. (2002) Sector–less Air Traffic Management. *Air Traffic Control Quarterly*, 10 (4), 379–393.

Edwards, P.N. (2003) Infrastructure and Modernity: Force, Time, and Social Organization in the History of Sociotechnical Systems. In Misa, T.J., Brey, P. and Feenberg, A. (eds.), *Modernity and Technology*. Cambridge: MIT Press*.*

Edwards, P.N. (2010) *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming*. Cambridge: MIT Press.

Edwards, P.N., Bowker, G.C., Jackson, S.J. and Williams, R. (2009) Introduction: An Agenda for Infrastructure Studies. *Journal of the Association for Information Systems*, 10 (5), 364–374.

Hanseth, O. and Lundberg, N. (2001) Designing Work Oriented Infrastructures. *Computer Supported Cooperative Work*, 10 (3–4), 347–372.

Heath, C. and Luff, P. (2000) *Technology in Action*. Cambridge: Cambridge University Press.

Huber, G.P. (1980) *Managerial Decision Making*. Glenview: Scott Foresman.

Korn, B., Edinger, C., Tittel, S., Kügler, D., Pütz, T., Hassa, O. and Mohrhard, B. (2009) Sectorless ATM: A Concept to Increase En–route Efficiency. In *Proceedings of the 2009 IEEE/AIAA 28th Digital Avionics Systems Conference*. Orlando: IEEE.

Maznevski, M.L., (1994) Understanding Our Differences: Performance in Decision–Making Groups with Diverse Members. *Human Relations*, 47 (5), 531–555.

Mongili, A. and Pellegrino, G. (eds.) (2014) *Information Infrastructure(s): Boundaries, Ecologies, Multiplicity*. Newcastle upon Tyne: Cambridge Scholars Publishing.

Neumann, L., and Star, S.L. (1996) Making Infrastructure: The Dream of a Common Language. In Blomberg, J., Kensing F. and Dykstra–Erickson E. (eds.), *Proceedings of the Fourth Biennial Conference on Participatory Design*. Palo Alto: Computer Professionals for Social Responsibility.

PACAS (2016) *Communication and Dissemination Plan*. [Online] Available at: http://www.pacasproject.eu/wp–content/uploads/2016/11/PACAS–D6.1–Communication–and–Dissemination–plan.pdf [Accessed: January 15th, 2017].

Pava, C. (1983) *Managing New Office Technology: An Organizational Strategy.* New York: Free Press.

Robbins, S.P. (1992) *Essentials of Organizational Behavior*. Englewood Cliffs: Prentice–Hall.

Schmidt, K. and Bannon, L. (2013) Constructing CSCW: The First Quarter Century. *Computer Supported Cooperative Work*, 22 (4–6), 345–372.

Star S.L. (1999) The Ethnography of Infrastructure. *American Behavioral Scientist*, 43 (3), 377–391.

Star, S.L. (2002) Infrastructure and Ethnographic Practice: Working on the Fringes. *Scandinavian Journal of Information Systems*, 14 (2), 107–122.

Star, S.L. and Griesemer, J.R. (1989) Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907–39. *Social Studies of Science*, 19 (3), 387–420.

Star, S.L. and Ruhleder, K. (1996) Steps Toward an Ecology of Infrastructure: Design and Access for Large Information Spaces. *Information Systems Research*, 7 (1), 111–134.

Vroom, V.H. and Jago, A.G. (1988) *The New Leadership: Managing Participation in Organizations*. Englewood Cliffs: Prentice–Hall.

Il lavoro nella e–Society: polarizzazione della struttura professionale e scomparsa delle professioni esprimibili in termini algoritmici

Federico FIORELLI[*a]

[a] Università degli Studi di Roma 'La Sapienza'

Dalla fine degli anni Ottanta le analisi econometriche mostrano come l'utilizzo delle tecnologie ICT ha comportato una polarizzazione della struttura professionale. A una crescita delle professioni high skills e low skills è succeduto un calo delle professioni medium skills.

Difatti la digitalizzazione dell'economia ha da un lato portato alla formazione di nuovi settori di mercato, favorendo nuove occasioni professionali per i lavoratori più qualificati, mentre dall'altro ha profondamente mutato la struttura occupazionale di molti settori tradizionali, comportando un ampliamento dello skill gap tra le competenze richieste dalla domanda e le capacità possedute dall'offerta.

La sempre maggiore diffusione delle tecnologie digitali richiede un accrescimento delle competenze computazionali della forza lavoro con il fine di mantenere inalterato il legame tra innovazione, sviluppo economico e crescita occupazionale.

Keywords: *Routine–biased technological change; disoccupazione tecnologica; polarizzazione struttura professionale; tecnologie ICT*

Introduzione

L'attuale evoluzione del mercato del lavoro si focalizza sempre più sulla relazione che intercorre tra crescita della disoccupazione e introduzione delle macchine, principalmente computer, all'interno degli uffici e degli opifici. In passato la maggior parte degli studi sociologici sul tema si riferivano ai cambiamenti organizzativi prodotti dai processi di automazione.

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[*] Corresponding author: **Federico Fiorelli** | e–mail: **federico.fiorelli@uniroma1.it**

Questo termine viene fatto risalire a John Diebold per un articolo del 1952 dal titolo *Automation: The Advent of Automatic Factory* (Pollock, 1970). In questa ottica i processi di automazione non si qualificano come uno strumento utile a ridurre i costi di produzione ma come un processo socio–tecnico che va dall'acquisto della tecnologia fino al cambiamento organizzativo passando per l'integrazione dei cambiamenti organizzativi nei precedenti sottosistemi sociali presenti nelle unità produttive.

Il passaggio tra fordismo e post–fordismo alla fine degli anni Settanta ha sollevato il problema del capitale umano nell'evoluzione dei modelli organizzativi (Kern e Schumann, 1991). Un modello di produzione completamente automatizzato, anche dinnanzi al sorgere della quarta rivoluzione industriale (Forester, 1985; King, 1981) o di un quarto settore economico (Machlup, 1984), non si sarebbe potuto realizzare senza un ricollocamento produttivo dei lavoratori. In altri termini una crescita economica stabile e prolungata nel tempo doveva prevedere un giusto equilibrio tra l'introduzione di nuove tecnologie e la riorganizzazione della forza lavoro. Questo paradigma tecnico–organizzativo prese il nome di 'human centred automation', l'esempio classico è la fabbrica integrata della Toyota, in opposizione a quelle logiche economiche che parlavano di 'unmanned factory' (fabbrica totalmente automatica).

In questa fase divengono fondamentali nuove figure professionali che vanno dalla supervisione delle macchine fino alla semplificazione dei modelli integrativi utili a equilibrare le esigenze del lavoro e il ritmo produttivo del capitale. Non a caso da qualche anno si sta assistendo a una crescita della richiesta di posizioni professionali che richiedono anche competenze umanistiche. Questo concerne sia le imprese 'web–based' che operano nel settore dell'e–commerce, le quali richiedono professionisti della comunicazione come nel caso del 'web reputation manager' o del 'social media manager', oppure le imprese manifatturiere che hanno necessità di figure professionali necessarie per gli aspetti logistico–gestionali. Lo spostamento dei 'knowledge workers' verso attività professionali non routinarie, spesso legate alla supervisione e al controllo delle macchine, ha portato a un profondo mutamento della struttura professionale favorevole ai lavoratori non routinari e qualificati.

Nuove tecnologie e possibilità occupazionali

La relazione tra tecnologia e occupazione ha da sempre rappresentato una tematica contraddittoria. Negli studi sulla relazione tra tecnologia e

società emerge come le innovazioni risultano sempre più interconnesse con i fenomeni sociali. Questa assenza di una contrapposizione continuativa dipende dal fatto che nel loro percorso evolutivo la società non si configura in perenne ritardo così come la tecnologia non è in perenne anticipo (Neresini, 2011).

A partire dall'avvento delle net–economy, a cavallo tra gli anni Ottanta e Novanta, è cresciuto il numero dei ricercatori sociali che reputano possibile un'evoluzione del mercato del lavoro in cui risulta centrale il ruolo dell'essere umano. La principale teoria di riferimento prende il nome di 'worker–robot interaction' (Johnson et al., 2009). Secondo questa impostazione la centralità dei processi organizzativi e la qualità del capitale umano rivestono grande importanza nel processo socio–economico che parte dall'automazione e termina con una crescita della produttività dei fattori di produzione. Le macchine non essendo in grado di svolgere autonomamente un processo produttivo nella sua interezza, finiscono per dipendere dalla destrezza e dalla creatività del lavoratore. In tal modo la loro funzione principale consiste nell'assistere il lavoratore sia nel lavoro effettivo che in una sua preventiva simulazione. Al lavoratore rimangono da svolgere le attività più sicure e meno alienanti (Sheridan, 2016).

Questi fenomeni fanno propendere non per una possibile fine del lavoro ma per una nuova divisione del lavoro in cui l'intelligenza umana viene coadiuvata da quella artificiale (Levy and Murnane, 2004). I lavoratori pertanto si possono dividere tra coloro i quali sono tenuti alla programmazione e al controllo delle macchine e coloro i quali possono beneficiare dell'assistenza digitale in molti fase del proprio lavoro. Pertanto resta di primaria importanza una formazione che possa garantire un capitale umano adeguatamente formato sia in termini di competenze tecnico–operative che in termini di creatività e di propensione al cambiamento.

L'attuale diffusione di ambienti di lavoro tecnologicamente densi, fenomeno dovuto sia a una diffusa cultura digitale che a una riduzione del costo delle nuove tecnologie a parità di potenza di calcolo, sta profondamente mutando le modalità con le quali le aziende si relazionano con i clienti, determinano le procedure decisionali, assumono il personale e mettono in comunicazione i vari settori aziendali. La presenza di ambienti lavorativi tecnologicamente e socialmente più complessi comporta una socializzazione dell'implementazione tecnologica e una tecnologizzazione dell'organizzazione sociale. Nel primo caso la mediazione tra le varie componenti dell'organigramma aziendale favorisce i cambiamenti tecnologici ('co–working strategies') mentre nel secondo caso la necessità di

digitalizzare le varie fasi della produzione comporta dei repentini cambiamenti dell'ecosistema lavorativo (Bernstein, Crowley e Nourbakhsh 2007).

Il principale obiettivo delle nuove tecnologie digitali, in particolare quelle che favoriscono la gestione, l'immagazzinamento e l'analisi delle informazioni, non è quello di sostituire le competenze dei lavoratori con quelle delle macchine ma, al contrario, quello di migliorare la qualità del lavoro umano attraverso l'utilizzo di tecnologie che lasciano al lavoratore le attività lavorative più creative e piacevoli. In tal modo la cosiddetta conoscenza tacita, specialmente nell'ambito socio–relazionale, continua a rappresentare il valore aggiunto del lavoro umano nelle attuali produzioni automatizzate (Moniz e Krings, 2016).

Nuovi scenari del mercato del lavoro

Per quanto concerne il mercato del lavoro contemporaneo, il XX secolo ha osservato un continuo mutamento delle tipologie di lavoro per via di un'accelerazione del progresso tecnologico. Da un lato vi è stata una specializzazione del lavoro mentre dall'altro una sua intellettualizzazione ('de–routinization'). Se durante le prime fasi della rivoluzione industriale i lavoratori si spostano dalle campagne alle manifatture, trasformandosi da contadini ad operai, nella seconda metà del XX secolo i lavoratori si spostano dalle fabbriche agli uffici, trasformandosi da operai a impiegati. Allo stesso tempo la divisione del lavoro, la complessificazione dei bisogni sociali e l'evoluzione delle tecnologie hanno richiesto una forza di lavoro sempre più formata e creativa.

L'operaio della catena di montaggio fordista, pronipote dell'operaio delle manifatture tardo settecentesche, era tenuto unicamente a eseguire degli ordini. Forza fisica e resistenza alla fatica erano le due principali qualità richieste dalla domanda di lavoro. Lo stesso Henry Ford, quando sceglieva i propri lavoratori pagandoli molto più della concorrenza, richiedeva una grande capacità di adeguamento dell'operaio al ritmo della produzione meccanizzata. La produzione di massa necessitava di un tempo di produzione serrato: l'operaio doveva essere resistente per adeguarsi a questo tempo e doveva ricevere un salario elevato per poter consumare i beni prodotti. Serialità e standardizzazione della produzione da un lato e consumismo dall'altro erano i principali pilastri su cui poggiava la società fordista.

Con l'avvento della terza rivoluzione industriale, che si può profanamente far iniziare con la scoperta del transistor nei Laboratori Bell, le esigenze della produzione richiesero un profondo cambiamento della struttura professionale. Per semplicità è possibile suddividere questo momento storico in due distinte fasi: una prima fase in cui domina la microelettronica e una seconda fase in cui domina il digitale. Nella prima fase, databile tra gli anni Cinquanta e la fine degli anni Settanta, lo spostamento dei lavoratori dal settore secondario al settore terziario avviene in un contesto di routinizzazione del lavoro essendo ancora nell'epoca fordista. Nella seconda fase, databile tra la metà degli anni Ottanta e i giorni nostri, la terziarizzazione dell'economia è stata affiancata da una 'de–routinization' del lavoro essendo passati all'epoca post fordista. Questa seconda fase, utilizzando una terminologia contemporanea, è definibile anche come economia post–industriale o 'knowledge economy'.

David Autor e Brendan Price (2013) in una ricerca dal titolo *The Changing Task Composition of the US Labour Market: An Update of Autor,* Levy e Murname dimostrarono come nel mercato statunitense dagli anni Settanta ad oggi sono diminuiti i lavori che fanno parte del settore 'routine manual', del settore 'non routine manual' e del settore 'routine cognitive'. Al contrario sono aumentati i lavori nei settori 'non routine analytic' e 'non routine interpersonal'. Stessi risultati sono stati riscontrati nel contesto europeo con riferimento a sedici distinti paesi (Goos, Manning e Salomons, 2009).

Risulta evidente come un'economia fondata sulla conoscenza, ovvero su un mix di innovazione tecnologica e di pubblicizzazione creativa dei prodotti, richiede un capitale umano altamente formato sia dal punto di vista delle competenze tecnico–operative che da quello delle competenze socio–relazionali. I nuovi consumatori, disposti a spendere una maggior quota di reddito in beni e servizi di qualità, richiedono una maggiore attenzione da parte delle imprese.

I nuovi modelli di consumo, alla pari del mutamento tecnologico, hanno determinato sia la terziarizzazione dell'economia che l'intellettualizzazione del mondo del lavoro. Queste due variabili risultano a loro volta interconnesse. Difatti un profondo cambiamento delle pratiche di consumo è legato a una crescita dei differenziali di produttività tra i settori che producono beni materiali e quelli che producono servizi immateriali. Conseguentemente la crescita dei redditi nel corso del XX secolo ha permesso alla maggior parte dei cittadini dei paesi industrializzati di poter soddisfare pienamente i propri bisogni materiali. Ad oggi una quota sempre

maggiore del reddito viene destinata all'acquisto di viaggi vacanza o di accessori tecnologici (beni secondari) piuttosto che all'alimentazione e al sostentamento (beni primari). Una maggiore libertà nella gestione del tempo libero, la possibilità di essere alla moda, l'accesso all'istruzione terziaria e il conseguimento di un'occupazione gratificante, rappresentano i principali determinanti del miglioramento della qualità della vita nei paesi industrializzati. Allo stesso tempo la crescita della produttività del lavoro nel settore industriale, maggiormente propenso all'introduzione di tecnologie 'labour saving' (a risparmio di lavoro), ha comportato un calo dei prezzi dei beni materiali. Non solo questi beni costano meno ma, allo stesso tempo, cresce la percentuale del costo che va imputata all'abilità socio–relazionale (marketing, *customer satisfaction*, vendita al dettaglio, etc…) piuttosto che alle tecnologie produttive (Turner, 2001).

Recenti studi (Autor e Dorn, 2013; Autor, Levy, e Murnane, 2003) hanno messo in relazione l'innovazione con i cambiamenti che avvengono all'interno della struttura professionale. La cosiddetta teoria del 'Routine– biased Technological Change' afferma che il mercato del lavoro si compone sempre più di due gruppi di lavoratori. Da una parte i lavoratori non di routine, complementari alle macchine, e dall'altro i lavoratori di routine, sostituibili dalle macchine. Questo avviene poiché le tecnologie incidono sulle competenze richieste dal mercato del lavoro. Ad esempio essere un lavoratore non di routine significa da un lato essere un lavoratore creativo e tecnicamente competente ma dall'altro significa essere un lavoratore flessibile e orientato al *problem solving*.

In tal modo l'innovazione tecnologica finisce per incidere sulle dinamiche occupazionali determinando un terzo 'travaso dinamico' (spostamento inter–settoriale dell'occupazione). Il primo è stato il passaggio dal campo alla fabbrica, il secondo dalla fabbrica all'ufficio e il terzo dall'ufficio alla rete. Questo terzo passaggio segna l'inizio di un percorso professionale che non è più contornato da uno spazio e da un tempo definito a livello aziendale. Il lavoratore, maggiormente indipendente rispetto al passato (*freelance*), si trova in un contesto professionale in cui da un lato è tenuto a essere aperto al cambiamento mentre dall'altro deve provvedere a un continuo aggiornamento delle proprie competenze (Gandini, 2015).

Questo processo di polarizzazione della struttura professionale rappresenta il prossimo futuro del mondo del lavoro. I lavoratori più qualificati continueranno a trovare posti di lavoro gratificanti e ben pagati mentre i lavoratori meno qualificati otterranno posti di lavoro meno gratificanti e mal pagati (Massari, Naticchioni e Ragusa, 2013). Utilizzando

una terminologia propria della futurologia di John Naisbitt si può affermare che per i lavoratori high–skills si aprono le porte dell''high tech' mentre per i lavoratori low–skills le porte dell''high touch'.

Va aggiunto che questa polarizzazione della struttura professionale è seguita da un *upgrading* delle credenziali educative per tutti i settori economici. Mentre nelle precedenti rivoluzioni industriali, che storicamente si fanno risalire a un cambiamento delle fonti di energia (vapore, elettricità) o dei modi di produzione (manifattura, divisione del lavoro e catena di montaggio), si era osservato un continuo *downgrading* della struttura professionale, quest'ultima rivoluzione tecnologica sta seguendo una direttrice opposta. I nuovi posti di lavoro creati dal mutamento tecnologico richiedono delle competenze più alte rispetto a quelle richieste dai posti di lavoro che vengono distrutti. Il meccanismo della 'distruzione creatrice' di Schumpeter, adeguandosi a un'intellettualizzazione delle professioni e a un mutamento tecnologico sempre più rapido (come previsto dalla legge di Moore), sostituisce i posti di lavoro routinari con quelli non routinari. Altresì i lavoratori più qualificati vengono premiati con posti di lavoro gratificanti mentre quelli meno qualificati con posti di lavoro dequalificanti.

La riduzione del costo di produzione delle tecnologie ICT, a sua volta dovuta ai processi di innovazione propri del settore, favorisce il ripetersi di questo processo di polarizzazione. La domanda da porsi è pertanto: come si evolverà nel prossimo futuro il mercato del lavoro?

Aspettando di osservare ciò che accadrà, è possibile rispondere a questa domanda facendo ricorso a tre scenari:

– il primo scenario prevede che nei prossimi venti anni circa il 50% delle professioni verrà sostituito dalle macchine. Pertanto, anche se circa la metà delle nuove professioni ancora non esiste, è possibile ipotizzare che la forza lavoro qualificata potrà accedere al mercato del lavoro (Frey e Osborne, 2013);

– il secondo scenario prevede che il ritmo dell'innovazione andrà a diminuire dato che la maggior parte delle innovazioni necessarie all'essere umano già esistono (Gordon, 2012). In tal modo le tecnologie digitali, più utili all'intrattenimento che alla produttività, non saranno in grado di mutare in modo così rapido la struttura professionale;

– il terzo scenario prevede l'avvento di una 'jobless society', ovvero di una società in cui la produzione è interamente in mano agli automi. In questo scenario andrebbe a scomparire il concetto stesso di lavoro obbligando le istituzioni economiche e politiche a riorganizzare le attività

umane nei pochi settori extraeconomici in cui le macchine non sono in grado di sostituire l'essere umano (Rifkin, 1995).

Competenze computazionali e disoccupazione

All'inizio degli anni Novanta Louis Perelman scrisse un libro estremamente critico nei confronti della scuola tradizionale. Il titolo è *School's Out: Hyperlearning, The New Technology, and the End of Education*. Secondo questo autore il modo tradizionale di tramandare il sapere negli istituti scolastici non è più in grado di seguire l'evoluzione del mercato del lavoro. Le vecchie competenze nozionistiche hanno lasciato il posto a una serie di nuove competenze, che vanno da quelle computazionali a quelle socio–relazionali, che l'istruzione è sempre meno capace di trasmettere alle nuove generazioni.

Tuttavia il cambiamento richiesto all'istruzione non è solo di natura tecnica. I modelli di apprendimento necessitano di adeguarsi a un mondo del lavoro in continuo cambiamento. I modelli organizzativi e le strategie di innovazione delle imprese seguono matrici che sono profondamenti differenti da quelle passate. L'attuale modello di sviluppo, supportato dalle nuove tecnologie dell'informazione, richiede delle infrastrutture reticolari fondate su di un'innovazione di natura ricombinante. I sistemi di creazione e di trasferimento delle conoscenze fondati sulla settorialità del sapere scientifico lasciano il posto a forme dello scoprire che favoriscono la convergenza tra saperi. L'attuale responsabile del Mit Media Lab, il giapponese Joi Ito, afferma che il futuro sviluppo economico passerà attraverso l'ibridazione dei saperi. L'anti–disciplinarietà permette di trovare un punto di raccordo tra le idee sviluppando quegli interstizi cognitivi che si possono esplorare solamente rompendo il muro artificiale che storicamente ha da sempre suddiviso le materie e gli approcci scientifici.

Anche nello studio dei fenomeni occupazionali al tempo della net–economy il piano organizzativo può rappresentare un punto di incontro tra la sociologia del lavoro e gli studi sociali in materia di sviluppo tecnologico (Wajcman, 2006). La tecnologia, osservabile come un prodotto socio–tecnico, rappresenta il risultato di un processo razionale che tende a mobilitare in continuazione delle risorse socio–culturali. In tal modo il mercato del lavoro è influenzato dall'innovazione tecnologica così come l'evoluzione del mercato del lavoro, sia da un punto di vista economico che istituzionale, determina la forma e la pervasività della stessa automazione.

L'evoluzione del mercato del lavoro e della cultura dell'innovazione rappresentano il prodotto di negoziazioni e discorsi che hanno plasmato i cambiamenti che stanno interessando l'attuale struttura occupazionale. La precedente dicotomia tra individui occupati e non occupati è stata affiancata da quella tra lavoratori 'high skills' e lavoratori 'low skills' e tra lavoratori qualificati che operano nei 'brain hub' e lavoratori qualificati che lavorano al di fuori di questi ecosistemi innovativi. Nel primo caso i lavoratori altamente produttivi hanno un posto di lavoro stabile e ben remunerato mentre quelli meno produttivi hanno un posto di lavoro instabile e poco remunerato. Nel secondo caso i lavoratori meno qualificati che lavorano in un ecosistema innovativo vantano salari superiori ai lavoratori altamente qualificati che lavorano al di fuori di questi ecosistemi (Brynjolfsson e McAfee, 2015).

La crescita economica e il mutamento tecnologico, concetti che tradizionalmente sono connessi con il funzionamento del mercato, devono altresì essere considerati come fenomeni capaci di accrescere la sperequazione sociale e di rallentare la mobilità sociale. In questo quadro diviene fondamentale il ruolo delle istituzioni pubbliche centrali e locali nel garantire l'accesso a biografie educative dove tutti gli individui, a prescindere dal capitale economico, culturale e relazionale delle proprie famiglie di origine, possano avere le stesse possibilità di raggiunge i vertici della piramide sociale.

Come detto la sfida occupazionale imposta dalle nuove tecnologie richiede un maggiore impegno da parte delle istituzioni pubbliche e private dal lato formativo. Sia dal punto di vista economico che politico è riconosciuta l'importanza della formazione nei processi di irrobustimento della crescita economica e occupazionale, del miglioramento della qualità del lavoro e del rafforzamento della coesione sociale.

Il fenomeno della disoccupazione di lungo periodo, sempre più diffuso all'interno di un mercato del lavoro tecnologicamente dinamico, richiede sistemi di istruzione non formale in grado di trasmettere e aggiornare le competenze professionali dei lavoratori (*insiders*) e dei disoccupati (*outsiders*). I nuovi bisogni di conoscenza, dovuti alla pervasività delle tecnologie ICT e alla digitalizzazione dei canali di comunicazione, richiedono nuovi strumenti formativi in grado di coniugare il sostegno al reddito con l'impegno attivo in attività professionalizzanti. Le nuove competenze richieste dal mercato del lavoro presuppongono la capacità dei soggetti di dialogare con le tecnologiche informatiche attraverso un'implementazione delle proprie competenze computazionali e un accrescimento delle proprie

doti creative (Florida, 2003; 2006). L'accesso, l'archiviazione e l'elaborazione delle informazioni digitali rappresenta un insieme di conoscenze indispensabili per costruire biografie professionali in cui l'inclusione del singolo diviene sviluppo della comunità.

Conclusioni

Dalla precedente revisione della letteratura emerge come il futuro mercato del lavoro lascia sempre meno spazio agli individui che hanno difficoltà a dialogare con le nuove tecnologie. La scomparsa delle professioni routinarie, che in molti paesi occidentali sta comportando una polarizzazione della struttura professionale, lascia poche possibilità occupazionali a quei lavoratori che voglio correre contro le macchine. Come affermano Brynjolffson e McAfee nel libro *Race Against the Machine* (2011), i vincitori delle nuove sfide occupazionali sono quei lavoratori in grado di dialogare con le macchine, ovvero di correre con le macchine.

A tal fine riveste una sempre maggiore importanza il ruolo dell'istruzione e della formazione. La necessità di trasformare le *materie* in *competenze* risulta propedeutico a una dimensione economica in cui la quasi totalità dei lavori ben retribuiti richiede la capacità di accedere, organizzare, integrare e presentare le informazioni. Pertanto alle competenze specifiche di carattere generale, abitualmente acquisibili nei percorsi di istruzione, si sommano le competenze generali di carattere specifico ('abilities'), le competenze trasversali ('cross–functional skills') e quelle cognitive (Argentin et al., 2016).

La 'frusta' dell'innovazione digitale richiede di superare il vecchio concetto di 'digital divide'. Il divario digitale non concerne solamente l'accesso alle tecnologie digitali ma anche l'acquisizione di capacità operative nell'utilizzarle e di capacità computazionali nell'integrarle. Un utilizzo unicamente ludico di tali tecnologie determina una diminuzione del tempo destinato alla formazione digitale così come una rottura del legame che intercorre tra l'utilizzo delle apparecchiature informatiche e lo sviluppo di un'intelligenza computazionale (Kirschner e Karpinski, 2010).

La crescita del gap tecnologico tra paesi sviluppati e terzo mondo come quella che riguarda i lavoratori qualificati e i lavoratori non qualificati rappresenta una delle principali determinanti delle disuguaglianze sociali (Hargittai, 2008). Allo stesso tempo un capitale umano poco formato incide negativamente sui cosiddetti 'digital dividends' (World Bank, 2016): i lavoratori hanno maggiore difficoltà nell'ottenere dei rendimenti salariali alti mentre le imprese soffrono un rallentamento della crescita della

produttività con riflessi negativi dal punto di vista della competitività internazionale.

La rivoluzione digitale, la globalizzazione e la flessibilizzazione del mercato del lavoro richiedono una profonda riforma dei sistemi di istruzione e di formazione. Ai primi è richiesta una maggiore capacità di adeguare le competenze di carattere generale ai nuovi contenuti conoscitivi richiesti dal mercato del lavoro mentre ai secondi è richiesto un maggiore impegno nei percorsi di 'lifelong learning' con particolare attenzione alla diffusione delle competenze computazionali, della comunicazione complessa e del *problem solving*.

L'utilizzo delle tecnologie digitali all'interno dei nuovi ambienti e dei nuovi processi formativi rappresenta un ulteriore passo avanti nel percorso di avvicinamento tra il sistema di istruzione–formazione e il mondo imprenditoriale. Possibili vantaggi possono derivare dalla diffusione di un apprendimento virtuale, attraverso l'utilizzo delle risorse educative aperte e delle postazioni interconnesse; dall'introduzione delle nuove tecnologie digitali come la lavagna interattiva e le piattaforme elettroniche per la didattica; dalla maggiore integrazione del sistema produttivo con il sistema scolastico, accademico e della formazione professionale; dalla formazione continua del personale docente e amministrativo specialmente in materia di competenze digitali e pensiero computazionale (Tamim et al., 2011).

In conclusione un'adeguata formazione scientifica e computazionale, unita a un miglioramento delle proprie competenze socio–relazionali, permette agli individui di ottenere dei vantaggi occupazionali all'interno di un mercato del lavoro digitalizzato e globalizzato.

Bibliografia

Argentin, G., Gui, M., Pagani, L. e Stanca, L. (2016) The Impact of Digital Literacy on Educational Outcomes: Evidence from Performing Tests. *Educational Studies*, 42 (2), 137–162.

Autor, D., Levy, F. e Murnane, R. (2003) The Skill Content of Recent Technological Change: An Empirical Exploration. *Quarterly Journal of Economics*, 118 (4), 1279–1333.

Autor, D. e Dorn, D. (2013) The Growth of Low Skill Service Jobs and the Polarization of the US Labour Market. *American Economic Review,* 103 (5), 1553–1597.

Autor, D. e Price, B. (2013) The Changing Task Composition of The U.S. Labor Market: An Update of Autor, Levy and Murnane. *MIT Mimeograph*.

Bernstein, D., Crowley, K. e Nourbakhsh, I. (2007) Working with a Robot: Exploring Relationship Potential in Human–Robot Systems. *Interaction Studies*, 8 (3), 465–482.

Brynjolfsson, E. e McAfee, A. (2011) *Race Against the Machine*. Boston: Digital Frontier Press.

Brynjolfsson, E. e McAfee, A. (2015) *La nuova rivoluzione delle macchine. Lavoro e prosperità nell'epoca della tecnologia trionfante*. Milano: Feltrinelli.

Florida, R. (2003) *L'ascesa della nuova classe creative. Stili di vita, valori e professioni*. Milano: Mondadori.

Florida, R. (2006) *La classe creativa spicca il volo*, Milano: Mondadori.

Forester, T. (1985) *The Information Technology Revolution.* Oxford: Blackwell.

Frey, C.B. e Osborne, M. (2013) *The Future Of Employment: How Susceptible Are Jobs to Computerisation?*. Oxford: Oxford Martin School e Oxford University Press.

Gandini, A. (2015) Il lavoro freelance: reputazione e capitale sociale nell'era del lavoro digitale. *Quaderni di Sociologia*, 69, 87–106.

Goos, M., Manning, A. e Salomons, A. (2009) Job Polarization in Europe. *American Economic Review*, 99 (2), 58–63.

Gordon, R. (2012) Is US Economic Growth Over? Faltering Innovation Confronts the Six Headwinds. *CEPR Policy Insight*, 63. [Online] Disponibile su: http://cepr.org/sites/default/files/policy_insights/PolicyInsight63.pdf [Accesso: 4 Marzo 2017].

Johnson, R., Saboe, K., Prewett, M., Coovert, M. e Elliott, L. (2009) Autonomy and Automation Reliability in Human–Robot Interaction: A Qualitative Review. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 53 (18), 1398–1402.

Hargittai, E. (2008) The Digital Reproduction of Inequality. In Grusky, D. (ed.) *Social Stratification*. Boulder: Westview Press.

Kern, H. e Schumann, M. (1991) *La fine delle divisione del lavoro?*. Torino: Einaudi,

King, A. (1981) A New Industrial Revolution or Just Another Technology. In Friedrichs, G. e Schaff, A. (1982) *Microelectronics and Society*. Oxford: Pergamon Press.

Kirschner, P. e Karpinski, A. (2010) Facebook and Academic Performance. *Computers in Human Behavior*, 26 (6), 1237–1245.

Levy, F. e Murnane, R. (2004) *The New Division of Labor: How Computers Are Creating the Next Job Market*. Princeton: Princeton University Press.

Machlup, F. (1984) *Knowledge, Its Creations, Distribution, and Economic Significance. The Economics of Information and Human Capital*. Princeton: Princeton University Press.

Massari, R., Naticchioni, P. e Ragusa G. (2013) Unconditional and Conditional Wage Polarization in Europe. *Neujobs Working Paper D3.6.* [Online] Disponibile su: http://www.neujobs.eu/sites/default/files/NEUJOBS_D.3.6_final%20versi on.pdf [Accesso: 24 Marzo 2017].

Moniz, A.B. e Krings, B.J. (2016) Robot Working with Humans or Humans Working with Robots? Searching for Social Dimensions in New Human–Robot Interaction in Industry. *Societies*, 6 (23), 1–21.

Neresini, F. (2011) *Il nano–mondo che verrà. Verso la società nanotecnologica*. Bologna: Il Mulino.

Pollock, F. (1970) Automazione: conseguenze economiche e sociali. Torino: Einaudi.

Rifkin, J. (1995) *La fine del lavoro: il declino della forza lavoro globale e l'avvento dell'era post–mercato*. Milano: Baldini e Castoldi.

Sheridan, T.B. (2016) Human–Robot Interaction: Status and Challenges. *Human Factors*, 58 (4), 525–532.

Tamim, R., Bernand, R., Borokhovsky, E., Abrami, P. e Schmid, R. (2011) What Forty Years of Research Says About the Impact of Technology on Learning. A Second–Order Meta–Analysis and Validation Study. *Review of Educational Research*, 81 (1), 4–28.

Turner, A. (2001) *Just Capital. Critica del capitalismo globale*. Bari: Laterza.

Wajcman, J. (2006) New Connections: Social Studies of Science and Technology and Studies of Work. *Work, Employment and Society*, 20 (4), 773–786.

World Bank (2016) *World Development Report 2016: Digital Dividends*. Washington: World Bank.

Personal Health Data in Frequent Users Life: From Institutional Design to Self–tracking

Alberto ZANUTTO[*][a]

[a] Università di Trento

Increasing strategies to perform new way to keep patient involved in health practices are missing often the point. Infrastructures are not able to intercept real interests of patients through wide open services. Personal health data management require personalization and support for personal health practices. Several strategies include the development of Personal Health Record systems (PHR).

In a Italian trial we explored three main strategies that often show a gap to pass over: practices to verify diagnosis; practices to support and manage therapies; practices to face space and time constraints.

Keywords: *Personal health record; user practices; health information systems; health infrastructures*

Introduction

National healthcare systems represent one of the most complex political challenges of our times. In recent years, due to the economic crisis and a contraction of resources following decades of continuing expansion, it has become increasingly urgent to intervene to ensure the sustainability of the system without, however, reducing the expected quality of service (European Commission, 2014). The complexity of the situation is rendered even more acute by the socio–demographic transformations that will lead to profound changes in western healthcare systems over the next few decades.

One of the stimuli that should help with attainment of these changes is undoubtedly the increasing introduction of computerized infrastructures that have the capacity to support the relationship between patients and

health care systems without losing the quality of service that people expect and their trust in their contacts with healthcare professionals. The first consequence of these changes is a progressive demand for co–responsibility on the part of patients, who must take increasing responsibility for a capacity to pre–empt healthcare issues and manage their treatments independently. This requires a special investment in infrastructures that are especially attentive to the needs of patients, that are designed according to their needs, and that are increasingly able to rebalance the relationship between patients and healthcare professionals. A second result will be the nature of these infrastructures, which must be able to help patients with their health–related obligations wherever they are, and throughout the course of the day.

PHRs are probably the most intriguing system designed by health institution to improve new model and new practices for taking any specific responsibility for patients. With very few exceptions, the centre of gravity of the projects always lay within the healthcare systems, and it is only in more recent times that patients have been able to become a part of some of the design processes relating to the infrastructures.

Of course, there has been no lack of criticism of these expectations. Many studies have shown that there a great variety of problems are associated with the introduction of these infrastructures. An excessive prevalence of the medical perspective has often reduced patients' comfort levels and led them to abandon the systems that were designed for them (HealthSpace NHS, GoogleHealth). Some works explored in extended way the constraints that infrastructures deal with their objectives and the patients' point of view (Greenhalgh et al., 2010).

Despite the continual recourse to rhetoric on patient empowerment and co–management of pathologies by patients themselves, the systems often seem to pay little attention to their role (patient empowerment rhetoric). In the structure we analyse here, we will see how in a PHR system developed on the basis of placing the patient at the centre, this element is considerably downgraded when the system is placed in service. Both quantitative and qualitative empirical observation reveals that patients still derive a noteworthy benefit from this innovation, however, so why is it that patients whose opportunities to produce useful information and collaborate with the health service by using infrastructures dedicated to them have been downsized are still satisfied with the new scenario regulated by these same infrastructures?

Related work

The topic of the development of infrastructures in the healthcare sphere has been being explored in various communities for some time now, but the aspect that has attracted the most attention from scholars from the outset is the doctor–patient relationship as created by these infrastructures (Bansler and Kensing, 2010). As far as scholars, especially those who study co–operative labour, are concerned, these issues constitute a continuing challenge. The pioneering works of Berg (1997; 1998) and Carl May (May et al., 2001) were among the first to identify the drift, misunderstandings and difficulties involved in looking at technology as a replacement medium.

One of the pathways with which this work wishes to interact is the one that opened up as the result the development of computerized patient records, and more recently of computerized patient records centred on patients themselves, known as Personal Health Records (PHR). These records have offered an opportunity for reflection on the infrastructures that support clinical work. Over the years, computerized medical records have become one of the points at which the old infrastructures have intertwined with the working practices of healthcare staff. Thanks in part to auditing systems, traditional infrastructures usually record patient flows (admissions to and discharges from hospital classified according to the Diagnosis Related Group – DRG), and allow healthcare.

Furthermore, the production of data in geographically remote contexts means that reflection on what takes place, for example, in patients' homes following the introduction of new Communication Technology information technologies cannot be avoided (Gherardi, 2010; Mol, Moser and Pols, 2010; Nicolini, 2006; Piras and Zanutto, 2014).

The PHR experience is possibly the one that has most clearly highlighted the social construction processes of technologies relating to computerized medical records developed with the idea of placing patients at the centre of the design. The purpose of these systems is to 'liberate' patients from coexistence with other parties, and to offer them various levels of independence in the management of self–produced healthcare data; these infrastructures place patients in direct contact with healthcare staff (Bjørn and Østerlund, 2014; Nazi, 2013; Østerlund, Kensing and Davidson, 2011).

Methods

Since it began, the project has been monitored by means of quantitative and qualitative studies planned and developed by the author with other colleagues for the entire duration of the trial phase and the first two years of operation (2008–2013). This paper presents data related to one of four activities for the assessment and monitoring actions carried out between December 2013 and February 2014.

Whole data were provided by:

- a survey conducted with the CAWI (Computer Assisted Web Interview) method addressed to 6,836 users registered with the infrastructure at the end of the first year of operation and who had accessed the system at least three times by 2013;
- an analysis of approximately 500 e–mail messages sent to the system's helpdesk by patients. The emails were post–coded according to content and evaluated both quantitatively and qualitatively;
- ten semi–structured interviews with institutional and technical actors who were responsible for designing the system and putting it into operation;
- ten detailed interviews carried out by selecting the ten most frequent patients/users of the system. The interviews with the users explored the changes brought about by this new way to archive and use data after the system's introduction. The interviews concentrated especially on initial expectations with respect to the system, the degree of satisfaction at the time of the interview, and interest in future developments. The interviews had an average duration of about one hour, and they were all recorded and transcribed for analysis. The interviews took place in the homes of the interviewees.

Findings

Thanks to the composite evaluation plan it was possible to gain a variegated picture of how the system was regarded by its users. It what follows, we discuss just findings provided by the most frequent end–users. Other field data are under analysis and further explorations.

The interviews with patients were conducted in order to determine their reasons for accessing the system and to understand the processes by which

they adopted it. Of course, these patients were self–selected by frequent use of the system, which often depended on continuous access to facilities especially for cardiac problems or cancer. The interviews showed that the PHR service was not considered an ordinary health service, but especially a privileged channel of access to health services. It was a completely new service which allowed a 'direct' encounter with the health care system and created new ways to relate with the organization. The rules of access and the services available regarding personal health data were compared unfavourably to the expectations people usually have when utilising other common Internet services. The benchmark for its functioning was everyday experience with other online services. The citizens interviewed insisted on the novelty of this data reception channel, which had made their lives easier. Immediacy, browser–based access, and the ease of immediately printing reports were the aspects most frequently cited by the patients interviewed. These interviews evidenced a new attitude by patients. Over time, the system had moved closer to patients' needs, and those in an intense relationship with the health services drew great benefit from it. This generated new practices of data access and use, freeing patients from the materiality of traditional documents and the need constantly to consult healthcare information counters.

For this reason it is important to move closer to the citizens' practices of system use. It is difficult to identify those practices that have actually been strengthened by the system and foreseen in the design. However, it is appropriate to explore certain of the new practices generated by patients and discussed with the interviewer. We limit the zoom–in so as to identify three most interesting practices (Nicolini, 2009). These should aid understanding of why the system is gaining a growing amount of appreciation from the population, notwithstanding its limited potential.

1. Practices of representation of healthcare histories.

With the infrastructure in place, this practice also belongs to patients. It can therefore happen that in some remote valley in the region subject of this study, an interview with the patient with heart disease carried out in a living room will show that computers have become an official part of the environment, in the centre of the room, and in the middle of the table. The patient can easily show the interviewer his new analyses, which he can finally consult freely as soon as they are ready as if he were in a doctor's surgery, or even better, as if he were a doctor.

'I have never experienced any problems. My son installed everything and now I check my exams for my heart treatment. I print everything so I can keep them separately and for my check–ups with my cardiologist. In this way, I can do my tests here in town and receive reports from the hospital without having to go there any more to pick them up. At the hospital, I go to for my consultations (which is outside the Region), I don't think they even know I do everything by myself. They don't have this service! Look how good I am using the system: two clicks and I'm in, and I keep everything under control!' (Flavio).

2. Diagnosis become a patients' practice as well

After receiving some unusual results from a test, patients can immediately google the internet, send their test results to their friends and colleagues for advice or directly to the specialist working with the patient on the various aspects of his/her illness.

'I'm one of the oldest users of the system. I've also given advice on how it could be improved and they listen to me. As a blood donor, I consult the system very frequently after each donation. The thing that really amazed me is the speed: having your exams immediately. For us donors, exams used to arrive in 4 to 5 days, but occasionally only in 10 to 12 days. Sometimes I go and see how my blood parameters are developing... but now I look at the system and my labels. It's really convenient! Even if the line isn't working I've saved all my tests! On one occasion, I had a problem with my prostate and I did the PSA exam, the 'total' one, and I saw it had gone up, so I got a prescription for more tests to see the 'free' PSA, and the day after I had the results and everything was OK! I look at my wife's tests in the same way!' (Giovanni).

Although communication with doctors is not yet supported by the infrastructure, patients can autonomously communicate their health data to various interested parties in order to verify the data and possible effects. Patients become active, and because information is available to them at an earlier stage, they ask the health service to deal with it or seek further consultations.

3. Management practices of time and space

Our work on the interviews with those individuals who used the system more frequently illustrated a series of changes in practice that chronic patients had put to use in order to comply with articulation work. In one particular case, for example, a cancer patient had his partner help him manage the infrastructure. This permitted a new method of interfacing with the cancer unit: for example, his partner was able to manage the tests freely without ethical issues arising, because under Italian law, she could not access the test herself because she was not a relative. The couple, who were in constant contact with a variety of specialists in other areas, forwarded the tests as soon as they received them so that the treatment to be followed could be verified. In addition, because chemotherapy can only be performed where a certain balance of blood components is present, the couple was able to manage every movement of the patient remotely and avoid having to travel to the hospital if the proper treatment conditions were not present. They could check them on their own without going to the hospital, and without consulting a doctor.

> 'It coincided with my husband's being diagnosed with a tumour. I wanted to have his exams looked at by whom I wanted and how I wanted without always having to ask... partly because we weren't married at the time, which meant that as far as the hospital was concerned I couldn't access his medical records. They always gave me the laboratory analysis, but not CAT scans, MRIs and PETs. This system has simplified everything for me: I don't ask anyone for anything and I can see everything immediately, so I have more control over the situation. Previously, you needed a few days and we often went for chemo but had come back home because they discovered while we were there that his transaminase was high. When I'm waiting for exam results, I'll go into the system as many as 20 times a day! This is exactly what I expected when I heard about the system. It's also happened that at first, when I travelled outside the Region, I thought I would find the same technology, but it's not like that. On one occasion, we made a pointless trip because there was no wi–fi at the hospital and I wasn't able to show them the tests in our system! One time, we were going on holiday in the Marche and we stopped at a motorway restaurant so I could go into internet and see the results of the tests without waiting for them and then leave again.' (Maddalena).

Conversely, for the same reasons, the husband of a cancer patient asked for his wife's access to the infrastructure to be blocked because when she changed her practices for access to healthcare data, she would alter her expectations of being cured as a result of wanting to try consultations and treatments that would destabilize the treatment already under way. Here, admission to hospital necessarily means accepting asymmetries with healthcare personnel. Patients must accept stigmatization as being bound to a network of humans and non–humans with a certain course of treatment.

Conclusion

The new e–health infrastructures permit new roles to be developed for patients and new practices to be constructed for the management of healthcare data. Although there have been a plethora of trials in the sector and massive investments for the purpose, computerized healthcare continues to register a series of failures, prominent among which is United Kingdom NHS HealthSpace project.

In this paper, taking what is an apparently successful case as our starting point, we have sought to identify how patients invent new treatment practices thanks to the new infrastructures. Their new margins for action are limited, however, due to a design management practice in which the interests of the health service prevail, but even given these constraints, patients find that there can be significant margins for establishing independence.

Patients appreciate the new opportunities to become protagonists of a new way of managing healthcare data that makes them freer and more dependent. This paper illustrates how this can happen in the areas of diagnostics and treatment. Although the possibilities are very limited – they include electronic filing, the assignment of codes and the opportunity to read medical reports immediately – patients interpret the system as a new style of relationship, with the hope that it might be the beginning of a new relationship with the healthcare system. The expertise that is so often cited in planning documents remains tied to development work, but it is increasingly opening up towards a type of clinical responsibility that is yet to be explored. While it remains an indirect relationship, the change in perspective that infrastructures such as this offers patients is clear.

References

Bansler, J. and Kensing, F. (2010) Information Infrastructures for Health Care: Connecting Practices Across Institutional and Professional Boundaries. *Computer Supported Cooperative Work*, 19 (6), 519–520.

Berg, M. (1997) On Distribution, Drift and the Electronic Medical Record. Some Tools for a Sociology of the Formal. In Hughes, J., Prinz, W., Rodden, T. and Schmidt, K. (eds.), *Proceedings of the Fifth European Conference on Computer Supported Cooperative Work (ECSCW'97)*. Lancaster: Kluwer Academic Publishers.

Berg, M. (1998) Medical Work and the Computer Based Patient Record: A Sociological Perspective. *Methods of Information in Medicine*, 37 (3), 294–301.

Bjørn, P. and Østerlund, C. (2014) Sociomateriality and Design. In Bjørn, P. and Østerlund, C. (eds.), *Sociomaterial–Design: Bounding Technologies in Practice*. New York: Springer.

European Commission (2014) *Acting Together: A Roadmap for Sustainable Healthcare*. Brussels: ESGSH.

Gherardi, S. (2010) Telemedicine: A Practice–based Approach to Technology. *Human Relations*, 63 (4), 501–524.

Greenhalgh, T., Hinder, S., Stramer, K., Bratan, T. and Russell, J. (2010) Adoption, Non–adoption, and Abandonment of a Personal Electronic Health Record: Case Study of Healthspace. *British Medical Journal*, 341, C5814.

May, C., Gask, L., Atkinson, T., Ellis, N., Mair, F. and Esmail, A. (2001) Resisting and Promoting New Technologies in Clinical Practice: The Case of Telepsychiatry. *Social science & medicine*, 52 (12), 1889–1901.

Mol, A., Moser, I. and Pols, J. (eds.) (2010) *Care in Practice: On Tinkering in Clinics, Homes and Farms*. Bielefeld: Verlag.

Nazi, K.M. (2013) The Personal Health Record Paradox: Health Care Professionals' Perspectives and the Information Ecology of Personal Health Record Systems, Organizational and Clinical Settings. *Journal of Medical Internet Research*, 15 (4), e70.

Nicolini, D. (2006) The Work to Make Telemedicine Work: A Social and Articulative View. *Social Science & Medicine*, 62 (11), 2754–2767.

Nicolini, D. (2009) Zooming In and Out: Studying Practices by Switching Theoretical Lenses and Trailing Connections. *Organization Studies*, 30 (12), 1391–1418.

Østerlund, C., Kensing, F. and Davidson, E.J. (2011) Personal Health Records in the US and Denmark: From Visions to Versions? In *Proceedings of the*

  Third International Workshop: Infrastructures for Healthcare.
  Copenhagen: IT University and University of Copenhagen.
Piras, E.M. and Zanutto, A. (2014) 'One Day It Will Be You Who Tells Us
  Doctors What to Do!'. Exploring the 'Personal' of PHR in Paediatric
  Diabetes Management. *Information Technology & People*, 27 (4), 421.

Accessible Learning Environments: When Care Meets Socio–technological Innovations for Pupils with Disabilities

Cristina POPESCU[*a]

[a] École des Hautes Études en Sciences Sociales, Paris

By adopting a sociological and ethnographical point of view, this article shows how care plays a key role within new technologies design and appropriation in the case of young people with disabilities. It underlines a new way of constructing knowledge about disability and special needs into education through collective processes that associate researchers, caregivers and people with disabilities during an experimental process.

The experimental and learning process appeared as an infrastructure allowing digital artefacts and people to meet. Technologies intended for users with disabilities overpassed their practical dimension by directly participating to the 'configuration' of their user. They included both mainstream and specialized affordances. In the same time, the relationship between the object and user should be understood as a complex adjustment process. Care then appeared as a reciprocal movement, with a collective dimension. On one hand, caregivers and families engaged into improving the future of students with disabilities by guiding them during the learning of adapted or accessible technologies. On the other hand, young people with disabilities tended to adopt the innovative artefacts in order to be autonomous and therefore facilitate the others' efforts and intervention over time.

Keywords: Accessible environments; care; students with disabilities; digital devices

Introduction. Main questions and approaches

Disability received multiple definitions across the diverse scientific areas and disciplines. Current social research underlines nonetheless it's main conceptual strength: disability refers to impairments and activity limitations

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[*] Corresponding author: **Cristina Popescu** | e–mail: **c.popescu@yahoo.com**

one might experience, but it also represents an environment and interaction–related matter. Disability 'is not something a person is, but something a person becomes' (Moser, 2005, p. 668). Therefore, it is important to closely follow 'how people become, and are made, disabled – and what the possibilities for articulating alternatives are' (Moser, 2005, p. 668). Disability is 'enacted in everyday practices' (Moser, 2005), often implying the use of the diverse categories of artefacts. In accordance with this methodological intuition, this article focuses on multiple and complex adjustments at work in a particular infrastructure combining both schools and health and social care institutions. More specifically, it takes into account the example of a particular accessible and *adapted* digital device designed to improve the learning environment for students with disabilities.

An STS approach is adopted further on, as it brings thicker understanding of the relationship between people and digital and technical objects, which are sometimes conceived as prosthetic devices. Technology often mediates human performances (Blume, Galis and Valderrama Pineda, 2014; Stone, 1995), while multi–layered adaptive processes operate between prosthetic objects and their users (Winance, 2000). Besides, the new devices' and technologies' design for vulnerable people keep a close relationship with the different paradigms of care (Mol, 2008; Pols, 2012) bringing a more interactive approach to knowledge construction, directly related to concern and engagement among individuals. This is often visible when researchers, caregivers and users associate themselves during technical and innovative experimental trials (Rabeharisoa and Callon, 1998). Eventually, digital technologies have the potential to appear as 'multiple objects' when connected to action: 'Multiplicity of objects means that people enact objects in different ways within different practices. […] This is not a matter of different interpretations of the object but of ontological differences: the object is different things in different practices.' (Pols, 2012, p. 163).

Data collection and analysis

The data collection used for the research was mainly based on ethnographical fieldwork, including participant observation during the process of conceiving and experimenting the digital device for the students with disabilities. At the end of a complex reflexive process, the object was defined as being suitable for partially sighted, deaf students and students with dyslexia. The project took place between 2013–2015. Three hundred students from four French geographic areas were involved, and they

attended all school levels. Fieldwork within schools and care centres for young children with disabilities brought additional qualitative data. Almost forty children and young students with disabilities and some of their teachers and caregivers were met for more detailed interviews.

The French online forums talking about school for children with disabilities built an additional fieldwork. Analysing the discussions on the use of digital technologies and their possible influence on the future of this category of students helped to enlarge the understanding of the general context. Additionally, ethnographic observation within a French training institution for specialized teachers during seminars, and class lectures, gave access to an increased amount of information.

In the following, three significant moments will be presented. They include specific forms of participation and configuration of actors, while the values, the evaluation processes, and the care perspective vary from one to another. The first moment concerns the creation and the configuration of the object. It is followed by an incentive moment when care interferes with the learning processes, showing itself essential during the adjustments between the object and its users. The last moment includes the selected description of the students' practices within an 'environment of care'.

School as 'inclusive' environment

210,400 students with disabilities attended French regular schools in 2011, and this number is especially explained by recent policy shifting. In that sense, the French equality law for people with disabilities, n° 2005–102 from 11th of February 2005 influenced several modifications concerning the right for pupils with disabilities to attend mainstream schools within a general environment of 'inclusive education'. Indeed, there were 55,000 more students in 2006 than before, with an average increase of 6.3 % of students with disabilities, while the amount of non–disabled students remained the same (French Ministry of National Education, 2012).

The new paradigm of 'inclusive education' transformed school into an experimental public space intended to offer a common ground to all learners, despite their different training needs. The general aim was to offer an improved support with the disability experience. That is why early intervention was considered as important from the very first years of school. The public policy therefore defined human and non–human solutions intended to bring equal participation to students with disabilities from

educational institutions. New technological tools could then be seen as compensation resources when human caretaking was less available.

Following this line of thought, 'inclusion' into mainstream classes was sometimes politically configured as an experience implying a search for technical solutions. Funding was for instance available in order to develop devices that could help students with disabilities within a mainstream learning environment outside specialized, but segregated, institutions which offered nonetheless the necessary conditions for stability. Within the specialized education environment, each computer and student had for instance their dedicated place, but the mainstream social participatory experience was almost absent (fig. 1).

Figure 1   *Computers and adapted desk for students with disabilities within a French specialized school.*

Figure 2   *An experimental device – made of a laptop and other portable components (webcam and scanner) – is used inside a classroom.*

The configuration was completely different when the learners had to attend the mainstream educational system. Often, inside this new environment, they didn't have enough place to range a big computer, they needed small technical devices, access to sockets and enough space on the

desk that was shared with other students. In mainstream schools and universities, learners change quite rapidly their places and rooms. In order to answer to this particular space configuration, modularity and mobility were underlined and encouraged through the design of new technical devices (fig. 2).

Making a composite autonomy–centred object

The following section will describe how a multiple steps process brought towards the creation of such a new device mainly meant to be used within the mainstream school environment, and to make the learning activities more accessible to the disabled students. Against this background, the design appeared as an ongoing form of care work that was declined according to the different actors' competencies.

Over a first phase, the object was expected to offer a diversity of choices for personalized profiles that addressed the various users' needs. Initially, an IT expert designed the basic software in relationship to the disability–related department of a 'major electronic systems company acting in areas such as defence, aerospace, airlines security and safety or information technology'. Between a logic of economic performance and a logic of care, the software was finally devised in to ensure an increased 'participation' of visually impaired employees to the company's activities.

An interdisciplinary cooperation for the design was observed when other actors like education, technical and care professionals joined the process in a second phase, showing their interest towards the software. They saw it as source for a broad range of possibilities for action. Soon, the software became the basis of a complex device meant to be tested through a project largely financed and supervised by the French Ministry of Education. The public institutions saw the technological solution as a sustainable resource answering the public responsibility engagement towards the diversity of students in schools and universities.

A few months' process began encompassing testing, error submitting, as well as multiple negotiations concerning the functioning of the object, but also its main definition. If initially conceived only for people with visual impairments, additional options seemed to apply to students with hearing impairments and dyslexia, too. The interdisciplinary team was the first one who tested the device and gave its feedback on it. The central interface of the device evolved accordingly to these experts' evaluation and suggestions, as they had a previous knowledge of disability–related needs. At the

beginning, it indicated access to tools like the webcam, the scanner or the speech synthesis, mainly through a keyboard use. This access was afterwards renamed, by keeping in mind the main keyword defining the action to be done. For instance, the menu 'blackboard' opened the possibility to take pictures of the blackboard, and the menu 'document' gave access to the software that helped with scanning paper documents. Following the diverse suggestions, new menus like 'notes' or 'folders' were added. If the first menus concerned a visual need (zoom, contrast), the newly added ones were mostly conceived around the easy access and organisation of the information, very helpful for cognitive need. The various layers of discussions and negotiations between the professionals appeared then by the way in which different options and menus of the interface were named and hierarchized. All of them took into account these adults' concern about the most suitable direction to adopt in order to improve both students' well–being and knowledge acquisition.

During a third stage, just before the large–scale testing phase, the diverse parts of the object were thus brought together. They included a computer receiving inputs from specific tools and software. A centralizing software offered an interface allowing a rapid access to multiple functionalities, a vocalized menu and the possibility to have different user–profiles. Additional software, based on the software created during the phase one, helped to save and transform images taken with the help of devices like webcam, interactive whiteboard, Mimio capture bar, or scanner. A note–taking tool allowed the students to create a chronological document with their notes and blackboard captures. An OCR software and a speech synthesis software allowed the computer to read the various paper or digital documents. A composite object emerged, made of hardware and software parts, and showing a 'social responsibility' related message: it included derivate existing solutions, and open source resources, recognized for their cost–free dimension.

The creation of an open source object aimed to provide inclusive, equal and easy access to technology for all the young participants to the project, despite their socio–economic background. It was a way of showing an 'imagined' care into practice. The object was made according to an 'average' image different participants and experts had of the students who would use it. They selected the functions which they considered to be relevant and integrated them to the object, in accordance with the various technical possibilities. The way in which the object was built and transformed during that process participated, in an indirect way, to the configuration of its users

(Woolgar, 1991). It included mainstream or specialized affordances (Gibson, 1977) and configured a specific ground for agency.

Moreover, within this general context, the State appears as the institution which takes care of the young people with disabilities by encouraging the creation of tools for their learning activities through the necessary resources allocation. Besides, in exchange for this 'opportunity', there is a logic of informed citizenship that becomes progressively visible. Learners with disabilities were asked to give their point of view on the device created for them and submitted to their evaluation. They were therefore defined as active participants to the construction of a new tool serving the inclusion paradigm into mainstream schools. But answering to this request was sometimes difficult. Some students lacked the necessary training concerning the general use of digital devices, while others encountered health issues making them too vulnerable to this kind of activity.

The experimentation period

During the experimental period nonetheless, an important number students managed to test the object at a larger scale, in a real–life setting. While some of them couldn't directly grab it, the professionals acted as 'gatekeepers' opening their access to the device's use. They were both education representatives from schools and universities, and medical and social–care actors specialized in visual, hearing impairments, learning disabilities, e.g. speech and language therapists, orthoptists, occupational therapists. Two general positions could be identified in direct relationship to the best practices of care related to learners' schooling: the first one belongs to the caregivers, the second one to the teachers. The following paragraphs describe these two positions.

The first case points towards the social and medical caregivers. The field research allowed to have a better image of their work with the disabled students. It included for instance tutoring for reading, writing, and orthography. The most present professionals from this category were the occupational therapists. During a visit to a secondary school and a high–school establishment from a poor area of a big city, one of them underlined her wish to improve the collaboration with the schoolteachers. She voiced her concern about one specific student's place within the school environment, and how the teachers less encouraged his use of digital technologies:

'The occupational therapist underlines again how important it is to inform teachers about the student's needs, they [with her colleagues from the centre] have already tried to talk to the teachers, but... And it is maybe true that things go better with teachers from ULIS ('Unité Localisée pour l'Inclusion Scolaire' – Localized Unit for School Inclusion), but they don't have one in this school. [...] There is almost a victory this year that the Mathematics teacher started to use the software Geogebra with the student. Anyways, it remains the French teacher ... she is the one with whom the student doesn't feel very well. She is a young teacher, in her early career, and she maybe needs some more flexibility. Miss M, the resource teacher, standing next to us, answers that the French teacher's approach will maybe change in a few years… Altogether, Miss M has also observed how independent the student was during the meeting. The occupational therapist agrees with her and she confirms he always goes and asks teachers for help according to his needs. He also asks for the digital version of the paper documents. It is only with the French teacher that he doesn't feel very free to do so.' (Source of quotation: researcher's field notes).

The occupational therapist draws on a more personalized approach of the training. Her engagement within the students' performance becomes clear in this context. Sometimes it is not enough for the student to manage the use of new technologies or the general process of knowledge management, the teachers' participation is therefore important and understood as a specific practice addressing information accessibility for all the learners.

A second case will emphasize how teachers position themselves in relationship to care practices. During a specialized workshop, the participants, all teachers, discuss their relationship and their collaboration or lack of collaboration with the various caregivers. Three of the participating teachers describe their previous experiences:

''Oh, she [the caregiver] arrives in my classroom, and then she sits down as in front of her desk...', says one teacher, a little irritated, about a care–professional who works with one of her students.

'Everything is fine within my school', says another teacher 'but I must say we also have an excellent academic manager.' 'Finally, I

think we are like fathers to students, while they are like mothers', concludes a third teacher.' (Source of quotation: researcher's field notes).

The last teacher makes here a clarifying analogy with the family roles in order to show the type of activity each category, caregiver or teacher, has in relationship to the student. A social collective dimension of care appears within this quote, as the professionals take the place of the family. They become a temporary 'collective body' (Mialet, 2013), with various configurations, built both on cooperation and confrontation concerning the definition of a better future for the students. Undoubtedly, a more in–depth discussion could be made around the use of the categories 'father' and 'mother' and the contents and actions associated to them.

Figure 3   Yellow labels on a portable scanner used by a partially sighted learner.

But beyond these competing discourses, an important number of professionals effectively developed similar cognitive artefacts or adjusted the objects in order to help the students adopt the new technology offered to them during the experimental period. They mainly 'translated' affordances by schematizing the action. Step–by–step learning methods, based on a logic of simplification, were applied to the general pedagogical documents so that the students with different types of learning difficulties could understand them. A basic process of showing the meaning of each item from the centralizing software interface was one of the first steps within this process. The explanation was kept in shorter phrases, with easy words written around captured pictures of the device. A text editor software allowed to organize these contents that were afterwards printed on ordinary paper. The professionals were therefore 'translating practices' after an invisible evaluation process during which they compared what was

proposed by the objects' makers and what they knew about the students' special needs in specific situations. This can often be considered as a 'tinkering activity', as each professional adapted herself to the task through particular documents and supporting learning actions, within the more general care background.

'Adapting' or adjusting the hardware components was also part of the process through which the objet was individualized and situated according to each student's needs. For instance, one occupational therapist used small yellow labels in order to summarize the main options related to the portable scanner (fig. 3). A first label showed the plug helping to connect the scanner to the computer, a second one pointed out the place were to put the paper document that needed to be scanned, while a third label marked the button that started the scanning process. Care was enacted here by simple gesture integrating the routine of the daily activities. It could be mainly related to the particular form of help the disabled students received during their learning activities. Undoubtedly, the professionals from the experimental process saw their 'traditional' roles transformed, but the care practices remained very present even if they crossed conflicts and negotiations.

Students in front of the object. Between a logic of choice and a logic of care

Students were often mentioned in the previous sections, but they never had the opportunity to 'express' themselves. Instead, they only appeared through the discourses of other adult actors. Device's technical design imagined a general or 'average' user, while its testing was conceived around the idea of identifying its negative or positive aspects. The students were expected to employ the device; they could adopt it or let it out of their daily activities according to the planned experimental process.

The distinction A. Mol (2008) makes between a 'logic of choice' and 'a logic of care' when she talks about the patients' and the customers' position in front of health issues offers a good interpretative frame for the cases previously presented. The public policy imagined students' practices as linear and isolated from collectives, and each individual was seen as responsible for her learning performance. The ideal of a well–informed choice appeared in the public discourse, but this showed itself difficult to identify in practice. It is even harder for the researcher to follow this kind of individualized logic, as the ethnographical fieldwork showed how practices are non linear and a tinkering process is often at stake, especially within the

professional practices. That is why a situational analysis articulating a logic of care can bring additional support.

The different participants do not engage in a transaction, i.e. they adopt a new objet or not, but they rather interact with and around it according to their specific needs and the affordances of the environment. The students who were encouraged in their device's use by the other students, professionals, or families, and who managed to overpass the presence of this digital object as a form of difference, were also those who could use it as a tool for further action. Moreover, the digital technologies and the specific experimental device became part of the students' daily activities when the 'collective of care' had the necessary material and cognitive resources to support them. As Annemarie Mol underlines it, care is 'a matter of various hands working together (over time) toward a result' (Mol, 2008, p. 18). Eventually, in the absence of a use–supporter, the learners often abandoned the device, as the technical knowledge and the stigma associated to the use of a specific differentiating object became hard to manage.

Two cases could be relevant for the configurations of the relationship between adult–mediation, action–with–the–device and stigmatization. They concern three learners with disabilities who started to use the experimental device. Their names were changed for privacy reasons.

Anne, 14 years old, was a middle–school student with a partial visual impairment. She attended an international school where she could use her own laptop on a daily basis – quite a normal situation at her school. Anne had been using the computer for four years. She also worked with a specialized teacher, who was totally blind. At the beginning of the experimental period, the teacher encouraged Anne to use the device. Anne's main teacher also helped her by introducing the special needs adaptation she was using to her class colleagues. They were very curious about the webcam she was using, but the teacher's presence made the explanation process easier. Anne used the device for a good number of her classes; it helped her in organizing herself by having all information she needed in the same place. She was a very 'chaotic' person, as she underlined it. At the same time, papers were not a good solution for Anne's learning activities, as she lost them all the time.

The situation was completely different for Emma and David, both 12 years old, students in a public middle school. They followed IT classes in a specialized institution, but they didn't understand why they had to use their laptops or Braille display in mainstream classes. In the first meeting with

them, Emma was only using the webcam from the experimental device. The scanner seemed useless to her. During a second session, she abandoned the webcam, as she didn't like anymore the image it brought on her display. She preferred to use her Braille display, a smaller less visible object she could carry with her. During the last meeting session, Emma was using her paper notebook within the classroom; she preferred not to answer when asked about her Braille display. David's situation was similar to Emma's. Their specialized teacher within the mainstream school tried to explain them the importance of the digital devices. They needed to get used to them as they could allow them to be more autonomous in two years' time, when they would leave their middle school, for entering high school. If during the middle school, a specialized teacher ensured the accessibility of documents for the learners with disabilities, they wouldn't have her afterwards. Therefore, it was important for them to manage the documents all by themselves. So they were responsible for the future of their achievements. At the same time, both students attended a mainstream class where they were the only ones having a computer. This caused jokes from the colleagues and made them different from the others. The adults had made no previous introduction or explanation of the students' use of a differentiating device. The 'stigma management' related to the digital devices' presence was therefore a heavy process the two students had to deal with.

Even if a single device was submitted to the students in order to be tested, it undoubtedly appeared as a 'multiple object' (Pols, 2012) at the end of the experimental process, as the meanings attached to it changed from mediator of a learning practice to a stigma–attractor according to the environment of care in which the learners and the professionals tried it.

Conclusion. Towards reciprocity within the environment of care

All the stages, from the device's conception to its use by the different categories of stakeholders, were presented within this article, as the whole process showed a 'multiple object' directly related to the manner in which it is used and modified into action, according to each actor's or category of actors' set of values. The relationship between the object and its users was therefore understood as a complex adjustment process (Winance, 2010).

The learning environment for students with disabilities is crossed by *care.* This could be observed on a daily basis, through the various

professional participants' practices. A mother testimonial on an internet forum about the school for children with dyslexia underlines nonetheless the shared experience of *care*:

> 'My son teaches me today the different keyboard shortcuts, he is so proud of himself, as well as I… I have the impression we share something else than dyslexia, dysorthography, we discuss computer and informatics…!' ('Et bien voilà, aujourdh'ui [sic] mon fils m'apprend les raccourcis sur le clavier , il est fier de lui , moi aussi ... j'ai l'impression de partager avec lui un peu autre chose que la dyslexie dysorthographie , on parle ordi et informatique... !').

This mother shows another dimension of *care* that becomes a reciprocal movement. On one hand, professionals and families engage into improving the future of students with disabilities by guiding them during the learning of adapted or accessible technologies. They can do that for instance through the mediation of digital objects. But students with disabilities also bring their contribution to this process of complex interdependencies. They tend to adopt new artefacts in order to become autonomous and therefore facilitate the others' efforts and intervention over time.

Acknowledgements

References

Blume, S., Galis, V. and Valderrama Pineda, A. (2014) Introduction: STS and Disability. *Science, Technology and Human Values*, 39 (1), 98–104.

French Ministry of National Education (2012) *La scolarisation des jeunes handicapés* [Online] Available from: http://cache.media.education.gouv.fr/file/2012/58/4/DEPP–NI–2012–10–scolarisation–jeunes–handicapes_214584.pdf [Accessed: October 31st, 2016].

Gibson, J. (1977) The Theory of Affordances. In Shaw, R. and Bransford, J. (eds.), *Perceiving, Acting, and Knowing*. Hillsdale: Erlbaum.

Mialet, H. (2012) *Hawking Incorporated. Stephen Hawking and the Anthropology of the Knowing Subject*. Chicago and London: University of Chicago Press.

Mol, A. (2008) *The Logic of Care: Health and the Problem of Patient Choice*. London: Routledge.

Moser, I. (2005) On Becoming Disabled and Articulating Alternatives. The Multiple Modes of Ordering Disability and Their Interferences. *Cultural Studies*, 19 (6), 667–700.

Pols, J. (2012) *Care at Distance. On the Closeness of Technology*. Amsterdam: Amsterdam University Press.

Rabeharisoa, V. and Callon, M. (1998) L'implication des malades dans les activités de recherche soutenues par l'Association française contre les myopathies. *Sciences sociales et santé*, 16 (3), 41–65.

Stone, S. (1995) Split Subjects, not Atoms. Or, How I Fell in Love with My Prosthesis. In Gray, C.H. (ed.), *The Cyborg Handbook*. London: Routledge.

Winance, M. (2000) De l'ajustement entre les prothèses et les personnes: interactions et transformations mutuelles. *Handicap – Revue de sciences humaines et sociales*, 85, 11–26.

Winance, M. (2010) Practices of Experimenting, Tinkering with, and Arranging People and Technical Aids. In Mol, A., Moser, I. and Pols, J. (eds.), *Care in practice. On tinkering in Clinics, Homes and Farms*. Bielefeld: Transcript Verlag.

Woolgar, S. (1991) Configuring the User: The Case of Usability Trials. In Law, J. (ed.), *A Sociology of Monsters*. London: Routledge.

Al Dente Textiles. Notes on Edible Textiles as Economic and Ecological Intermediality

Tincuta HEINZEL[*a], Svenja KEUNE[b], Sarah WALKER[c] and Juste PECIULYTE[d]

[a] 'Ion Mincu' University of Architecture and Urbanism; [b] University of Borås;
[c] Nottingham Trent University; [d] Vilnius Academy of Arts

One of the red lines of aesthetics as modern established discipline was the definition of media categories and disciplines in order to support 'efficient' ways of expression. The debate between Gotthold Lessing and Charles Batteux in the 18th century, and later on the propositions of artists and critics in the beginning of the 20th century, have all emphasized the need of a certain 'aesthetic efficiency' of artistic production. This aesthetic 'efficiency', a term of economical ascendency, was to be achieved by taking into account the limitations of materials used by different forms of expressions and the sensorial channels they were addressing.

The present paper questions the notions of 'media efficiency', 'economy of attention' and 'media ecology' through an intermedia research based on a series of experiments with edible materials, conducted during a workshop on textile interactions in the frame of ArcInTex Conference at the Swedish School of Textiles in Borås in April 2016.

The paper suggests that the present intermediality researches are the signs of a new paradigm that tries to exceed the modern industrial affordances schemas.

Keywords: *Edible textiles; media specificity; media efficiency; ecology of media; intermediality; economy of attention*

Introduction

This paper presents reflections on a series of experiments from a two–day workshop on textile interactions, focused on edible materials in textiles

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and provides an overview on related examples in contemporary art and design practices to investigate edible textiles as a new hybrid form of media. Our reflections relate to the present debates on new materialism and economy of attention, by questioning the concepts of 'medium specificity'. Both 'new materialism' and 'economy of attention' are forms of critical interventions. New materialism addresses human and non–human agencies in an attempt to reconfigure nature / culture, body / thought, concrete / abstract dichotomies. The 'economy of attention' is an expression used by theoreticians like Herbert Simon (1971) and Bernard Stiegler (2010) to speak about new forms of attention management in contexts of information overproduction.

The debate on the specificity of the media was launched in the 18th century when the industrial forms of production started to impose themselves. The medium specificity debate guided most of the modernist enterprises that were trying to accommodate the role of arts in the industrial schema. Therefore, the focus on the 'aesthetic efficiency' of artistic production hints an economic concern (Heinzel, 2014).

The multifaceted aspects we encountered open up for a discussion on how media is defined, suggesting intermedia is not only a condition for alternative forms of expressions, but also the mark of a new paradigm that exceeds the modern industrial affordances schemas. Supported also by STS studies' conclusions on the nature of relationship between materiality and sociality (Law, 2008), our research points towards possible design strategies of material intervention.

Intermedia has to be understood here as the coming together, in a unified manner, of different already established forms of media. 'Edible textiles' are seen as textile structures that contain or are made of materials that can be consumed by living beings such as humans, animals or micro–organisms. Consequently those structures relate to 'food art' and biodesign, proposing new opportunities for textile artists and designers to explore new expressions by developing new materials, design methods, aesthetics and forms of interactions.

Experiments on textile interactions: edible textiles

During a two–day workshop on textile interactions conducted by Delia Dumitrescu and Hanna Landin in the frame of ArcInTex Conference which took place between April 11–15, 2016, at the Swedish School of Textiles in Borås, there was a general interest in the work–in–progress materials

developed by Svenja Keune. Her approach consists in integrating edible and growing materials into different textile structures i.e. knitting, weaving and crochet. These hybrid materials can be activated in order to change shape, pliability, and consistence or to initiate processes of plant–growth (fig. 1).

One of the groups constituted during the workshop agreed to use these materials for further explorations. By defining different forms of expertise, we worked in pairs towards what we called a 'chain of production' (fig. 2): 'hunters and collectors' (collecting materials to be integrated into textiles), 'fillers' (dealing with the integration of collecting materials into textiles), 'master weavers' (in charge to produce a fabric from these hybrid materials) as well as 'activators' and 'documentarists' (working towards the 'activation' of the resulted fabrics).
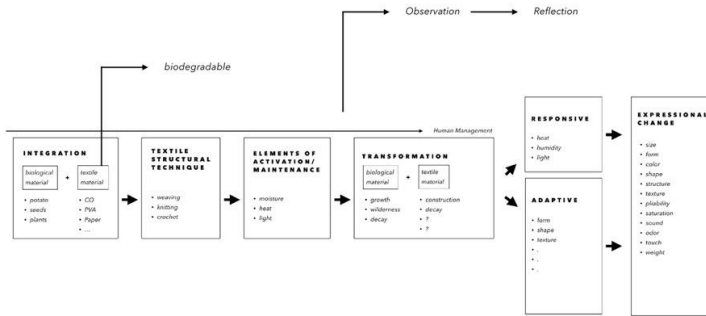

Figure 1   Diagram of the experiments. Copyright: Svenja Keune & Juste Peciulyte.
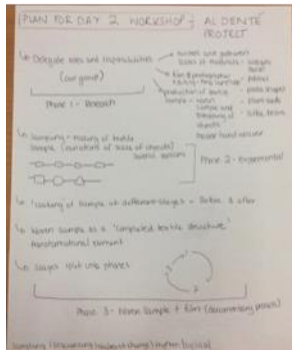

Figure 2   Photo of the planned activities. Copyright: Svenja Keune.

Materials

Commercially available tubular knitted materials from cotton, wool and synthetics were used as a basic material, and thus we focused on creating hybrid textiles, a combination of textile materials and edible/biological materials. The collected edible and biological materials to fill the basic textile materials with were cornflakes, corn, coffee beans, hazelnuts, pasta, coconut fiber tablets and boiled eggs. These materials were filled into the tubular material by using a straw and/or manual pressure to bring and spread them across the length of the tubes (fig. 3). The result was a series of different threads that could be used further, i.e. in hand weaving.

Figure 3   Making of hybrid threads. Copyright: Svenja Keune.

By using plain weave, the produced threads were used as weft material on an ARM–loom in a hand–weaving process, partially supported by using common yarns (fig. 4). Later on, the samples were activated to generate ideas for textile interactions and transformations, based on the potential of the edible materials used in the thread–production (fig. 5). Important design parameters were: filled materials, diameter and density of the knitted material, the weaving material in warp and weft. Fundamental for the overall expression were the edible/biological materials in terms of size,

shape, surface structure, smell and colour, as well as their reaction to moisture, heat and light over time.

Figure 4   Woven Combinations. Copyright: Svenja Keune.

Figure 5   Activating fabric with water. Copyright: Tincuta Heinzel.

Experiments

In the following section, three experiments are described more in detail: corn, coffee beans and pasta. The experiments varied according to the type of filled elements we used.

Fabrics with corn

For the fabrics filled with corn, a spray can filled with water, a heat gun and a microwave has been used (fig. 6). Due to the heat required for the popping of the corn, the textile can start to burn quickly. This can be avoided by using flame retardant materials or by careful observation and cooling breaks for the fabric in between the heating phase. As the corn stores the heat, those cooling phases don't disturb the process of popping too much. The popped corn adds more variation to the textile structure such as an additional color, an opposing consistence through the light, crisp but fluffy popcorns that consequently enhance the texture and that add three–dimensionality and odor to the structure (fig. 7). The popcorn can be picked from the textile surface or the floor if it popped out, and can be eaten. By activating the corn with water, the corns start germinating within one or two days. The small sprouts fight itself through the knitted structure. Here the overall expression and dimensions of the weave itself stay the same and are only affected by the germinating seed and its further growth.
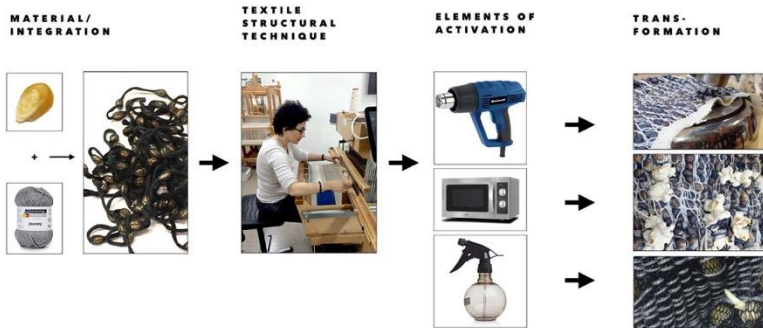
Figure 6   The production line with corn. Copyright: Svenja Keune and Juste Peciulyte.

Figure 7   Weaving with corn. Copyright: Tincuta Heinzel.

Figure 8   Weaving with coffee beans. Copyright: Tincuta Heinzel.

Fabrics with coffee beans

The weave with tubular inserted coffee beans was soaked in hot water for a couple of minutes. Observed was a slight change in the color of the water and the weave, it turned brownish. The strong odor of the roasted beans stayed the same (fig. 8) and consequently opens up for uses in interiors where smells need to be neutralized or that would profit from the smell in other forms.

Figure 9   Weaving with pasta. Copyright: Svenja Keune.

Figure 10   Pasta soaked in cold water over night. Copyright: Svenja Keune.

Weaving with pasta

The weave with pasta has been partly soaked in cold water over night and in hot water for a couple of minutes. Observed was a change of colour and consistency. Under pressure the soft pasta squeezed through the tubular knit. The overall expression changed towards a flat, textured surface that became rigid through drying (fig. 9 and fig. 10). This experiment with a distinct passive, as well as active structure, opens up for using edible materials to achieve certain transformations or material properties such as flat or three–dimensional, soft or rigid, pliable or stiff.

Examples of edible textiles

At the end of these experiments the concept of 'edible textiles' imposed itself. Therefore we decided to investigate some other examples of existing edible textiles.

Camilla Wordie 'textile based' approaches

The Scandinavian artist Camilla Wordie works at the intersection of textiles and food, defining herself as a food stylist. She translates different textures of food into textile structures or produces textile structures by using different kinds of foods. The *Wearing Rice is Nice* project (fig. 11) was inspired by rice textures.

Figure 11   Camilla Wordie, 'Wearing Rice is Nice' (2013). Copyright: Camilla Wordie.

The installation *Am I chocolate or not?* (fig. 12) consists of a tabletop made from chocolate to enhance the common experience of 'crumbly' and 'dusty' chocolate powder. Parts of the table can be eaten or react to forms of use, such as traces of melted chocolate caused by warm plates.

Consequently the scenarios open up for re–contextualizing experiences of food and related activities by inducing a certain 'ambiguity'.

Figure 12   Camilla Wordie, 'Am I Chocolate or Not?' (2013). Copyright: Camilla Wordie.
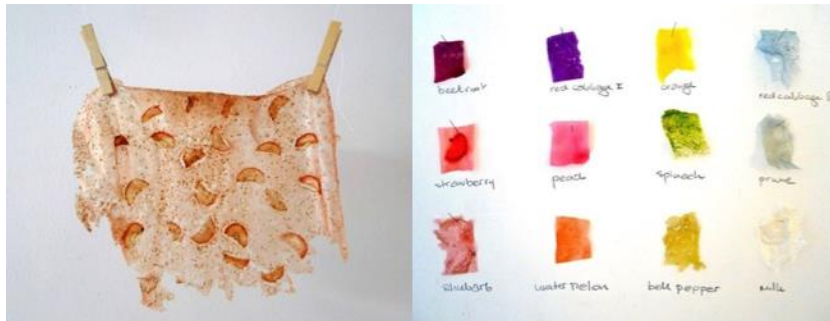
Figure 13   De Culinaire Werplaats (Eric Meursing and Marjolein Wintjes) – 'you are what you eat'. Copyright: Marjolein Wintjes for De Culinaire Werkplaats Amsterdam.

De Culinaire Werplaats 'you are what you eat': 'politically conscious approaches'

Eric Meursing and Marjolein Wintjes (fig. 13) produce edible pastry wrappers made out of dehydrated fruits, vegetables and herbs in their design studio/restaurant. They created a collection named 'taste the unwearables', aiming to raise the awareness towards natural and organic food, but also to debate about the ephemeral nature of fashion. In contrast to Wordie's experiments with food, Meursing and Wintjes collection encourages the consumption of the textile. They also follow a more holistic

ideology/approach which is represented by a comment they stated in regard to their collection: 'food equals fashion, what you eat and and what you wear reveals who you are' (see their website).

Jana Sterbak's (and Lady Gaga's) meat dress

By using meat to portray the contrast between vanity and bodily decay in a dress made in 1987, Jana Sterbak supported a political and societal discourse through using food as a controversial media that finds reference in every living being. Sterbak used salt to manufacture the dress by uniting the used flanks of meat in a curing process. At the time the dress received a lot of negative critique, especially from animal rights activists. Since Sterbak's creation, the meat dress has been iterated and worn by Lady Gaga to pick up the discussion on mortality, which equally sparked outrage again. Consequently these portrayals of edible materials mediate social and ecological discourses and thus challenge the definition of media.

Orange fibers

Orange Fiber is a startup that aims at the creation of sustainable textiles from citrus waste which currently valuing 700.000 tons just in Italy (as stated on the project website). Initiated by a fashion designer, the project builds on the principles of sustainable production and consumption. Besides that, the project also ventures the new fibers properties – they can nourish the skin of the wearers. The production of fibers from food waste does not have an important impact on the aesthetic qualities of fibers, but opens up to new forms of use for textile fibers. Last but not least, the project was highly mediatized as an example of sustainable business models for textiles and food industries, both of them being known for their high rates of waste.

Aniela Hoitink: growing textiles (MycoTex)

In order to investigate and to develop new methods for textile and fashion production, Aniela Hoitink, a Dutch fashion designer and researcher, developed a dress from mycelium, a living material which forms fruit bodies in forms of mushrooms and which she uses as a material for design. Usually grown on solid substrates such as wood, the mycelium here was grown in a liquid environment to manufacture thin textile–like layers. The pieces, shaped by their petri dishes they were grown in, were then merged to form a dress. The mycelium reacts to environmental conditions, degrades and can be repaired by natural processes. The dress mediates imaginations on future

forms of manufacturing, aesthetics and materiality of textiles and clothes (fig. 14).

Figure 14   Aniela Hoitink, 'MycoTex' (2016). Copyright: Aniela Hoitink.

Textiles and food as medium

The described experiments that are condensed under 'Al dente textiles' question the possibility of edible textiles as medium. It is also to notice that if it is to keep us in the recurrent understanding of media as form of communication, then neither textiles, nor food are conventional forms of communication. They do not really use codified information inscripted on a material support for straightforward interpretation. They are rather forms of expression. Both in the case of textiles and food, the opposition between support and content is a fragile one. Therefore, one of the questions we have to address is through which means textiles and food become expressive and what do they mediate?

Textiles as medium

One of the key persons in the definition of textiles as a medium was the Bauhaus artist and designer Anni Albers. In her book *On Weaving* (Albers, 1974), Anni Albers defined fabrics in terms of construction (Heinzel, 2012). The specificity of the textiles would reside, from her perspective, on the way the threads are brought together to form a fabric. That it is also why, the main channel of appropriation of a fabric is the texture, which is generally

given by the threads' properties and aspects, as well as by the way they fold. Different from other mediums of artistic expression, like painting, for example, the qualities of the fabrics are not to be appropriated only through vision, but also by touch.

Often used for sound insulation and, more recently, synthetically produced, the textiles display qualities like sound absorbance or impermeability which not only are defined in relation to an physical environment, but are also pushing forward the relationship between the natural and the artificial properties of the fibers. In a way, the new physical properties of textiles are translating the technical advancement of their sites of production. The transformation of textiles in interfaces (Heinzel, 2012) it is even more obvious in the case of electronic and smart textiles. The augmented capacities of textiles materials and their controlled performances are all supporting this perspective.

The use of fabrics can result in textiles artifacts, like cloth or furnishing, which at their turn can become a medium, as Marshal McLuhan see them. For him cloths are our second skin and therefore a body extension. And, as he describes in *Understanding Media* (McLuhan, 1964), the cloth has a double role: 1) to offer a thermo–regulatory mechanism to the body and 2) to socially define the individuals (the difference between cloth, costume and style, for example, it is to be taken into account). Fashion in this sense participates to the definition of the social distinction through cloths.

Food as medium

When it comes to food, we can delimit between cooking and eating. Both have rich aspects to consider: from the products that are cooked, to the way they are acquired, the hygienic conditions of cooking, the use of condiments, specific traditions of cooking, to the accessibility and variety of food and the cultures of food consumption. Like cloth, as a basic need, food is consumed /used on daily basis. But then, like in the case of cloths, we can also delimit between common food and special occasions food or ritual food. The discrepancies between different geographical regions, between social classes, are also not to be neglected. Such interpretations cannot take place out of the context in which they are performed. Their form of expression is related to their 'affordance' (Gibson, 1979; Lievrouw, 2014) in terms of functions, relations and repertories of uses culturally and socially sanctioned. It is in this note that we should also interpret our approach to textile and food waste.

Notes on media

The idea of bringing together two media like textiles and food, forces us to acknowledge the existence of two distinct media. This fact pushes us to define them and to find what are their specificities. The preliminary tests and the examples we have studied served to question the aspects to consider while generating new intermedia forms. Still, the whole picture would not be complete, if these speculations are not placed in a larger historical perspective. Tracing back the ways in which arts and design have defined the media specificity, will help us to understand the strategies design had used in order to make relevant interventions into the socially constructed nature of materiality (Law and Mol, 1985).

Media specificity theory

The debate on media (medium) specificity it is not a new one. It can be traced back to 18th century when Gotthold Lessing opposed Charles Batteaux on how to approach the arts. If Charles Batteaux (2015) was suggesting that the rules of art should follow the classic principles of imitation of nature and, therefore, all arts should be treated in the same way, Gotthold Lessing opposed him by arguing that 'an artwork, in order to be successful, needs to adhere to the specific stylistic properties of its own medium.' In Lessing's perspective, as derived from *Laocoon* (Lessing, 1836), some arts are more likely to express better certain ideas than others. The poetry, for example, was to be used to depict actions, while painting was fitting better to represent moments.

In this way, the specific stylistic properties of the medium are to be understood as ways to achieve a maximum aesthetic effect by using the medium's most common properties. In other words it was about how to reach an 'aesthetic efficiency' of the artistic product by mastering the limitation of the materials and by studying the fastest way to reach an aesthetic impact. The scope of each artistic discipline would be in this sense to develop their own methodologies, to delimit their own areas of competence.

The quest for the specificity of the medium was at the core of most modernist theories, being them art (Greenberg) or craft/design (Bauhaus) related. Bauhaus school's workshops, for example, followed the principles of media specificity and were organised based on the used materials following Bauhaus Manifesto's lines in which it was stated that art cannot be taught, there are only the techniques that can be taught. It was only through technical competences that pertinent and critical interventions were

possible. The workshops were looking to develop new methodologies for every discipline and the trained competences were to form a sort of aesthetic 'automatisms' which would allow students to better respond to the industrial forms of ideation and production.

Translated into economic terms, the medium specificity it is to be understood as aesthetic 'efficiency' (Heinzel, 2014). Going along the industrial serial production, the medium specificity's role was to ensure that the aesthetic dimension, the sensitive appropriation of the objects, was universally functional, facilitating in this way the social insertion of industrial production. Modernist claims of not being a style and of being un–historical, it is to be understood also in this key. This aesthetic efficiency was later to be acquired by studying the perceptive abilities of the users (aesthetics and psychology), ergonomics, measurements' standardization and/or observation of their life style (anthropology).

Still, already in Annie Albers' writings, we will found references to the synthetically produced fibers and their enriched properties. Today, through the development of nano–technologies we can speak even of materials as machines (Bensaude–Vincent, 2010), where the molecules are about to be active agents in the environment. At the same time the development of 3D printed manufacturing and the debates on alternative fabrication models (like fab labs, or robotized production, for example) are promising to revolutionize the industrial mass production model. Not only we have today a new understanding of the matter, which is not in terms of materials, but in terms of functions (Bensaude–Vincent, 2010), but we can also see initiatives that are looking to allow us to customize our mass production and subsequently, to have less of waste. Therefore a new understanding of the media is making its way.

An economic lecture of the media finds nowadays it's way through what it is generally called the 'economy of attention'. Unlike the modernist perspective, which was trying to accommodate the role of arts into an industrial society, the 'economy of attention' concept nowadays evolves into a context of overproduction of objects and data. Such research into a society dominated by scarcity of attention (Festre and Garrouste, 2015; Stiegler, 2010), becomes a key factor in various decision–making contexts, including arts and design.

Through 'media ecology' concept, some media theorists like Matthew Fuller (2007) or Jussi Parikka (2012) bring us to consider not only the mediatic aspects, but also to the environment in which this media perform. Jussi Parikka goes to the extend of saying that the new materialism is a

media theory, one that should consider the technological specificity, the materialities of media cultures and the materialities of their relations and sensations, the transformations of the media and their residues.

Critics of media specificity theory

But media specificity theory counter–arguments are also to be heard. One of them is formulated by Noel Carroll (1985) who criticizes precisely the aesthetic media efficiency being based on the physical structure of the medium and not on the *telos* (the content) of the artwork. Would an aesthetically non–efficient artwork be less valuable? Also, the difficulty to identify the raw materials of a medium (the materials or rather the time, the space of the work?), as well as the difficulty to assign the aesthetic effect a work of art should engage (especially in the case of performative arts), are for him sufficient arguments to reject the theory of media specificity. Another aspect he brings into the discussion is that of the provisional uses of a medium, which explains the evolution of the medium, the medium's permanent reinventions. Last but not least, the injunction between 'differentiation' and 'excellence requirements' as present into media specificity theory is just a path towards the sacrifice of excellence in art and the reference to a judgemental position. Still, as he himself acknowledges, a certain media specific use has pedagogical usefulness and can support future repositions.

Medium and matter

One of the issues to consider when it comes to medium specificity theory is related to the materiality of devices. Very often the materiality of the medium extends towards the technical means employed in its transformation, in a sort of technological determinism (Suchman, 2014).

Still when it comes to the concept of medium, we can notice that there are two different perspectives in its definition (Heinzel, 2012). One is materialist and technologic determined, the other one is phenomenological and anthropological based.

We will find a materialist perspective in the writings of French anthropologist André Leroi–Gourhan, for example. In *L'Homme et la matière* (1943), Leroi–Gourhan proposes the concept of 'technical tendencies' by which he understands the universal (non–historical and non–contextual) technical dynamics that operate beyond the technical facts (concretisation of different technical tendencies in certain contexts). To support his research he used different states of the matter as tool of characterization of

technical tendencies. For him, the materials are conditioning the way we develop our tools and we use them. Given the determinism between the matter and the tools, there is a certain neutrality of the medium. The limits of technology will reside in the resistance and the limits the matter induces.

The second approach is one that takes into consideration the effect certain technologies have upon the human *psyche*. The technology in this case is nothing else than the extension of our body and of our senses. It is the case of Marshal McLuhan's theory of media. What McLuhan understands by media, are the 'extensions of the man', in other words the technological extensions of our senses. This is why the technologies are re–defining our existence. And the syntagma 'the medium is the message' proves it. If there is a message to send, then this message lies in the change of scale, rhythm, or pattern the new media produces (McLuhan, 1964).

We encounter here two different approaches. While in the case of Leroi–Gourhan the medium is material and exterior to the person that interferes with it, being related to the act of 'making' (in other words, to 'techne'), in the case of McLuhan, the medium is 'aesthesis', less related to the materials' aspects, as to the sensorial and psychological phenomena that have an impact on the related person.

Still, as we could see earlier, the artists and designers role was never assigned to one or another of the theories. Media specificity theory asserts in fact that, being into an operational position, artists and designers have to know well enough their tools to better support their mediation interventions.

Final remarks: edible textiles as intermedia

Edible textiles pushed us to question the notion of intermedia.

Our experiments have shown that there are new potentialities and forms of expression for both textiles and food when brought together. Combining the two media allow new forms of interaction and transform the structures of two mediums as well.

As illustrated by the experiments, the intersection of two mediums always addresses, in a way or another, the two media specificity's efficiency. They are doing so via formal, discursive or technical interventions. Imitating the stylistic expressions of one medium was used mainly to attire the attention to one or another medium's oversaturated, mainstream forms of expression and its uses. On the other hand, as in the case of *Orange Fibers* and *Mycotex Dress*, the interventions invites to new forms of production,

ecologically aware. In this sense media specificity it is to be read as a predominant form of mediatic affordance.

Often defined as a crossing border between traditional and contemporary media, between different art activities, intermedia has been most of the time perceived not as an accumulation of two media, but as collision, as exchange and transformation (Youngblood, 1970). The question, of course is to know what does it change and transform.

Intermediality was of high interest for the Fluxus movement's artists (Higgins and Higgins, 2001) who use it to express their anti–mechanistic critic of society and production of objects. Critical against categories and classification, Fluxus' intermedia actions were about to produce a space of dialogue, of aesthetically rewarding possibilities. Such a position attacks precisely the economic perspective of media specificity. In reaction to media specificity as form of marketization, the French Fluxus artist Robert Filliou (1984), for example, sketched some possible intervention towards a 'poetic economy'. The aim was to go from the 'work as toil' toward the 'work as play'. Ironically addressing the world of art under economic auspices, Filliou will place under the concept of 'The Principle of Equivalence' three categories: 'well made', 'bad made', 'not made'. If the 'bad made' is about failure and experimentations in art, the 'not made' is about the possibility of non–production, as de–construction of the theory of values applied to arts.

Probably the best way to answer to the question related to what kind of media the edible textiles are, we should ask ourselves: Would you wear your food? Would you eat your cloths? And for sure, there would be not only one answer. The materials hold potentials for active and adaptive properties, they could be used as food source, to neutralize smells, to reinforce textile structures in order to adapt to or to create certain forms. By using biodegradable materials only, the materiality of clothing or interior textiles would promote alternative ways of living and interacting, especially in terms of afterlife or circular design scenarios.

Our experiments were looking at textiles' new potentialities when combined with edible materials. The edibility of textiles is also to be seen in todays' context of frequent synthetic interventions on the matter and the development of new tools of fabrication. The examples of edible textiles we have given, balanced between critical and ecological interventions. But finally there are the terms of systemic affordances that we have to clarify before any attempts to start or to analyze any edible textiles interventions.

References

Albers, A. (1974) *On Weaving*. London: Studio Vista Publishers.

Batteaux, C. (2015) *The Fine Arts Reduced to a Single Principle*. Oxford: Oxford University Press.

Bensaude–Vincent, B. (2010) Materials as Machines. In Nordmann, A. and Carrier, M. (eds.), *Science in the Context of Application*. Dordrecht: Springer.

Carroll, N. (1985) The Specificity of Media in the Arts. *Journal of Aesthetic Education*, 19 (4), 5–20.

Festre, A. and Garrouste, P. (2015) The 'Economics of Attention' : A History of Economic Thought Perspective. *Oeconomia. History, Methodology, Philosophy*, 5 (1), 3–36.

Filliou, R. (1984) *Das immerwahrende Ereignis zeigt Robert Filliou* (Catalogue of the exhibition), Erlhoft, M. (ed.), Hannover: Sprengel–Museum.

Fuller, M. (2007) *Media Ecologies: Materialist Energies in Art and Technoculture.* Cambridge: MIT Press.

Gibson, J.J. (1977) The Theory of Affordances. In Shaw, R. and Bransford, J. (eds.), *Perceiving, Acting, and Knowing: Toward an Ecological Psychology*. Hillsdale: Lawrence Erlbaum.

Gibson J.J. (1979), *The Ecological Approach to Visual Perception*. Boston: Houghton Mifflin.

Heinzel, T. (2012) *Textiles électroniques et réactifs : fondements et textures*. PhD Thesis, Paris 1 University Pantheon–Sorbonne.

Heinzel, T. (2014) Haptic and Sound Correlations in Textiles. In *Proceedings of Ambience'14 Conference*. Tampere, Finland. CD–Rom.

Higgins, D. and Higgins, H. (2001) Intermedia. *Leonardo*, 34 (1), 49–54.

Law, J. (2008) On Sociology and STS. *The Sociological Review*, 56 (4), 623–649.

Law, J. and Mol, A. (1995) Notes on Materiality and Sociality. *The Sociological Review*, 43 (2), 274–294.

Lessing, G.E. (1836) *Laocoon. Or the Limits of Poetry and Painting*. [Online] Available from: https://archive.org/details/laocoonorlimits00rossgoog. [Accessed: December 18th, 2016].

Leroi–Gourhan, A. (1943) *L'Homme et la matière.* Paris: Albin Michel.

Lievrouw, L. (2014) Materiality and Media in Communication and STS Studies. In Gillespie, T., Boczkowski, P. and Foot, K. (eds.), *Media Technologies. Essays on Communication, Materiality, and Society*. Cambridge: MIT Press.

McLuhan, M. (1964) *Understanding Media*. New York: McGraw–Hill Book Company.

Parikka, J. (2012) New Materialism as Media Theory: Medianatures and Dirty Matter. *Communication and Critical/Cultural Studies*, 9 (1), 95–101.

Simon, H.A. (1971) Designing Organizations for an Information–Rich World. In Greenberger, M. (ed.), *Computers, Communication, and the Public Interest*. Baltimore: Johns Hopkins Press.

Stiegler, B. (2010) *Taking Care of Youth and the Generations*. Stanford: Stanford University Press.

Suchman, L. (2014) Mediations and Their Others. In Gillespie, T., Boczkowski, P. and Foot, K. (eds.), *Media Technologies. Essays on Communication, Materiality, and Society*. Cambridge: MIT Press.

Youngblood, G. (1970) *Expanded Cinema*. New York: P. Dutton & Co.

Websites

Orange Fibers [Online] Available from: http://www.orangefiber.it/en/ [Accessed: December 18th, 2016].

Aniela Hoitink [Online] Available from: http://neffa.nl [Accessed: December 18th, 2016].

Camilla Wordie [Online] Available from: http://camillawordie.com [Accessed: December 18th, 2016].

De Culinaire Werplaats [Online] Available from: http://www.deculinairewerkplaats.nl [Accessed: December 18th, 2016].

SECTION IV

Designing Environments

Emotions behind a Sphere. Experimentations for an Interactive Object Communicating Brand Values and Encouraging Behavioural Changes (or Reactions)

Francesco E. GUIDA[*a], Camilla FERRARI[†a], Serena LIISTRO[a], Mauro VITALI[a] and Ernesto VOLTAGGIO[‡b]

[a] Politecnico di Milano; [b] Dotdotdot

The line separating visual designer and developer appears to be blurring, and this is not limited to the screen or projected image (Reas, McWilliams and Barendse, 2010). It also affects the design of physical spaces and the empiric field. The increasing accessibility to open technologies allows visual designers to conceptualize and practice new processes and results in the representation of organizations' values and in the design of points of contact.

An experimental project (developed during the third year of the Bachelor in Communication Design) gives rise to a discussion of changes in the fields of Communication, Interaction and Experience Design. The brief was to design visual identities, programming and using open source codes and hardware like Arduino, in order to communicate intangible brand values through an interactive and multisensorial experience in a physical space. This brief led some student groups to design objects that act. One of those results is a communicative machine named Phos Light Experience.

In order to comprehend the actual interaction with the object persona (Cila et al., 2015), the prototype was tested by real potential users, employing specific sensors to collect biometric data. In addition to the predicted results, unexpected forms of relationship and use emerged, generating new levels of discussion.

Keywords*: Visual design; communication design; object's agency; emotional data*

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[*] Corresponding author: **Francesco E. Guida** | e–mail: **francesco.guida@polimi.it**
[†] Corresponding author: **Camilla Ferrari** | e–mail: **camilla9393@gmail.com**
[‡] Corresponding author: **Ernesto Voltaggio** | e–mail: **ernesto@dotdotdot.it**

FRANCESCO GUIDA, CAMILLA FERRARI, SERENA LIISTRO, MAURO VITALI, ERNESTO VOLTAGGIO

Visual design and programming: the context

The knowledge, way of thinking and workflow of the visual designer is changing because of the new possibilities offered by programming (Lehni, 2011). But the use of programming in visual design it is not something peculiar only to the so–called Generation Y (those born between 1980 and 1996) designers, for which the use of technology is natural if not obvious (Wicht, 2011).

In visual and graphic design there is a particular field, that is, the design of types and fonts, that has emerged in the last 30 years as extremely suitable to experimentations in this direction. Type designers are used to comparing their designs both to formal and technical meanings. Moreover, because of this inner nature of the design of types, when digital technology arrived in the 1980s, type designers made the accidental a starting point for new ideas. As they became more adept with the new technology, some began to intervene in the underlying computer code (Crow, 2008).

In the design of visual identities interesting evolutions emerged also in the use of code to program devices to produce and generate visual artefacts able to manage variations (e.g. logo–generators). It is possible to name those devices 'toolboxes': visual designers have still to define the set of rules and a framework to shape a visual identity and they can easily manage it automatically or through external parameters.

Visual designers involved in experimental and professional practice are more and more engaged with programming, thus becoming designer–programmers or designer–developers and using their everyday work tools, as computers are, in a more consistent way. Computational design usually requires the designer to write programs and because of that, it is possible to mistake the practice of computational design as a technical skill rather than a way of thinking. Learning to program and engage the computer more directly with code, opens the possibility of not only creating tools, but also systems, environments, and entirely new modes of expression. It is here that, using the McLuhan metaphor, the computer ceases to be a tool and instead becomes a medium (Reas, McWilliams and Barendse, 2010).

Moreover, it is important to consider accessibility to instructions and information related to codes, offered by the global open source culture, as a critical component in this evolutionary process (Lehni, 2011). This culture allows the sharing of knowledge, results as well as codes, making possible a constant upgrade. It becomes knowledge available for all, blurring the borders of a merely professional disciplinary field.

An antidisciplinary experimental practice

Contemporary academic culture organizes disciplinary fields of study with its own particular words, frameworks, and methods. Design, by its inherent nature, is a discipline that is between scientific knowledge, technical competencies and art. It resembles an interdisciplinary field where people from different disciplines work together, share their knowledge and design new things preserving their single fields. But designer knowledge and culture is more and more something that it is difficult to fit into any existing academic discipline. It is becoming an antidisciplinary field, evolving from the design of objects both physical and immaterial, to the design of systems, to the design of complex adaptive–systems. This evolution is bringing about a shift in the role of designers; they are no longer the central planners, but rather participants within the systems they exist in. This is a fundamental shift, one that requires a new set of values (Ito, 2016). In addition, there is a clear shift from the centrality of function to that of meaning (Antonelli, 2011). Just in the past few years, communication has exploded into new fields: responsive objects, ubiquitous data and information, and newly instinctive interfaces. Design itself has become a way of communicating, with the open–source movement and constant connectivity changing how ideas are conceived and products made.

This rapidly described context is the background that inspired the teaching and tasks of one of the Visual Communication Design Final Synthesis Studios of the Communication Design Bachelor at Politecnico di Milano over the last four years. The Studio's main theme is to get the students to work on visual and brand identities, which is definitely one of the key areas in the communication design field. However, the approach to this area is unconventional: students are at the same time introduced to programming and open source hardware, to be used during the design process.

Unreal organizations were assumed as subjects of the design; the aim was to allow students to work deeper on the conceptual side and to look for case–histories (to be taken as inspirations) that did not necessarily refer to the assigned organization, as well as to get students used to cross disciplinary borders and to adopt a critical approach to fixed fields. Trigg's (2003) comment on experimentation as a way to find solutions, even in areas that we (as teachers and/or practitioners) or students do not precisely know, is incredibly fitting. A learning by doing approach, aimed to result in prototypes, is the main methodological framework. During project development, students experienced something close to the definition of

thinkering (Antonelli, 2011) in which a final result it is possible through progressive collective refinements.

The applied methodology (fig. 1) can be summarized in a spiral model (Dubberly, 2005), which perfectly represents repeating cycles of design moving away from a central starting point. In each of the 4 main phases students experienced different design steps as they gradually approached, in practical terms, their final solutions. The class is organized in groups of 4 or 5 students each. First, each group has to define the whole concept and the organization of the assigned subject, their aims and values, through targeted research and then design the visual system, defining appropriate communication channels, tools and applications. During last year (2015–16) the class worked on visual identities referring to unreal companies producing everyday objects like umbrellas, light–bulbs, buttons or hangers.

Each group had to design the visual identity in both two and three dimensions. In addition, students had to work on the design of an experience to be contextualized in a fixed area of 4x4x4 meters, by realizing devices ('communication machines') that interpreted companies' values making them accessible to users. 'Communication machines' were objects, installations or interactive devices to be realized as prototypes to be verified and tested. Those 'machines' are intended as a 'object personas': an extension of the design research and educational process arguing for design fiction as an important methodological tool. Design fiction represents a speculative mode of thinking that can open up new questions and unfamiliar opportunities (Cila et al., 2015).
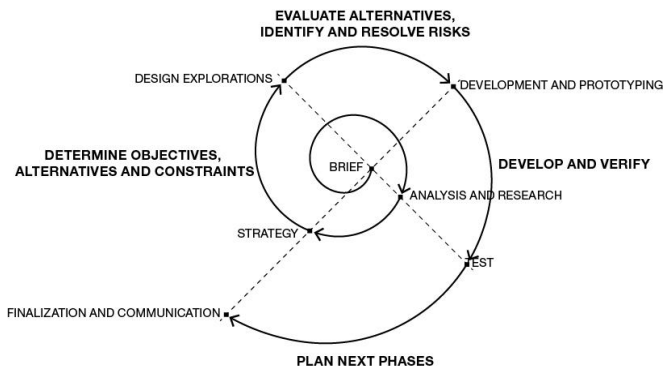

Figure 1   The spiral model of the methodology applied among years in the experimental Visual Communication Design Studio at Politecnico di Milano.

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The Phos sphere

Artificial light is one of the symbols of modernity. We use it in our everyday life, it is an obvious presence, and when we have to buy new light bulbs we do not care about the brand: what is relevant is its light–colour, power and consumption. However, Phos, the ideal company adopted for the following experimentation, tries to give new values to the light bulb: light as heat, emotion, shelter, source.

Once the visual identity was defined and possible communicative applications designed, to complete the brand experience, a concept for a 'communicative machine' was developed: an easy–to–use object able to make users react emotionally and/or rationally to it and interact with it.

The installation was called the Phos Light Experience (PLE), and it is based on the interaction with a sphere with a light–bulb inside (fig. 2) which changes its colour depending on the user's hands heat and movements (fig. 3). The user would find this sphere lying on a table inside a dark room pulsating white–light, and would have different possibilities of interaction: picking it up, the colour would change depending on the heat of their hands, rotating it, the colour would blend and finally, shaking it vigorously, the colour would change randomly.
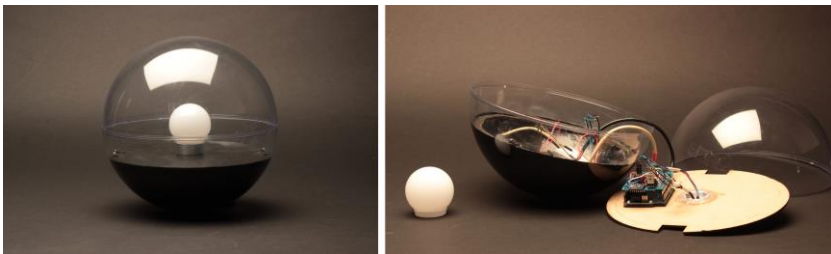

Figure 2   On the left the prototype of the sphere, on the right the technology inside.

The main element of the PLE is a sphere of transparent plexiglass which contains a 3W light–bulb with LED RGB technology capable of playing a wide range of colours while maintaining a strong brightness. The sphere has a dark part that serves as a base and hides all the technological components useful to the device's operation.

In the base is collocated Arduino Uno, which is able to handle and process all the data detected by the sensors, thus acting as the 'brain' of the sphere. In order to detect the heat of the users' hands, an infrared temperature sensor (MLX90614) has been used, because more efficient than a contact sensor and faster in detecting the temperature. The

MPU6050, a sensor which incorporates a three–axis gyroscope and an accelerometer in a single component, detects the movements that the sphere is subjected to.

To identify the rest position a hall sensor has been used, positioned on the bottom of the sphere, which detects the magnetic field of the magnets placed on a fixed base. Lastly, the autonomy of the device is guaranteed by a 13400 mAh battery which has an estimated duration of 8 hours without recharging. The battery also serves for balancing the sphere.

All these sensors, connected to Arduino, work thanks to a specifically encoded program which manages the different conditions in which the sphere can find itself. The main functions of the program manage the LED RGB lighting, the gradient transition between the different colours, and the 'rest' phase (when the hall sensor detects the magnetic field in the base) which reset all the variables in order to provide a clean experience to each user.

Figure 3   Color reactions of the sphere during the interaction.

Once the prototype was ready and firstly tested some questions emerged. If we accept the idea that objects, like human subjects, have agency (Gell, 1998), can we measure this agency somehow? Can we record the user's reactions and the empathy she or he develops with an object? Are all users' reactions and feedback predictable by a designer? Or should the designer accept the idea that some design issues are unpredictable?

The use of emotional data in the testing phase

To search for confirmation it was deemed useful to carry out an experiment: to allow real potential users to interact with the PLE sphere. Therefore the prototype was subjected to a series of tests to investigate and verify if the interaction between this object and the users corresponded to what was expected. The main goal of the test was to assess the strengths

and weaknesses of the sphere, how and what it actually communicates to users, in order, in the end, to discover any problems and/or possible improvements.

To find this information, it was decided to collect emotional data generated by a person in the form of biological parameters, facial expressions, behaviours or words.

Emotional data is quantitative data which is able, at the same time, to capture qualitative elements, such as emotional state. For designers, emotional data is that interesting middle space between the density of ethnographic research and the rigid logic of research based on data, where context can easily be lost (Henry, 2016). This kind of data can help clarify why users act in a certain way, giving a new information channel which is, at the same time, simple to analyse and were collected using three different types of tools: video footage, interviews and biological sensors.
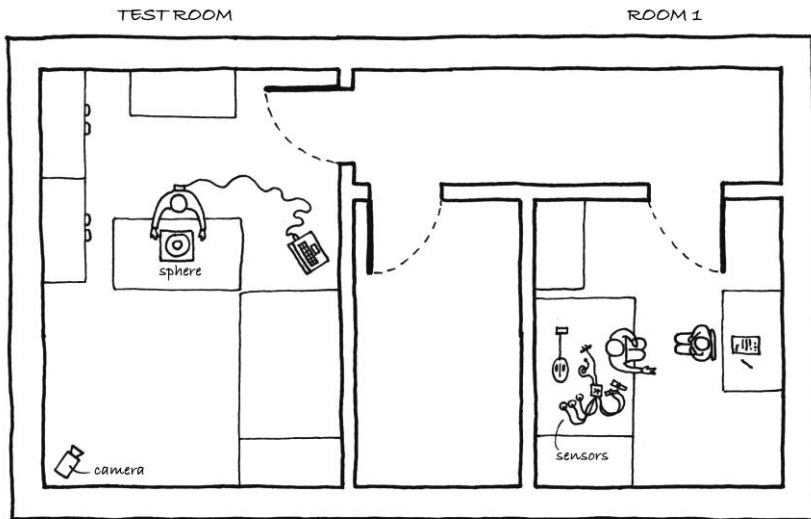
Figure 4   Test environment.

Due to its articulation, the test was done in two different locations (fig. 4). One with full light to prepare the user for the experiment, for the application of sensors and to conduct the interviews (Room 1). The other, instead, had to simulate as much as possible the location designed for the PLE, having a size of about 4x4x4 meters, with a table near the entrance, and dark (Test Room). Thanks to this subdivision of the test into two rooms

it was possible to record the initial reaction of the subjects at the sight of the sphere.

Figure 5   Tools used to collect the emotional data from users.

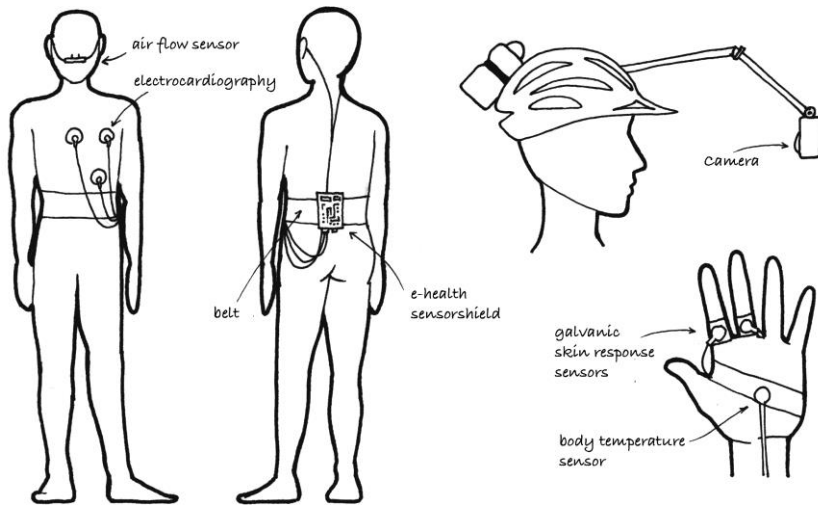Video footage was used to record users' behaviours, gestures and facial expressions during their interaction with the PLE. From these data it was possible to highlight the emotions expressed by the user during the experience, if she or he was feeling comfortable or uncomfortable, or if she or he had any difficulties while interacting with the device. Moreover, collecting data on gesture allowed for an understanding of the intuitiveness of the object and observation of the different approaches of the users while interacting. Facial expressions, on the other hand, because they are more difficult to control, permitted an understanding of the emotional state of users. During the test phase two cameras were used: one into the Test Room and the other attached to a helmet worn by the subject.

However, gestures and facial expressions do not always reflect the emotions felt by the subject. Different levels of expressiveness and social and cultural filters (like familiarity with technological and / or digital devices) can mask the visible signs of a change in the emotional state in the individual. This is the reason why it was chosen to collect also biometric parameters. This kind of data allows one to detect the user's emotional states that are invisible to the human eye. For this experiment, the vital parameters – which are signs of a change in the emotional state were

collected through a series of sensors (fig. 5), namely: respiratory rate, heart rate, sweating and body temperature.

Lastly, the sample of users underwent an interview. In this phase, the tool of 'coding and categorization' of words and behaviours was used. The coding part consists in defining labels to summarize responses or behaviours. In transcripts of interviews there are often found many words or phrases with an emotional or sentimental value. These elements can be de–contextualized and condensed into a single word, without losing too much of their individual meaning (e.g.: bizarre, nice, enjoyable, interesting, relaxing, magical). By counting the encoded labels the number of categories is identified, and, subsequently, the number of users belonging to these categories. This is not a technique which is not already used in design research. What is different in this case, is the focus and the connection with the emotions between the coding and the analysis phase (Henry, 2016).

The structured interview with the users was based on seven questions:
- What do you think of the experience that you just had?
- What did you like the most?
- What can be done with the sphere?
- Did you have any problems or difficulties, or something that bothered you?
- Would you change or add something?
- Why does the colour of the sphere change?
- Do you judge this a rational or an emotional experience?

The interviewees had no time limit nor were they interrupted during their response, so that they could create a continuous stream of thoughts without feeling judged in any way. To collect the responses in a more precise way they were recorded.

Test steps and sample of users

The test was divided into three stages. The first part consisted in the application to the subject of the various sensors in order to record the vital parameters at rest. This record was useful in the case of peculiar or abnormal results during the interaction, because it could verify if the same flaw or error was also found in the data initially taken. Thereafter, the subject was asked a series of questions to collect basic information: age, sex, nationality, mother tongue, employment, level of interaction with technology and any physical characteristics that may have affected the test results (heart problems, motor limitations, asthma, etc.).

In the second stage of the test the subject was conducted into the Test Room, where he was left alone for four minutes to interact with the sphere, having been given no information regarding the object. The interaction was recorded by the two cameras. After four minutes the interaction was interrupted.
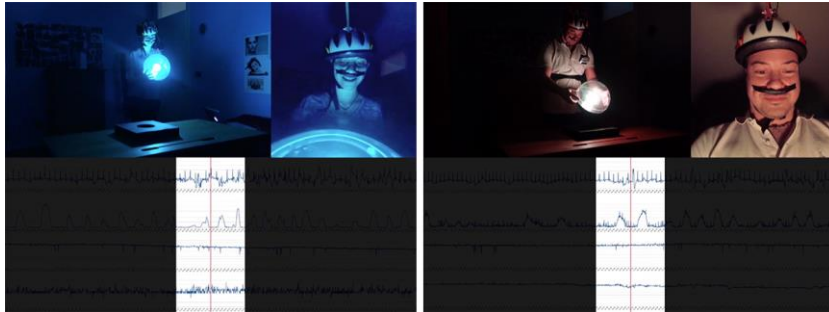

Figure 6   Some phases of the experiment with users' reactions and some measurements.

In the third stage of the experiment, the subject was brought back into the First Room. Here, once the sensors were removed, the interview took place and the user had the opportunity to express his thoughts about the interaction. After the interview the experiment officially ended.

To establish these stages a pilot test was conducted which gave an understanding of whether the test could be done properly and if the information collected was sufficient for the aims of the experiment.

In choosing the subjects to be analysed an attempt was made, as much as possible, to have diversity in every aspect: from age, to origin, to level of interaction with technology. An amount of 15 subjects were analysed, which it is not a substantial sample of users, but because of a diversity of age (between 12 and 76 years), sex and profession, it was assumed as useful reference for the experiment. Of course results cannot be considered as absolutely thoroughs.

Some results of the testing phase

The results of this experiment were surprising, both for the way they verified expected results and for the fact that a multitude of new interaction scenarios emerged.

What emerged, above all, was that a common cognitive path made by all the users during the interaction could be traced. No interaction was only emotional or rational. Considering as emotional all interactions subsequent to feelings like unexpectedness, surprise or affection and rational all interactions consequent or addressed to an understanding of the device functionalities (Branco, 2003; Tuan Pham, 2007). In general, through measurements of biological data, it was found that the subjects passed through 4 different phases, whose duration and intensity varied according to the individual (fig. 7):

- Emotional Moment 1 (EM 1): the interaction begins, the subject is excited to start the experiment and is surprised to be confronted with an unknown object;
- Rational Moment 1 (RM 1): after the first impact with the object, the subject tries to understand the operating principle of the sphere;
- Emotional Moment 2 (EM 2): the sphere does something unexpected (usually it changes colour abruptly), and the subject allows himself to get carried away by the moment;
- Rational Moment 2 (RM 2): the subject has learned more information and has summarily understood the operating principle of the object.
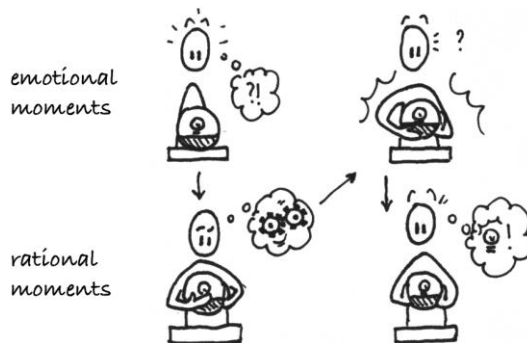
Figure 7   The users' four different phases during the experiment.

At the revelation of the sphere (EM 1), in 8 subjects a significant variation in the biometric parameters occurred: in everyone the heartbeat increased and in 2 also the respiratory rate increased and the conductivity changed. Moreover, all subjects had changes in their vital parameters at the first contact with the sphere. Regardless of the action carried out, when the sphere changed colour abruptly (80% of the interactions) the users' heart

rate increased. The same happened for the subjects who performed the planned and designed action to shake the sphere (40%, EM 2).

In general, it can be said that the experience was positively perceived and evaluated by the users. Furthermore, comparing the biometric data and the interviews, it can be affirmed that, in most cases, the colour changes of the sphere were not perceived as random but depending on specific actions by users.

From the analysis of the actions it seems that the subjects attributed to the object features that do not belong to it. In fact, initially, many users moved their fingers and hands over the sphere's surface, expecting a reaction from it . This may have been because they were comparing it to the electrostatic sphere. The interaction of the subjects was essentially shaped around the understanding of the sphere's operating principle and its use (RM 1). In fact, no one lived the experience as end in itself, but every person used the interaction in order to understand what the sphere was and how it worked.

The sphere intrigues and never gives the idea of a static object (RM 2). Everyone interacts with it to some extent in a dynamic way. Moreover, the sphere creates a strong empathic relationship with most of the subjects, as confirmed by recorded emotional data. This is clearly evident in the interview responses, where the users declared that they perceived the sphere as a living being, a 'sort of animal' whose 'colours correspond to its emotions.' And colours were precisely the most appreciated part of the object, especially when they changed abruptly. This is clear from the biometric parameters, particularly from the heart rate increase when the colours change, but it equally shines through the subjects' facial expressions when they let slip a slight smile or a laugh. Many people highlighted how the combination of colours and darkness created a magical atmosphere, moving strong emotions. Equally appreciated was also the spherical shape of the object, both for the endless possibilities of interaction and for a simple aesthetic issue.

Conclusions

As expected, and hoped, no one had particular problems or difficulties during the interaction, but some users were bothered or felt frustrated at not being able to fully understand the operating principle of the sphere. Many subjects suggested additional elements to the experience and the one

proposed by most was to add sound to the sphere or the location, a proposition that was evaluated during the design phase of the PLE.

All in all, these considerations lead to the conclusion that the interaction designed meets the expectations, because it realizes the main goal of the project: users are touched and create an empathic relationship with the sphere. The object has no specific function, if light changes are not considered, and his meaning is to communicate values referred to light bulbs in order to intrigue the user and interacting with it. Here there is the shift from the centrality of function to the one of meaning and the relevance of uselessness as a design principle (Kaplan, 2000).

Nevertheless, it is clear that it is not possible to accurately measure the empathy between subject and object. It is only possible to analyse the dialogue or part of the relationship through the emotional data that helps to understand these dynamics, measuring them and providing useful information on the functionality of the object. Users react emotionally at a first interaction with the Sphere and again when they understand (rational interaction), that changes can be determined by some specific actions.

Designing an object like the sphere for the PLE was an excuse to design a process (the experience) and to define the activator (the object). What was interesting from our point of view, is that this object could be of interest for users both in the context it was conceived for (a brand exhibition) as well as out of his original context as it was during the experiment. During the experiment, users were surprised, excited to use the sphere and to determine changes with the hands once they understood the device mode of operation.

Some aspects of the experience are unpredictable (e.g. when something could exactly happen through user interactions); it is not possible to have everything under control, only some general guidelines can be predicted (functionalities, shape, general goal). From the designer's point of view this is a difficult aspect to manage, but when designing an experience there is always a possibility that a user can experience it in an individual way, through a personal interpretation, and this has to be accepted.

Another interesting aspect was to have introduced, in a teaching context, an approach that did not consider the acquisition of skills and knowledge in a fragmented manner, but in an evolutionary way. The use of programming to start processes and develop applications was adopted as a key element of the designer toolset (Lehni, 2011). This approach allowed the customization of some applications both at the development stage (and prototyping stage) as well as in the verification and testing stage. From an

educational point of view, this made it possible, in a practical way, to liken the typical design process to a scientific methodology.

It is our firm belief that this way of working and designing should be encouraged, especially during students' education, in order to make possible the use of digital tools in a more consistent and appropriate way.

Acknowledgements

References

Antonelli, P. (2011) Talk to Me. In Hall, E. (ed.), *Talk to me. Design and Communication between People and Objects*. New York: Museum of Modern Art.

Antonelli, P. (2011) States of Design 03: Thinkering. *Domusweb.* [Online] Available at: http://www.domusweb.it/it/design/2011/07/04/states–of–design–03–thinkering.html. [Accessed: December 8th, 2016].

Branco, P. (2003) Emotional Interaction. In *Proceedings of the Conference on Human Factors in Computing Systems (CHI)*. New York: ACM Press.

Cila, N., Giaccardi, E., Tynan–O'Mahony, F., Speed, C., and Caldwell, M. (2015) Thing–Centered Narratives: A Study of Object Personas. In *Proceedings of the 3rd Seminar Research Network for Design Anthropology*. Aarhus: The Research Network for Design Anthropology.

Crow, D. (2008). Magic Box: Craft and the Computer. *Eye Magazine.* [Online] Available at: http://www.eyemagazine.com/feature/article/magic–box–craft–and–the–computer [Accessed: December 8th, 2016].

Dubberly, H. (2005). How do You Design? A Compendium of Models. *Dubberly Design Office.* [Online] Available at: http://www.dubberly.com/wp–content/uploads/2008/06/ddo_designprocess.pdf> [Accessed: December 8th, 2016].

Gell, A. (1998). *Art and Agency. An Anthropological Theory*. Oxford: Clarendon Press.

Henry, S. (2016), Build Better Products with Emotional Data. *Interaction Design Association Conference.* [Online] Available at: https://vimeo.com/160091621 [Accessed: December 8th, 2016].

Ito, J. (2016). Design and Science. *Journal of Design and Science*. [Online] Available at: http://jods.mitpress.mit.edu/pub/designandscience [Accessed: December 8th, 2016].

Kaplan, F. (2000). Free Creatures: The Role of Uselessness in the Design of Artificial Pets*.* In *Proceedings of the 1st Edutainment Robotics Workshop*. Sankt Augustin: GMD–AiS.

Lehni, J. (2011). Teaching in the Spaces between Code and Design. *Eye Magazine.* [Online] Available at: http://www.eyemagazine.com/feature/article/teaching–in–the–spaces–between–code–and–design [Accessed: December 8th, 2016].

Reas, C., McWilliams, C. and Barendse, J. (2010). *Form+Code in Design, Art and Architecture*. New York: Princeton Architectural Press.

Triggs, T. (2003) *The Typographic Experiment: Radical Innovation in Contemporary Type Design*. London: Thames & Hudson.

Tuan Pham, M. (2007). Emotion and Rationality: A Critical Review and Interpretation of Empirical Evidence. *Review of General Psychology*, 11 (2), 155–178.

Wicht, P. (2011). Generative Identity. *Enigma*. [Online] Available at: http://enigmaprod.ch/en/where–we–stand–3/identite–generative/ [Accessed: December 8th, 2016].

Interrelations Between Human Agency and Object Agency within Co–Making Environments

Ricardo SAINT–CLAIR[*][a]

[a] Politecnico di Milano

Makerspaces and Fablabs are widely known as open access workshops where people collaborate with shared tools, resources, and know–how to make commercial and non–commercial products and services. They represent a random synthesis of virtual and physical environments via a mix of tangible and intangible attributes: co–creation, socially shaped innovation, non–linear routines, open knowledge, and loosely structured platforms. Often restricted to the sole purpose of prototyping workshops, there is currently a proliferation of hybrid models, where individuals, entrepreneurs, and start–ups interact in a shared and relaxed work style, the likes of which challenge the traditional notion of a workspace.

This paper examines the parallels and intersections between human agency and object agency through an interactive device – a conceptual cultural probe – that aims to increase human connection inside Makerspaces. It is part of an ongoing empirical study investigating patterns and congruencies of these adaptive built environments, with a focus on distinct locations on European cities, such as Milan, Paris, London and Barcelona. Extensive participatory research has been conducted in the more prominent spaces, examining the objects, structures and settings that can really encourage human agency, interaction, and innovation.

To what extent does the design of objects and spaces affect how people feel and interact, enabling them to become more collaborative and inventive? This interactive object employs a set of sensors and actuators via the current standards and platforms of the IoT network, affecting ultimately the attitudes and behaviours of members, making use of open source resources and the common machinery of digital fabrication. The qualitative analysis of this pilot cultural probe informs the blurry and often absent borderline between human and non–human entities, more precisely the extended capabilities of smart

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[*] Corresponding author: **Ricardo Saint–Clair** | e–mail: **ricardo@dialogodesign.net**

> objects shifting the roles of designers as users within co–making environments.

> **Keywords**: Co–making; human agency; object agency; built environment

Introduction

Makerspaces are an epicentre of intertwined subjects and components that are having a profound impact on our contemporary society. Social, economical, and technological spheres merge with political and environmental ones, unearthing some of the more intricate problems and fast–paced emerging issues that are challenging citizens, governments and organisations today. Definitions of Makerspaces can vary, but traditionally they are identified as shared machine shops, gathering the tools, resources, and know–how within an open access environment, for activities of learning, working and collaborating through participative and heterogeneous processes (Dickel, Ferdinand and Petschow, 2013; Gershenfeld, 2005). In contrast to other expert communities and closed professional institutions, they welcome and encompass a variety of actors and stakeholders, often non–professional and non–commercial, forming a decentralised peer–to–peer network that collaborates outside normal organisational boundaries (Nuvolari, 2004).

During the last decade, these co–making environments have left the realm of niche communities and stakeholders and gained wider appeal amongst everyday citizens, the mass media, and their respective entities and governments. Some cities have even drawn up political policies, assigning ambitious goals concerning their economy and sustainability – in which these spaces play a pivotal role in the achievement of real innovation and change. The success of such endeavour is yet to be seen or measured. Yet, the impressive growth of Makerspace's physical facilities spreading all over the world informs their impact and optimism, ranging from the dawn of a third industrial revolution with the advent of mass customisation (Anderson, 2010; 2012; Rifkin, 2014) to an entire redistribution of manufacturing, reconfiguring the mass production global map towards a more local and sustainable alternative (Kohtala, 2014; 2015).

Even though this topic covers many areas of knowledge and research, the ongoing analysis focuses on the built environment, mapping and comparing 18 locations in major cities of Europe, seeking the platforms, settings, and lay–outs that support and enable their collaborative and innovative practices. The bottom–up approach of these adaptive spaces,

usually co–designed by their users (Seravalli, 2012) and not by experts or outsiders, offer the opportunity for findings that are novel, valid, and truly valuable.

The conception and development of an object acting as a cultural probe, in order to support the enquiry activity, gave rise to some unforeseeable concerns from the members about the influence of smart devices in the human interaction within the Makerspace workplace, revealing the change of critical and ethical perceptions of makers and designers when they shift their roles from active producers to passive end–users.

This paper's intent, however, is not to discuss the theories underpinning the agency of objects, such as whether designed entities can truly be deemed self–sufficient agents or merely instances of rational and intentional human decisions (Hoffman and Novak, 2016). Moreover, the author departs from the personal assumption that agency can have an independent occurrence that may or may not have any relation to a human action. The complexity of ingredients in a co–making and co–working environment, where human and non–human elements interact, and where members and algorithms are part of the tangled web of interior and exterior actors, empirically reveal that agency emerges continuously throughout a co–acting process.

Humans are biological organisms with a special collection of skills that tend to collaborate in social networks, shaping constantly the world and things around them. On the other hand, they are also malleable, manipulable, and as a consequence shaped by the very things they construct and interact with. The experimental project presented in this paper endorses that this designer being is concurrently redesigned by its own designed habitat. A constellation of objects, networks and systems all reveal its interdependency with artefacts. Here, agency is therefore embedded in all; in the object, in the human, in the space that surrounds them. This outlook of a space with agency infers and supports that socialising and technology, shaped by humans and non–humans entities, should not be separated or perceived as discrete parts (Latour, 1992).

Making agency

The broad range of resources that might constitute a Makerspace explains its multiple tasks as a catalyst for the so–called Maker Movement: a worldwide cultural phenomenon characterised by the motivation of human agency through the cooperative act of tinkering and making. Its actors

suggest that we are all 'makers', and that tinkering and fixing were a common practice of humanity passed down from generation to generation until we all became alienated by mass production and mass consumption (Dougherty, 2012). The revival of making has already lasted long enough for being simply defined as an ephemeral fashion fetish. More surprisingly, as we live in a period of material abundance, we might rightly assume that the movement itself is not fuelled by necessity, but by a genuine human need to feel enhanced, fulfilled, and more in control of their lives, not just thanks to technical skills, but via a sense of agency (Dellot, 2015). Learning (the principal practice of most of these spaces) and finding ways of creating viable business models via testing and prototyping are also aspects considered in other author's studies (Wolf et al, 2013; Khotala, 2016).

Technologies for digital fabrication are at the central stage of these spaces. The rising importance of IoT (Internet of Things) is evidenced by the increasing number of projects that involve objects that attain different levels of agency, both experimental and commercial oriented. Among the participants of the qualitative interviews, there was a growing interest in the production of active artefacts, those that can act in the physical world and influence people's behaviour and experience. However, a view of the end–user as a distant persona from the reality of the Makerspace revealed itself, showing that there is a lack of debate about how the agency of an object could affect their own agency as makers and designers, evidence that among makers the technology–centric approach still prevails over the user–centric one.

Irrespective, whether a Makerspace is merely reproducing another elementary 3D printed object or it has a clear strategy to engage people in producing meaningful smart things that have function and value for local communities or global problems, many authors agree that Makerspaces are more than just about making things: they are all about making culture and ideologies. At first glance, the act of making could be regarded as merely a pastime or leisure activity, but Makespaces are also shaped by political and anti–consumerist models, confronting the issues of material supply and consumption that are traditionally embedded in the contradictions of old industries (Gershenfeld, 2005; Kohtala, 2015). Of course, the level of awareness encompassing these ideals will vary dramatically from location to location, and even between individuals sharing the same environment.

Therefore, one of the main contributions and impacts of such co–making environments is on the individuals and citizens themselves; it is more than just about what people make, but rather who they make with. Socialisation

and interaction with other members, culminating in meaningful connections, were cited in interviews as a major factor for people using Makerspaces. In the end, the multitude and diversity of entities, human and non–human, bodily and digital, inform the there is a certain degree of agency in the space itself, encompassing objects, fixtures, members, methods, procedures, both tangible and intangible attributes, that could constitute the physical ecosystem as a whole.

Hyperlinked cultural probe

In this paper, we address questions about agency and social interaction within the built environment of Makerspaces through a simple pilot experiment that was used as a research instrument. The designed smart object, the *MeetMaker* (fig. 1), tackles some concepts present at the ongoing PhD study and within the resulting research framework that will be addressed in the following session. This conceptual framework (Fig. 4) establishes correlations between the virtual and physical landscapes throughout attributes, qualities and abstractions observed within these co–making environments. For this experiment, 'Hypertext' and 'Hyperlinking' between people and places are the principles being investigated.
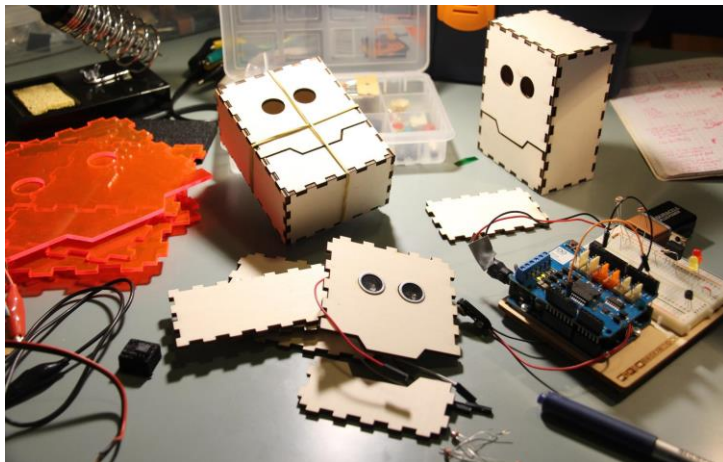

Figure 1   The eyes of the 'MeetMaker' cultural probe host an ultrasonic sensor.

Hypertext is a term that was coined in the 1960's, and it is fundamentally a text which contains links to other texts. It was widely used in the first computer networks, mainly at Arpanet, the first with a set of common

protocols that were able to join together multiple academic networks, and that became the technical blueprint for the Internet. With hypertext came other terms and functions such as hyperlinks and hypermedia, where text could reveal progressively numerous levels of details, from texts, tables, and content, up to graphics, audio and video. Inside the Makerspaces, even though we are surrounded by manual tools such as hammers, screwdrivers, soldering gears and sanders, the most frequent action observed is the clicking of mouses and the touching of screens. It is, innately, a core characteristic of our contemporary digital life, the way we connect and share information. However, the interviews revealed that the participants of Makerspaces considered hyperlinks as a means of immediate and infinite access to anything. Here, the frequent discourse of a space where 'you can make almost anything' arises again, and it shows the positive and proactive attitude towards learning, researching, collaborating and sharing via the readily available know–how and resources from the maker global community.

Analogously, the features of the physical space and the members themselves could be perceived also as instances of hyperlinks. It stands to reason that everything is connected or ready to connect. It is an environment that promotes the random collision of its elements, and the information spillover from one project to another, were collaboration and inspiration happens in unpredictable ways. The space assures that connections can occur anywhere and at any time, not just with electrical sockets and data access, but by hosting a highly engaged community. During the field research, the author was constantly approached by other members, and asked for his name, activity, and project that he was currently working on. Even the most introvert member cannot stay alone for long. Social events, gatherings and happenings promote encounters and develop the community. Even the more relaxed areas have chairs and sofas placed in a circle setting, inviting for an informal meeting or a conversation. If we consider the knowledge process to be essentially rooted in a social process, the interior design of a Makerspace plays an important role in enabling as much social interaction as possible.

However, despite an environment conducive to hyper–connection, a Makerspace still needs ample effort and daily commitment in order to foster interrelations between the members. This gave birth to the idea of a smart object that could have an agency on people's behaviour, promoting encounters and physical proximity. The *MeetMaker* employs basic materials and elements of digital fabrication, with an open source coding and the use

of low–cost electronic components, such as Arduino boards, ultrasonic sensors, thermal and sound probes, RFID readers, Bluetooth and Wi–Fi shields, in order to connect all the pieces to the Internet network. The aesthetic choice for the *MeetMaker* was to keep it akin with same visual language of laser–cut plywood boxes, hosting and hiding all the elements inside. The recording of movement becomes from sensors in its 'eyes', and other sensors and actuators are positioned around its 'mouth'. The purpose of giving the smart object a facial character was to communicate instantly that it is an another 'member' of the Makerspace, with the sole objective of promoting meetings and encounters between people. It is an object, but in fact, it gives agency to a space, more precisely one of the 'meeting rooms'.
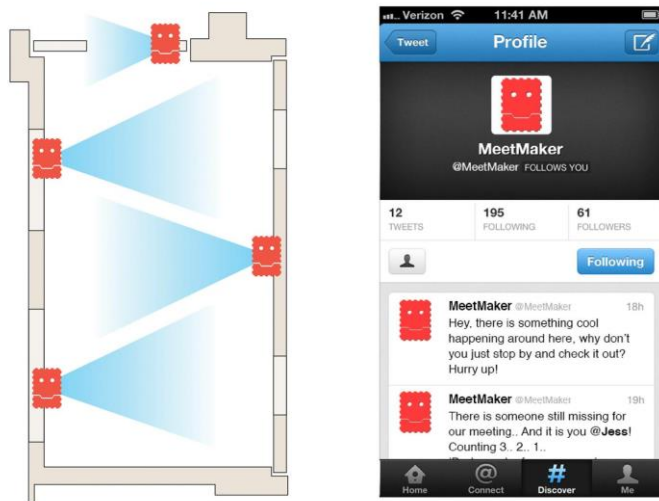
Figure 2   Floor plan layout of the meeting room with four beacons, and the user interface at the Twitter account.

The concept of the 'meeting room becoming a member' is made possible by the opening of a Twitter account, which other members could 'follow' and use as an interface for communication with the *MeetMaker*. By placing 4 beacons throughout the meeting room (fig. 2), a set of algorithms could calculate the parameters probed inside the space such as movement, temperature, lighting, and noise, defining the actions and messages that should happen via Twitter. Thereafter, the *Meet Maker* would send messages, invites and reminders, informing people that there is something active and interesting happening in the meeting room, tempting them to

join and participate in. Other possible functions were the reminding of specific meetings and the checking for absent members via the identification of their access cards or Oyster Cards with RFID tags (fig. 3). As a result, the absent member would also be noticed via the Twitter account. Future functions englobe the direct acting into the environment, such as turning up the heating or lowering the lights via Twitter messages.
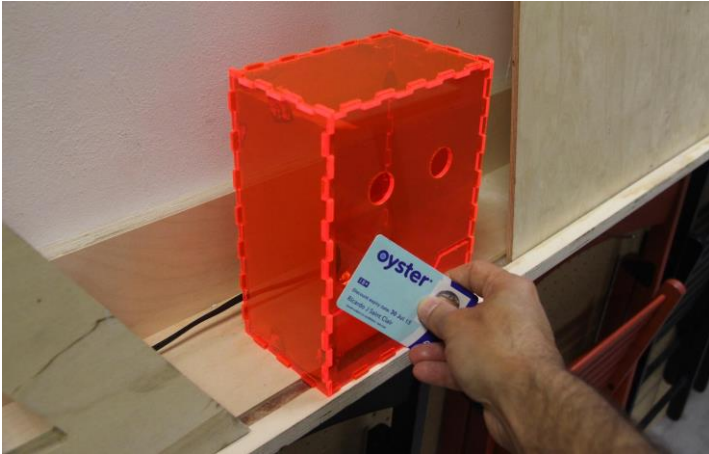
Figure 3   *RFID cards, such as Oyster Transport for London, could be used as identification.*

Twitter accounts can be perceived as non–human representations of ourselves, the icons and figures of subscribers, spreading messages and endorsing our texts and thoughts. In this sense, the cultural probe is a tridimensional figuration of its own Twitter representation. Where does the actual 'thing' reside? In the micro controller board, the brain? In the sensors and actuators? In the few lines of code and algorithms? The signals sent via the Wi–Fi intranet? The physical representation is part of the whole, as much as with any intangible instance. The non–human entity is formed by an assembly of many other non–human entities, both figurative and non–figurative, forming a chain of delegations all responsible for the construction of its own agency (Latour, 1992).

Algorithms in their core are all about agency. They are made of a set of instructions, in a logical order, that will await for a certain input of data, the reading of an scene (in this cultural probe, mostly from sensors sending electric signals to the microcontroller), and an output, in other words, an action (in this cultural probe it is a 'tweet' sent to members, groups or

individuals). This nonhuman action may or may not lead to a subsequent human action, such as motivating people to actually leave their desk and go to the meeting room. Once more, there is an interrelation between human agency and object agency, a negotiation that will affect behaviour. If the person enters the meeting room, his or her presence will be noted or perceived by the cultural probe, and the action will loop, from non–human to human, and then to non–human again, establishing the endless and interdependent cycle once more.

General research context

The growth of locations and importance of Makerspaces all over the world gives the phenomenon a rising significance for investigation. Their built environments are the physical stage where tangible and intangible ingredients commingle and intertwine, representing the hybridisation between bits and atoms, between virtual and physical arenas. The hypothesis investigated is a consequence of the observations and participatory research gathered from 18 sites across Europe. The main hypothesis is that the digital qualities, attributes, and characteristics of digital realms are being transferred and materialised into their physical built environment (Saint Clair, 2014). Usually a hypothesis is not a requisite in qualitative research or even desirable, however, it offered a pivotal way to sharpen the focus of such a broad and tangled subject. The enquiry about the hypothesis aimed to produce a conceptual framework that could further be applied as a research instrument to the design, refit, or build of Makerspaces and other types of Innovation Labs.

Located in central London, *Makerversity* is the primary case study for the current research, and it is also the source of the 22 participants that agreed to take part in the individual qualitative interviews and focus groups concerning the smart object used as a cultural probe, presented in this paper. *Makerversity* is an example of a facility that has chosen the innovation support model instead of the facility model of Makerspaces (Troxler, 2010), focusing more on supporting innovation and its stakeholder ecology than just providing production facilities. Frequent events, talks, symposiums, and a dedicated staff for events and community building are shreds of evidence that they are more active than the average Makerspace in seeking prospective members or people that could contribute to their existing network. The projects developed there are not only about learning, experimenting, or prototyping, but aimed mainly at a complete

implementation process into the general market, making them viable, scalable, and professional. The merging of services of a co–making facility with the platforms of a co–working one, with the rental of a fixed desk and meeting rooms, as well as an attentive curation of events, talks, and coaching services for entrepreneurs and startups have indeed produced dozens of successful outcomes.

The present conceptual framework maps patterns and congruencies by examining the hybridisation of virtual and physical environments. By categorising these aspects and concepts into the polarised groups of intangible and tangible, the framework also helped to observe and presuppose possible correlations and causalities between these virtual and physical realms, which are the core constituents of the hypothesis being investigated. These proposed interrelationships are shown in Figure 4, where the red lines indicate the primary and direct correlations, whilst the green line denotes the secondary ones. These connections and interdependencies were discussed and co–created alongside in–depth qualitative interviews, in order to reveal the respondent's views and perceptions about these conjectures and concepts in the validation of the suggested hypothesis.
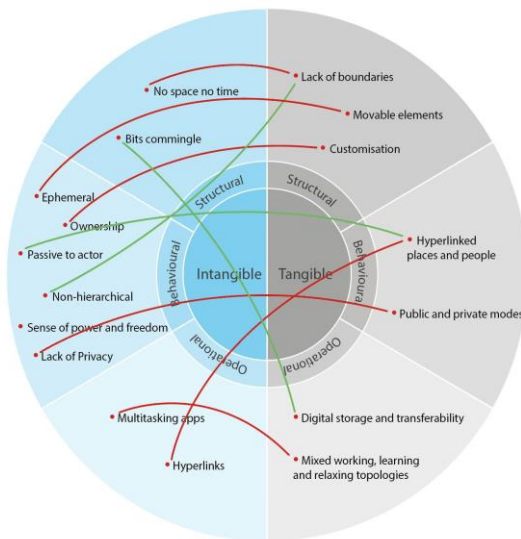

Figure 4   Conceptual framework exploring correlations and causalities among tangible and intangible attributes of digital and physical realms.

Methodology

The general research methodology was based on case studies and ethnographic methods, favouring the theory building practice throughout preliminary participatory observations. This decision was taken given the complexity of the interrelated components of the phenomena. It is important to note the nature of the research theme: the workspaces of a certain type of community that highly praise the act of making and changing the world. Since the very first visit to the first Makerspace in Milan, in 2014, it was clear that the research should seek to go beyond simply describing and explaining, but actually aim to shape and improve the spaces being observed. As a consequence, a participatory action research was the chosen strategy.

For several reasons, mostly economic and political, a fully participatory action programme was not feasible. However, the desire to bridge theory and practice was a continuous concern and promise, openly shared with every research participant. The use of conceptual cultural probes was valuable for knowledge building, but also to guarantee participation and engagement of the members of the research. By acting as an ordinary maker, instead of an outsider researcher, with their same struggle to make real things, it would prove helpful for collective collaboration and community identification, interaction with key participants and forming focus groups for debates, fruitful discussions and contextual analysis.

The general research has taped more than fifty in–depth audio/video interviews. Concerning the smart object discussed in this paper, there were 22 participants. Data has been analysed with the help of the qualitative software Maxqda. It offers the practical functionality of coding comments and audio segments, helping to establish a hierarchical structure by the organisation of codes and the subsequent design of conceptual maps. Frequency could be also observed, however, due to the small size of the population, it was not relevant for this paper.

Qualitative interviews

Even though still in the prototyping phase, the conceptual cultural probe was praised among the participants, with a high–level of positive criticism revealing the member's intention to uncover technical flaws and fragilities and to propose enhancements for future versions and prototypes. On the other side, there was also an ongoing concern and debate about theoretical

and ethical issues common to the Human–Computer Interaction (HCI) discipline, when dealing with interrelations of the agency of humans and non–humans entities. The participants also assumed an uncomfortable position when they found themselves as the researched users instead of the makers and producers.

As it common with other cultural probes addressing other concepts of the framework, participant's first reactions revealed more concern with aesthetics and technical issues. The visual appearance and materials used were assumed appropriate for prototyping, but too 'unfinished' for future implementation or commercial use. One participant stated that the object 'looks childish and amateur. It should be sleek or hidden,' while another commented, 'it is nice that it has a face, as an individual, a member, but the form is not enough to communicate its function or purpose of use.' Some interviewees discussed the concept of affordances, arguing that in the interaction between the object and the users both would be agents as long as all possible actions are clear to the user (Norman, 2013).

There was a frequent assumption that data was being generated everywhere and every time. But, of course it was invisible and so any attempt to make it visible would be valuable. 'It does not matter the accuracy of the object's metrics or the range of its functionalities.. as long as it helps to get people a bit together,' said one interviewee. In contrast, the borderline and contradictions between the physical and the virtual became evident when the discussions started to move away from the object itself to the whole system and how it encompassed the space and its members. 'The whole point of a physical community space is the human face to face interaction… aren't we here bringing us back to much to the virtual non–human world?', pointed out another participant. By giving the meeting room a certain amount of agency, the participants were worried that it would diminish the member's agency, a core characteristic of Makerspaces. They also assumed that this concern did not emerge often during their IoT projects, as they distance themselves from the end–users. By becoming the end–user, this shift in role made them much more aware and critical of the smart object's agency and influence on their own behaviour.

The focus groups showed a growing consensus that IoT projects should move away from metrics, interface efficiency and quantitative technical optimisation, and embrace qualitative, experiential and contextual matters. Designers and makers should think beyond the technological artefact if they want to understand and define desirable behaviours, and therefore embrace the complexity of relationships and systems within the interaction

context of users, as some authors have defined as a third wave in HCI, where culture, emotion and experience play pivotal roles (Bødker, 2006). Participants were accepting of the fact that smart objects and smart spaces may induce a state of passivity or influence their choices. However, the overall conclusion was that they will always serve the agency of their users, by enhancing human capacity as technology often does. As one interviewee put it: 'we will soon become more and more used to non–human entities helping us to be more human. It is paradoxical, but true.'

Conclusion

The use of conceptual cultural probes throughout the ongoing research has proved valuable in many aspects. Even though the population sampled was small, it has shown that designers are neither comfortable being the subject of research, nor at being put into the position of passive users. None of the participants had previously participated in a focus group session, even though they did recognise the value of interaction research in carrying out their own practice and projects.

The common concern among the participants was that the level of object agency may imply a reduction of human agency, and this is a matter that warrants further investigation. IoT devices are pervasive and expanding at an exponential rate, leaving little room for more in–depth debate about the ethical responsibility of designers, users, and even the objects themselves, not to mention the lack of a broader public debate about regulation policies. As a global phenomenon, IoT and smart devices transcend borders, frontiers, and national guidance. Participants in the research acknowledged and understood that they are part of an expansive and expanding constellation, and, by examining just a small proportion of this immense universe – their relationship with their own meeting room – they were able to envision how complex and unlimited any interaction can become when connected to the global network. Attitudes were generally positive towards the enquiry, attesting that HCI must continue to expand beyond technological aspects, and embrace the aid of disciplines from humanities, such as sociology and behavioural psychology.

In fact, the cultural probe needs other actors, humans, to achieve the fully intended program of action, not just to enter the space and activate its sensors, but to respond later to the call of action. Its success is hard to ensure. It is the interrelations and symbiosis of both entities that makes the desirable scene: in this case, more people meeting with more people. The

full assembly should not be perceived as separate entities, detached or discrete parts (Latour, 1992). Human and nonhumans were all part of this small social ecosystem, a compact meeting room, that is certainly physical but also manifests itself in the intangible digital space where its own 'tweets' navigate. Therefore, a more accurate approach is that the space has also agency, encircling objects, furniture, signage, furnishing, people, sensors, actuators, and algorithms. Space agency reassures that the social and the technological aspects will never be living apart.

Acknowledgements

References

Anderson, C. (2010) *The Long Tail: How Endless Choice is Creating Unlimited Demand*. London: Cornerstone.

Anderson, C. (2012) *Makers: The New Industrial Revolution*. New York: Crown Business.

Bødker, S. (2006) *When Second Wave HCI Meets Third Wave Challenges*. Paper presented at the 4th Nordic Conference on Human–Computer Interaction.

Dellot, B. (2015) Ours to Master. How Makerspaces Can Help us Master Technology for a More Human End. *RSA Report*. [Online] Available from: https://www.thersa.org/discover/publications [Accessed: November 23rd, 2015].

Dickel, S., Ferdinand, J. and Petschow, U. (2013) Shared Machine Shops as Real–life Laboratories. Setting the Scene: The Nature of Networked Innovation. *Journal of Peer Production*, 5. [Online] Available from: http://peerproduction.net/issues/issue–5–shared–machine–shops/peer–reviewed–articles/shared–machine–shops–as–real–life–laboratories/ [Accessed: November 23rd, 2015].

Dougherty, D. (2012) The Maker Movement. Innovations: Technology, Governance. *Globalization*, 7 (3), 11–14.

Gershenfeld, N. (2005) *FAB: The Coming Revolution on Your Desktop. From Personal Computers to Personal Fabrication*. Cambridge: Basic Books.

Hatch, M. (2013) *The Maker Movement Manifesto: Rules for Innovation in the New World of Crafters, Hackers, and Tinkerers*. New York: McGraw–Hill.

Hoffman, D.L. and Novak, T.P. (2016) Consumer and Object Experience in the Internet of Things: An Assemblage Theory Approach. *SSRN*. [Online] Available from: https://ssrn.com/abstract=2840975 [Accessed: November 14th, 2016]

Kohtala, C. (2014) Addressing Sustainability in Research on Distributed Production: an Integrated Literature Review. *Journal of Cleaner Production* (in press).

Kohtala, C. (2015) *The Opportunities and Limits for Socio–Environmental Sustainability in Fab Labs and Distributed Production*. Paper presented at the Fab 11th Conference and Symposium: Making Impact, Boston.

Kohtala, C., Bosqué, C. (2014) The Story of MIT–Fablab Norway: Community Embedding of Peer Production. *Journal of Peer Production*, 5. [Online] Available from: http://peerproduction.net/issues/issue–5–shared–machine–shops/peer–reviewed–articles/the–story–of–mit–fablab–norway–community–embedding–of–peer–production [Accessed: November 14th, 2016].

Kohtala, C. (2016) *Making Sustainability. How Fab Labs Address Environmental Issues*. Helsinki: Aalto Arts Books.

Latour, B. (1992). Where Are the Missing Masses? The Sociology of a Few Mundane Artifacts. In Bijker, W. and Law, J. (eds.) *Shaping Technology/Building Society: Studies in Sociotechnical Change*. Cambridge: MIT Press.

Mikhak, B., Lyon, C. , Gorton, T., Gershenfeld, N., McEnnis, C. and Taylor, J. (2002) *Fab Lab: An Alternative Model of ICT for Development*. Bangalore: ThinkCycle.

Norman, D. (2013) *The Design of Everyday Things: Revised and Expanded Edition*. Cambridge: MIT Press.

Nuvolari, A. (2004) Collective Invention during the British Industrial Revolution: The Case of the Cornish Pumping Engine. *Cambridge Journal of Economics*, 28 (3), 347–363.

Rifkin, J. (2014) *The Zero Marginal Cost Society*. Palgrave: Macmillan.

Saint–Clair, R. (2014) *In the Interior of Innovation: The Fablab Paradigm*. Paper presented at the 5Th STS Italia Conference. Milan.

Seravalli, A. (2012) *Infrastructuring for Opening Production, from Participatory Design to Participatory Making?* Paper presented at the 12th Participatory Design Conference, New York.

Troxler, P. (2010) *Commons–based Peer–production of Physical Goods: Is There Room for a Hybrid Innovation Ecology?* Paper presented at the 3rd Free Culture Research Conference. Berlin.

Wolf, P., Troxler, P., Kocher, P., Harboe, J., and Gaudenz, U. (2013) Sharing is Sparing: Open Knowledge Sharing in Fab Labs. *Journal of Peer Production,* 5. [Online] Available from: http://peerproduction.net/issues/issue–5–shared–machine–shops/peer–reviewed–articles/sharing–is–sparing–open–knowledge–sharing–in–fab–labs [Accessed: November 14th, 2016].

Designing Digital Encounters and their Agency on Users. A Case Study

Mauro CECONELLO[a] and Davide SPALLAZZO[*a]

[a] Politecnico di Milano

This paper analyses the interactive exhibit 'Leonardo racconta Leonardo. Milano, vita, natura' (Leonardo Plays Leonardo. Milan, Life, Nature), an installation located in the cloister of Palazzo delle Stelline, Milan, about Leonardo da Vinci and his Milanese period. The installation allows visitors to meet a life–sized simulated hologram of the Master who tells stories about his life, the years he spent in Milan and his relationship with nature. The project is set in the field of HCI, looking at the world of digital encounters and interactive systems based on embodied interaction. We investigate if and how the designers' choices succeeded in achieving the stated aims and persuading people to behave accordingly. Relying on user tests and direct observation, we discuss how the interactive exhibit and the digital Leonardo affected visitors' behaviour, effectively capturing their attention and fostering interaction. Furthermore, we examine how visitors perceived the digital character and the gestures he, directly or indirectly, asked them to perform to trigger actions.

Keywords: Digital encounter; design; embodied interaction

Introduction

This paper analyses and discusses *Leonardo racconta Leonardo. Milano, vita, natura (Leonardo Plays Leonardo. Milan, Life, Nature)*[1], an interactive installation about Leonardo da Vinci and his Milanese period located in the cloister of Palazzo delle Stelline in Milan. The building represents a unique location for Leonardo da Vinci, as it stands in an area the Sforza family had built around the complex of Santa Maria delle Grazie to host courtiers and dignitaries in the immediate vicinity of Sforzesco castle. It is located in front

of Santa Maria delle Grazie, which hosts the renowned Last Supper and close to the recently restored vineyard of the Renaissance Master, near Casa degli Atellani.

The specificity of the location has been recently acknowledged thanks to a joint effort by Fondazione Stelline, the Lombardy Region and the Superintendence for Architectural and Landscape Heritage of Milan that chose the building to host *Hub Leonardo*, a cultural centre for the promotion of knowledge about Leonardo da Vinci and a multimedia hub designed to highlight the *genius loci*, the spirit of the place where Leonardo lived and worked. *Leonardo Plays Leonardo* is part of *Hub Leonardo* and aims to introduce citizens and tourists to the world of the Master through three digital holograms of a human–sized Leonardo da Vinci who welcomes visitors and tell short stories dealing with (i) his Milanese period (ii) his life and (iii) his relationship with nature.

This paper analyses the project from the specific point of view of how the agency (Latour, 2007) of the digital character impacts visitors, namely his ability to affect their behaviour, successfully capturing their attention and fostering interaction. Digital characters are indeed unusual agents.

If we consider the four categories of agents classified by Kaptelinin and Nardi (2009) – (1) *natural or cultural things*, (2) *natural or cultural non–human living beings*, (3) *human beings*, (4) *social entities* – it would be quite difficult to locate digital characters in only one of these categories. These agents perform actions according to the will of their designers and programmers, that is to say, on someone else's behalf, thus characterizing their type of agency as 'delegated agency' (Kaptelinin and Nardi, 2009) and producing unintentional or unexpected effects beyond what the designers had in mind. The authors (Kaptelinin and Nardi, 2009, p. 244) attribute these forms of agency to 'cultural things', artefacts created by humans to produce specific effects. This category of agents includes all works of art, industrial design products or machines as well as digital interactive artefacts.

There is no question that digital characters are not human beings, but it is also problematic to fully identify them as mere things. These kinds of characters – especially when personifying real women/men and portrayed as life–sized – resemble human beings in every way and appear to behave accordingly. They mimic human beings, and the ambiguity and fascination they trigger underlies a number of projects in the field of Cultural Heritage that offer visitors encounters with digital characters as a means of providing information and interpretive content in an engaging manner. Exploiting renowned characters as privileged witnesses of historic periods, artistic

movements and important events is a common approach in the field of cultural interpretation, whether the character is digital or a flesh–and–blood actor.

To contextualise the project discussed here, it is worth presenting a brief overview of the various solutions that have been adopted in the field, listed below in order of the degree of realism they achieved. Specifically, we outline three broad categories of ways anthropomorphic representation have been employed, addressing digital representations in an inclusive sense that encompasses both 2D/3D characters and real people portrayed in videos: (i) digital narrators, (ii) digital appearances and (iii) real actors portraying someone else.

The examples in the first category (i) employ digital characters as witnesses and narrators and are not aimed at creating a sense of realism. An example is the installation *Bologna Story* by Cineca located at Palazzo Pepoli in Bologna. In this case, visitors are invited to sit in a virtual theatre and watch a stereoscopic video that traces the story of the city under the guidance of a 3D character, the Etruscan APO. The realism of the virtual reconstruction of the city across the centuries is contrasted with the cartoon–like representation of APO, who is designed to involve visitors in the narration and provide entertainment.

The second category (ii) encompasses projects characterised by the particular attention they pay to creating realistic settings and astonishing visitors with the appearance of highly realistic historical characters. Typically, these examples employ holograms and are based on tangible and embodied interaction (Dourish, 2001; Hornecker and Buur, 2006). An example is the installation located at Palazzo Ducale of Gubbio entitled *An audience with Federico* (In udienza da Federico), which brings Federico da Montefeltro back to life thanks to a professional actor and rear–projected screens. The duke engages in dialogue with an angel in a dramatized 15–minutes pièce, giving bystanders the impression of having these characters before them in the flesh. Visitors cannot interact with the digital characters; rather, the actors continuously perform their representation like ghosts juxtaposed in the present.

At Venaria Reale, near Turin, human–sized digital courtiers, scullions, cooks, ladies and gallants in period clothing appear when visitors walk past, in the project *Peopling the Palaces* by Peter Greenaway. The projections materialize in different rooms and locations, continuously stimulating visitors' interest and giving them the impression of being surrounded by a baroque world. As in *An audience with Federico*, visitors to this exhibit

occupy a passive role, receiving information that is provided in a film–like fashion.

A similar approach is modelled by Studio Azzurro with *Story Bearers*, life–sized holograms of ordinary people that walk on rear–projected screens (Studio Azzurro, 2010; 2011). Visitors can stop the digital characters by raising their hands and, once stopped, the characters tell their stories, directly addressing the visitor who hailed them. The world of the digital characters in *Story Bearers* responds to users; they can interact with the system using a natural gesture and therefore move beyond the role of mere passive consumers of multimedia content.

An even more natural interaction with digital characters can be found in the *New Dimensions in Testimony* project aimed at allowing young students to 'talk' with holograms of Holocaust survivors. The first experimentation provided a class of pupils with a hologram of a survivor sitting on a chair who was capable of understanding questions about his life and answering accordingly.

The third category (iii) achieves the highest degree of realism in that it includes experiences based on the performance of real people, actors in the flesh playing the role of historic figures. An example of this is provided by the project *Being Leonardo da Vinci. An impossible interview*, an itinerant theatre performance directed and interpreted by Massimiliano Finazzer Flory that has been staged mainly in museums and cultural centres. During the performance, the actor interprets the Italian Master, wearing period clothes and answering approximately 70 questions about his life, activity and work.

All the projects described above and included in the three categories have in common the fact that they employ anthropomorphic digital characters, interactive or not, as narrators or figures that help visitors to comprehend cultural content. In addition to verbal communication, they also exploit non–verbal registers, for instance by communicating through facial expression, posture, body movement, gaze and so on.

What distinguishes these categories is the digital characters' degree of realism and how they trigger interaction. *Bologna Story* (i) and *Being Leonardo da Vinci* (iii) have very different approaches to realism since the first presents a cartoon–like 3D character and the second a real actor performing on a stage; at the same time, however, they use the same methods to engage visitors. Indeed, they place users in the role of passive receivers of information, spectators of a film/theatre show with which they cannot interact. For both the projects, the character's simulation, however

realistic it may be, serves the purpose of involving visitors in the story and does not aim at astonishing or surprising. In contrast, the four projects in the second category (ii) all seek to simulate highly realistic encounters with digital characters, deliberately concealing the technological equipment in question in order to increase the sense of wonder.

All of these examples engage visitors in fascinating narrative experiences in which they meet digital historical figures or ordinary people, but they differ in that they offer visitors different levels of interaction. The projects of the first and third category as well as the first two projects of the second category do not permit users to interact at all; viewers cannot produce an effect on the digital system through their own actions. This impossibility to act is underlined by the physical separation designers impose between the digital characters and the users, who are cast as passive consumers of a movie. The *Story Bearers* of Studio Azzurro and the survivor hologram, that introduce interaction by means of natural input, namely gestures and speech, are subject to different considerations. Being configured as interactive systems, they act as cultural things (Kaptelinin and Nardi, 2009) and, usually by implementing the intentions of human beings (designers and programmers), they produce effects on human beings, in this case the visitors who modify their behaviour according to the actions and re–actions of the digital characters. Interactivity, together with realism, is therefore a key–factor: by reacting to visitors' actions and *consequently* modifying their behaviour, the digital characters trigger a virtuous circle of action and reaction that is at the basis of all human communication.

In this study, we understand the three interactive installations of *Leonardo Plays Leonardo* to represent examples of 'cultural things', 'inherently persuasive' design products that embed and embody the arguments of the people who designed them (Redström, 2006). Whether or not the designers managed to achieve their aims and persuade visitors to behave accordingly is an open question and one we address here in this paper. At the same time, we seek to understand if the digital character in each case can move beyond the simple condition of interactive object and be perceived by users as a sort of human being.

Methodology

The study presented here is grounded in quantitative and qualitative data gleaned through diverse methods of inquiry.

The first set of available data is the usage statistics provided by the system, which records every interaction performed at each of the three installations. The data collected to date cover 83 non–consecutive days of usage and provide information about the date and time of the interaction, the number of users, the number of videos watched and the language selected.

In order to shed light on the statistical data and gain insights from users, we also conducted interviews using the think–aloud protocol (Dorst and Cross, 2001; Someren et al., 1994) with a consistent set of expert users. Eight post–graduate students in Design, aged between 22 and 26 and coming from six different countries – 3 Italian, 1 Chinese, 1 Turkish, 1 Bulgarian, 1 Greek and 1 Polish – were recorded while they interacted with the system and then involved in an informal post–experience focus group. The same sample of users also completed a questionnaire designed to verify the consistency of the opinions they expressed in the interviews and focus their attention on the experience of use and how much they enjoyed it. Furthermore, direct observation of the aforementioned expert users as well as casual visitors allowed us to gain useful insights into the relationship between these people and the digital Leonardo.

Description of the system and how it is used

Three installations are the core of the interactive system of *Leonardo Plays Leonardo*. Each installation is composed of two parts: a back–end concealing the computer and video projector and a front–end structure holding a 90' holographic screen together with the interaction and audio equipment.

When entering the cloister of the building, visitors catch sight, at a distance, of a man dressed in Renaissance–style clothing moving into and out of the three screens. Every time he enters the stage, he wears a different outfit and displays a different mood: sometimes he is thoughtful and wearing luxurious clothes, at other times he appears wearing work clothes and gives the impression of being very busy, still other times he invites bystanders to come nearer. When visitors approach one of the screens, Leonardo appears. He speaks Italian and asks the user to choose his or her preferred subtitle language: visitors can choose Italian by raising their right hands and English with their left. Once a language is selected, a first video begins to play, chosen randomly by the system form among the five contained in each installation. A brief introduction displays the title of the

piece, then Leonardo appears and talks for about two minutes, addressing the bystanders directly. When a story ends, users can choose to listen to another one – by raising their right hands – or to end the interaction – by raising their left. All five of the videos use the same mechanics of interaction and, once they have finished, Leonardo kindly bids the user goodbye and begins moving in and out of the screen once again.

Figure 1   Users in front of the interactive installations.

Designers' choices and users' perceptions

Giving citizens and visitors the chance to enjoy a digital encounter with Leonardo da Vinci was the main aim of this project, which drew inspiration from the aforementioned examples and in particular those pertaining to the second category. We borrowed from them the idea of using life–sized characters, the mechanics of interaction based on bodily movements and gestures, and the choice to feature human actors instead of virtual characters. At the same time, the challenges we faced were different, especially given that it was impossible to hide the technological apparatus with the help of darkness as in the abovementioned projects. This choice was precluded due to the location, in a cloister, and the resulting light conditions: the perimeter of the corridors facing onto the inner garden with its old magnolia tree is filled with windows, so there is significant amount of

light at almost every hour of the day. We therefore chose to transform a problem into an opportunity and create a very evident, high–tech and industrial sort of portal that would suggest a timeless space in which visitors could encounter Leonardo. Indeed, the edgy stainless steel structure, greyish screen and clearly visible sensors were intended to create a marked impression of detachment between the contemporary structure and the historical character, dressed in Renaissance clothes.

Figure 2 *The structures of the Leonardo Plays Leonardo installation: on the left, the back–end wooden box; on the right, the stainless–steel frame with screen.*

Three out of eight expert users expressed an opinion about the structure during the think–aloud session. All of them expressed aesthetic appreciation for the installation but two out of three would have preferred a structure more in line with the historical character. For example, R3 reports: 'The frame is too rough, industrial and contemporary. I'd change the style, given the historic figure'. Evidently users did not pick up on the idea we wanted to evoke of a time portal or did not consider it relevant.

Instead, the eight expert users focused specifically on the digital character, which was designed with the aim of capturing visitors' attention and making them feel as if they were face–to–face with Leonardo, in the flesh. The choices we made in order to convey this intended sense of realism were, first of all, to use an actor rather than a virtual character, secondly, to

project him life–sized and, finally, to have the actor direct his speech towards the camera in order to maintain eye contact with viewers.

All the expert users reported having experienced a sense of having a real person in front of them, addressing them directly; they particularly appreciated the realism of the digital character. In the think–aloud session R2 says 'It seems the character is right in front of me' while R7 states: 'The interesting thing is that Leonardo seems to be a real person in front of me and telling about his works'.

At the same time, our intention that the character maintains eye contact was prised by evaluators, who report a resulting sense of interaction and intimacy. R1 says that 'it's nice that the character looks in my eyes while he is telling the story. It seems to augment the interaction and the involvement'. R4 focuses more on the intimacy triggered by the eye contact: 'The real size character is ok, and it seems he's talking to you intimately, with direct contact. I like the actor and that it seems he's talking only to me'.

These results are confirmed by the questionnaires the respondents filled out following the experience. Indeed, they give the feeling of interacting with a real person quite a high score (2 very high, 5 high and 1 average). The informal focus group that followed the test session further confirmed this impression even while adding an unexpected insight: every one of the users was confused by Leonardo's appearance. That is, they expected to see a tired, old man with a white beard, as Leonardo is traditionally portrayed, not an energetic man in his fifties with a short red beard, as we imagined he probably appeared during his last period in Milan.

Another point worth addressing is how users perceived interaction with the digital character. When designing the mechanics of interaction that were to have characterized the system, we decided to employ a mix of implicit and explicit interactions, both of which take advantage of the human body as an input system. The first type of interaction occurs without any intention on the part of users: they simply pass in front of the installation and, in so doing, unwillingly trigger a reaction in the digital system, namely the whimsical appearance of Leonardo inviting users to act. This is an implicit interaction based on motion detection and aimed at surprising visitors and giving them the impression that Leonardo was there waiting for them.

The other kind of interaction is instead activated by deliberate gestures on the part of users: they must raise their right or left hands and approach the screen to choose the subtitles language (right hand for Italian and left for English) and to make the stories continue (right hand) or stop (left hand).

The first kind of interaction, the implicit one, was easily understood by all the expert users, who were naturally drawn to approach the screen and surprised when Leonardo appeared and immediately made contact with them. Regarding this point, R6 states: 'Entering the corridor I see three panels with a character moving. He attracts me. When I approach the screen a sort of contact is established and Leonardo invites me to enter his life'.

The second kind of interaction, the explicit one based on hand gestures, entails different considerations. All of the testers immediately understood the mechanics of interaction and appreciated them, as they made clear in the questionnaires as well. Indeed, the majority of expert users felt confident using the system (5 high confidence, 3 very high confidence) and they generally appreciated the use of the body to interact with it (4 neutral, 3 high, 1 very high), but four respondents complained that the degree of interaction offered was limited.

During the process of designing the system, we actually decided to limit users' freedom of interaction in order to enhance the sense of having an encounter with a real person and empower the narrative approach. Just as would be the case with a real person, once Leonardo begins telling a story he carries it through to the end, without being interrupted. Furthermore, Leonardo – that is, the system – decides which story to tell, in order to simulate the behaviour of a sentient character as much as possible. This choice, and the motivations behind it, were perceived as limiting by expert users, however. R2 states 'It's interesting the modality of reaching out a hand to interact with the system, but it seems limiting the possibility of choosing only the language and whether to continue with the story or not'. In other comments respondents go further, suggesting other forms of interaction. R5 would have preferred to 'choose the topic to better interact. It would be nice to have Leonardo asking questions and, by answering them, to get other topics'.

Mechanics of interaction and users' behaviour

The above comparison between the designers' intentions and users' perceptions and understanding highlights both problem areas and strengths in the system's ability to fully communicate its meaning and how it functions. Nevertheless, in order to fully understand the agency of the designed system on users we must assess the capacity of the interactive installations to foster the 'correct' behaviour.

Direct observation of the expert testers during the think–aloud sessions, as well as observation of other casual visitors, showed that almost all of them immediately understood how the system worked and behaved accordingly. In particular, the mix of implicit and explicit interaction proved to represent an effective means of engaging users gradually, as it is capable of attracting their attention and then fostering interaction. The whimsical and unexpected way Leonardo appears when user approach (implicit interaction) worked well to surprise them and kindle their curiosity. During direct observation, mainly in the first days of the exhibition, we noticed that most people stopped and listened to Leonardo and some of them decided to start interacting with the system. In other words, the system persuaded users to behave as they were expected to, namely to be intrigued by the digital character and to stop in front of it.

Once engaged in the interaction, most of the users followed the instructions provided by the digital Leonardo and used their hands to launch the narration. The presence of a person, albeit digital, who modelled the gestures users were asked to perform turned out to be very effective in avoiding incorrect actions and misunderstandings. These results are in line with what emerged from the tests with expert users and the questionnaires, as discussed in the previous section. Hence, from the point of view of interaction itself the system proved to be efficient in persuading users to act as we had foreseen: they were indeed attracted to the screens and did not encounter any major problems in the interactions.

In terms of involving users in the interaction, however, the results were not as satisfactory: specifically, the aim was to retain their attention and convince them to listen to all five of the videos at each installation. Quantitative data gleaned from the system logs show that the vast majority of users listened to either one video or all five of the stories. Indeed, the percentage distribution is: 46% 1 video, 4% 2 videos, 4% 3 videos, 2% 2 videos and 43% 5 videos. Therefore, the data highlight two very distinct behaviours: on the one hand, there are users called by Leonardo to interact but evidently not very interested in the stories or bored by them while, on the other hand, there are visitors keen to listen to the digital character.

Direct observation as well as the test with expert users shed light on this percentage distribution. Specifically, we noticed that many passers–by were surprised by Leonardo's appearance and drawn to interact but, once the story started, they immediately left: it is true that the three installations were located in a passageway and most of the visitors were not there to view the exhibit. Furthermore, the data show that a significant component

of the interactions involving just one video were in English (about 25%), which is not surprising since the language spoken by Leonardo is Italian. R4 comments that reading the subtitles prevents the viewer form looking the character in the eye, and R6 adds that it would be nice to listen to Leonardo in English. Hence, the design choice of maintaining a philological approach may have hindered non–Italian users from listening to all five of the stories.

Comments by expert users, on the other hand, may clarify why the majority of users listened to more than one video and a great many of them all five of the stories. R3 says that 'the stories are not too long, enjoyable and not boring' and R5 adds: 'it's nice to listen to his stories regarding nature… it's both didactic and entertaining'. Other comments focus on the ability of the actor to retain viewers' attention and the quality of the scenography. R6 says that 'it's nice the way the actor interprets what he's reading or thinking or writing. I like his facial expressions and the scene props'. As a matter of fact, the quality of the scripts and the professional actor's ability to interpret the Master played an important role in keeping visitors interested. Furthermore, comments highlighted a great appreciation for Leonardo's costumes: R3 says that 'the character speaks well and it's nice that he changes clothes in the different stories' and R4 adds 'I like the change of clothes. It lets me understand that the setting changed'.

In an effort to summarise, we could argue that the mechanics of interaction – designed as a mix of implicit and explicit interaction – proved efficient in modifying users' behaviour in accordance with the designers' will but that the digital character played a fundamental role in communicating how the system functions and retaining viewer's active interest.

Conclusions: is the digital character just an interactive thing?

Recalling the four categories of agents proposed by Kaptelinin and Nardi (2009) and the reasoning presented at the beginning of the article, the interactive installations Leonardo Plays Leonardo plainly fall under the category of 'cultural things'. Characterized by 'delegated' and 'conditional agency', they act on someone else's behalf and produce unintentional effects. However, it remains difficult to fit the digital character completely within the category of 'things' and the results of our research seem to corroborate the idea that such characters actually go beyond this category. Indeed, evidence from our inquiry suggests that users considered the digital Leonardo more than a simple 'cultural thing'. During the tests with users we

observed that testers constantly referred to Leonardo as a real person with whom they were experiencing an authentic encounter. Furthermore, the questionnaires confirm that most users had the impression that they were interacting with a real person, standing before them in the flesh.

Another point worth noting is that most users immediately understood how to interact with the system by imitating the gestures of the digital Leonardo. This aspect may seem secondary but it is particularly relevant for systems based on embodied interaction (Dourish, 2001), which are usually rich in labels and other paratextual apparatuses intended to train users to interact with the system and inform them how it functions.

Finally, during direct observation sessions we frequently identified behaviours that are typical of in–person communication. During sessions with a lot of background noise, several users brought their ears closer to Leonardo's mouth to hear better, a meaningless behaviour given that the two stereo loudspeakers were very visible at the base of the system. Furthermore, we observed that most users tended to maintain a distance from the digital Leonardo that proxemics (Hall, 1990) would define as personal – from 1 to 1.5 meters – and only drew nearer, to an intimate distance, in order to interact with the system.

Despite these considerations, we cannot assert that digital characters such as our Leonardo constitute something more than 'cultural things'. We can, however, remark that they tend to stimulate behaviours that go beyond those fostered by common interactive systems, an aspect that deserves to be taken into due account by designers in general and interaction designers in particular.

References

Dorst, K. and Cross, N. (2001) Creativity in the Design Process: Co–evolution of Problem–solution. *Design Studies*, 22 (5), 425–437.

Dourish, P. (2001) *Where the Action Is: The Foundations of Embodied Interaction*. Cambridge: MIT Press.

Hall, E.T. (1990) *The Hidden Dimension*. New York: Anchor.

Hornecker, E. and Buur, J. (2006) Getting a Grip on Tangible Interaction: A Framework on Physical Space and Social Interaction. In Grinter, R. Rodden, T., Aoki, P., Cutrell, E., Jeffries, R. and Olson, G. (eds.), *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. New York: ACM.

Kaptelinin, V. and Nardi, B.A. (2009) *Acting with Technology: Activity Theory and Interaction Design*. London: MIT Press.

Latour, B. (2007) *Reassembling the Social: An Introduction to Actor–Network–Theory*. New York: Oxford University Press.

Redström, J. (2006) Persuasive Design: Fringes and Foundation. In IJsselsteijn, W.A., Kort, Y.A.W., de Midden, C., Eggen, B. and Hoven, E. van den (eds.), *Persuasive Technology.* Berlin: Springer.

Studio Azzurro (2010) *Sensitive city*. Milano: Scalpendi.

Studio Azzurro (2011) *Studio Azzurro. Musei di narrazione. Ambienti, percorsi interattivi e altri affreschi multimediali*. Milano: Silvana Editoriale.

Van Someren, M.W., Barnard, Y.F. and Sandberg, J.A.C. (1994) *The Think Aloud Method: A Practical Guide to Modelling Cognitive Processes*. London: Academic Press.

Artist as Science Communicator

Michelle KASPRZAK[*a]

[a] Madeira Interactive Technologies Institute

Artists and designers working with scientists or science–related topics in their work often work in ways which partially mirror the science communicator. In this paper I demonstrate that artists working on long–term investigative projects with science have a unique role to play which adds more nuance to the overall 'straight' science communication offering. I examine three case studies: Paper Moon, a multimedia installation by designer Ilona Gaynor; The International Space Orchestra, an ongoing performance project by designer Nelly Ben Hayoun; and Cloud Maker, an experimental object by artist Karolina Sobecka. My paper will describe the unusual merits of these three cases as science communication in addition to their status as art objects, from my perspective of having worked closely with both artists on the works as commissioning curator.

Keywords: *Artist; science communication; publics; interdisciplinary; research*

Introduction

When working with scientists or science–related topics in their work, artists and designers can often mirror some of the aspects of the science communicator role. While more traditional delivery mechanisms (public radio, science in museums, etc.) form the basis of popular notions of science communication, in this paper I wish to demonstrate how artists working on long–term investigative projects with science have a unique role to play which adds more nuance to the overall 'straight' science communication offering. I examine three case studies: *Paper Moon*, a multimedia installation by designer Ilona Gaynor; the *International Space Orchestra*, an ongoing performance project by designer Nelly Ben Hayoun; and *Cloud Maker*, an experimental object by artist Karolina Sobecka. The three case studies I have chosen to analyze here collectively represent very recent work

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[*] Corresponding author: **Michelle Kasprzak** | e–mail: **michelle.kasprzak@m–iti.org**

(completed within the past 5 years), and different approaches in terms of medium and presentation (performance, object–based, and installation/online). This paper will describe the merits of these three cases as science communication in addition to their merits as art objects. In addition, our contemporary technological age informs the process of creating and displaying these works. To fully disclose my role, this paper will be informed by my perspective of having worked closely with these three artists on the works as commissioning curator. The position of being present and having varying levels of interaction with artists from the genesis of a project onward is a common methodology of new media art curating: the role of the new media art curator is flexible and mutable, and is '...constantly questioned – they commission or produce and contribute; they shape the artwork during its production process, rather than creating context for completed works' (Diamond, 2008). The context for the completed works, rather, is shaped partially by the many non–gallery contexts in which the public will encounter them: public performances (in the case of Ben Hayoun), encountering the object in public space (Sobecka), and online (Gaynor). When the gallery is no longer the only assumed context for a work, and when artists work in collaborative teams (with curators, scientists, designers, and others), art–science works can be indistinguishable from science experiments or works of science communication to the public.

Interactions between art and science

The interaction between art and science requires some context. Art and science co–existing peacefully as disciplines is difficult, and in 1959 C.P. Snow gave his famous lecture, *The Two Cultures*, talking about the divisions and conflicts. Snow says:

> 'This cultural divide between art and science is there for two reasons. One is our fanatical belief in educational specialisation. The other is our tendency to let our social forms crystallise. This tendency appears to get stronger, not weaker, the more we iron out economic inequalities: and this is specially true in education. It means that once anything like a cultural divide gets established, all the social forces operate to make it not less rigid, but more so' (Snow, 1959).

Despite this difficulty, and what Snow called the 'frozen smile across the gulf' (Snow, 1959) artists and scientists work together anyway. From the collaborations with Bell Labs in the sixties, to the artist in residence

programme at Xerox PARC active in the nineties, links between science, innovation, and creativity have long been established. (Shanken, 2005) Today, artists are science autodidacts, working with scientists directly, or engaging with science in their artistic research, also outside of formal residency programs. Of course, there are pitfalls even when parties initiate and enter into a collaboration willingly. As playwright Stella Duffy recently said at a conference: 'When SciArt goes wrong, ...the art is used to make the science palatable, the science is used to make the art 'correct'' (Albert, 2016). Duffy refers to the phenomenon of scientists looking to engage with artists superficially to make pretty visualizations of their results, and artists propping up an otherwise conceptually–lazy piece with a bit of armchair science. Duffy's point of view is corroborated by observations from artist, producer, and curator Sara Diamond who remarked that artists can 'misuse or misunderstand' science and that scientists can 'yearn for artists to be illustrative' (Diamond, 2008). Even when art or design is employed to straightforwardly communicate scientific results, due to lack of communication between artist and scientist it can be that 'representations repeatedly fail to communicate understanding or address obvious questions about the underlying data'(Frankel and Reid, 2008). In extreme cases, an artist seeking to faithfully represent scientific data makes an aesthetic decision that changes the interpretation, or that in effect is 'redesigning the experiment', causing 'unexpected science' to result. (Frankel and Reid, 2008).

Not only are there immense difficulties in bridging the two cultures at all, things are complicated by financial considerations. In her 2002 essay for the journal Public Understanding of Science, Siân Ede notes that '...a good way of attracting the interest and time (or even money) of science organizations and scientists is to emphasize the value of art in promoting the public understanding of science...' (Ede, 2002) Ede highlights how funding, even when tied to conditions outside of artistic concerns, can become an attractive lure, as professionals are drawn to remunerative work.

For the people doing the work and research, the lines between the two cultures are often muddied and complex. In his seminal book, *Information Arts*, Stephen Wilson notes that there are several points of divergence between art and science ('evocative' versus 'exploratory'), but that there are also common properties:

- Both value the careful observation of their environments to gather information through the senses.
- Both value creativity.

- Both propose to introduce change, innovation, or improvement over what exists.
- Both use abstract models to understand the world.
- Both aspire to create works that have universal relevance (Wilson, 2002).

In another example, artist Angelo Vermeulen has a background in science and his practice is genuinely hybrid. He says: '...depending on the moment I'm operating more like a designer, an artist, or a scientist, and it's never pure. It's not that on occasions I'm only a scientist, and on others only an artist. It's a continuous movement of focus within a mixed field of specialties' (Kasprzak, 2013a). The kind of hybrid identity described by Vermeulen is also commonly observed of practitioners associated with the growing field known as artistic research. This field has developed in prominence in the past decade with the emergence of several practice–based PhD programmes, wherein artistic research and practice is submitted alongside or in lieu of a written thesis. For several years there has been a Master's programme in Artistic Research at the Royal Academy of Art The Hague (KABK), the Netherlands. As part of the promotional material for the programme, the phenomenon of artist–as–researcher is described in this way:

'The methodologies artistic research entails are as diverse as artistic practice itself. [...] inter–personal dialogue, reading artists' writings, critical texts and academic essays, gathering aural, visual and physical materials, forming image–based, textual, musical and sound archives, watching and making films, doing interviews, visiting exhibitions, attending performances and carrying out collaborative experiments with people in other fields' (KABK, 2016).

Julian Klein, Director of the Berlin–based Institute for Artistic Research, goes into a level of detail on this definition which is beneficial to read alongside the statement by the KABK:

'Against this background the phrase 'art as research' seems to be not quite accurate, because it is not the art, which evolves into research somehow. What exists, however, is research that becomes artistic – so it should be rather named 'Research as Art', with the central question: When is Research Art?' (Klein, 2010).

In summary: art and science have been portrayed as at odds with each other, and there are difficulties in engagement, but the creation–as–artistic–

research turn is only growing. Specifically looking at art–science collaborations, what does this mean for communicating that research in public? As Julian Klein asks, when is research art? Examining motivations to produce this type of artwork can also inform an analysis of how the outputs can be communicated. Siân Ede defined 4 reasons why artists would work in a scientific context or with a scientist:

1. The challenge of materials;
2. Fascination with scientific paradigms;
3. Assist with scientific investigation;
4. Engage in a complex way with ethics, politics of science (Ede, 2002).

I responded to Ede's list with my own list of 3 qualities, any one of which makes art–science projects also a form of communicating research to a public as a type of science communication:

1. That there are novel findings to present;
2. That the artist provides a compelling narrative which imparts scientific information or histories;
3. That the art provokes science–related questions in the public.

These three qualities are key, since not every art–science project presents specific narratives or questions, or works with novel subjects – for example, works which exist as abstract representations of scientific data. To support this list of qualities, I will now outline three projects which exemplify these properties and demonstrate how they fulfill their role as science communication projects as well as artistic projects. Firstly, I will examine art which promotes science communication by provoking science–related questions in the audience, in this case through the creation of an object which can be encountered by chance in public as well as viewed in an exhibition context at a gallery space.

Case studies

Cloud Maker

Cloud Maker, which was commissioned from artist Karolina Sobecka in 2012 as a response to the emerging philosophical fields of object oriented ontology and speculative realism, was designed to reflect on our relationship to the environment as society applies intense scrutiny to climate change. As Sobecka describes it in an interview I conducted with her over e–mail:

'*Cloud Maker* is a personal device for weather modification. It consists of cloud–making gear sent up into the atmosphere in a

weather–balloon payload. As it reaches specific altitudes it disperses Cloud Condensation Nuclei (CCN), heat and water vapour. Moisture in the air condenses into cloud droplets around the CCN, forming into small clouds. This method is inspired by a geo–engineering technique proposed to create brighter, more reflective clouds which shield earth from sun's radiation, and thus partly counteract the climate change' (Kasprzak, 2013b).

When discussing this piece with her, Sobecka also likened trying to make a tiny cloud in the atmosphere as a miniscule gesture, a bit like trying to make a wave in the ocean. Making a cloud is an absurdity especially when we consider that clouds are temporary local manifestations of what we globally call the 'hyper–object' of the climate (Kasprzak, 2013b).

Figure 1   Installation view of Cloud Maker, Speculative Realities exhibition curated by Michelle Kasprzak. Image courtesy Karolina Sobecka.

Sobecka goes on to say: 'The *Cloud Maker* is focused on human understanding of 'nature' and our place in it, or as Timothy Morton would put it, on developing our ecological awareness. It centres on engaging people in endeavours and conversations that might seem borderline absurd and thus revealing of particulars of one's actions in the world' (Kasprzak, 2013b). Sobecka also carefully documents each launch of the device, and

retrieving it from where it has landed. She has had several interesting encounters with people when she tracks the device and attempts to retrieve it – she has no control, ultimately, on where the balloon will land.

Figure 2   Installation view of Cloud Maker, Speculative Realities exhibition curated by Michelle Kasprzak. Image courtesy Karolina Sobecka.

In one instance Sobecka's device landed in someone's backyard and the highly–suspicious property owner insisted that Sobecka be cleared by the local police before she was allowed to collect her device. She states: 'Interesting conversations ensued, with the police, the property owner, and the local tree service, bringing up such issues as legality of cloud–making,

social and personal responsibility, privacy, and lawful enforcement of environmental protection' (Kasprzak, 2013b). Records of these conversations, still images and video, and other artefacts all become part of the final exhibition of the work, along with the cloud–making device itself (figg. 1 and 2). By presenting the work in this way, the audience is provoked to consider not just the technical aspects of cloud–making, but the wider implications of this potential practice environmentally and socially.

Figure 3   *International Space Orchestra mission patch by Protoplot. Image courtesy Nelly Ben Hayoun Studio.*

International Space Orchestra

Next, I will examine how science communication is promoted by providing a compelling narrative which imparts scientific information or histories in the case of Nelly Ben Hayoun's *International Space Orchestra*. In 2012, commissioned by the California–based ZERO1 Festival, Nelly Ben Hayoun developed the *International Space Orchestra* (figg. 3 and 4), an amateur orchestra composed of roughly 50 scientists from NASA Ames Research Center and other Californian space science institutes. Their first performance, *Ground Control: An Opera in Outer Space*, re–enacts the first

minutes of Neil Armstrong's landing on the Moon and is dedicated to the memory of lost astronauts.

Figure 4   International Space Orchestra rehearsing in front of the NASA Ames wind tunnel. Image courtesy Nelly Ben Hayoun Studio.

One aim of the *International Space Orchestra* (ISO) is to educate the broader public about NASA's missions and NASA's contributions to wider Silicon Valley culture, while engaging NASA Ames staff in a unique project that conveys their work in an accessible way. This is a straightforward aim, however from the start of the ISO project, an extra layer of complexity was involved: the project had to fit within existing NASA structures for outreach and but not compete with these internal forces. Therefore, Ben Hayoun had to consider novel ways in which her project could bring additional cultural capital to NASA Ames and how that could be displayed publicly: to give one example, images from the International Space Station showing the ISO compact disc in zero gravity are now displayed in Ames' visitor center (Ben Hayoun, 2016). In a paper delivered at the International Astronautical Congress in 2016, Ben Hayoun also details the numerous issues faced by NASA's presentation of itself to the public, including a strategy of simply providing 'beautiful images' from outer space, but Ben Hayoun noted that these strategies were not robust enough to advance NASA's public image

without something more substantial in terms of a communications and PR strategy to support these images (Ben Hayoun, 2016).

The ISO took the idea of quality content ('beautiful images' or something else) a step further than just having a PR strategy. Ben Hayoun discovered the power of taking a certain tone which was able to frankly address human struggle and fallibility. Approaching human frailty directly in a scientific narrative allows empathy to develop between the public and NASA scientists: '...human failures and inherent risks, might, in turn, trigger empathy from members of the public. Empathy is a powerful cue, since it facilitates the articulation of a cultural consciousness and a sense of common belonging' (Ben Hayoun, 2016).

Another part of Ben Hayoun's strategy to humanize and communicate the work of NASA was to subvert the notion of who a scientist is, and what they do. She discovered that the scientists at NASA Ames Research Center were already musically talented, though this wasn't widely exploited or advertised: they were simply playing informally in after–hours bluegrass and jazz groups. Ben Hayoun wished, as part of the many aims of the ISO, to highlight that these top scientific thinkers were also artistically creative, and that the space exploration projects developed by NASA were also cultural moments in their own right – moments to be celebrated, memorialized, re–lived and turned into bombastic musical performances (Ben Hayoun, 2016). In her own PR and communication about the project, Ben Hayoun also explicitly positions the ISO as vehicle for the public to re–imagine science: '...a call to imagine and disrupt future human relations to science – to adapt science to our creative needs' (Ben Hayoun, 2012).

The ISO is still playing, and in 2016 played the Hollywood Bowl as an opening act for Icelandic rock group Sigur Rós. The music of the ISO was also delivered to the International Space Station by Italian astronaut Samantha Cristoforetti, and returned to Earth in a Soyuz capsule (fig. 5). Another ISO recording still orbits the earth aboard a Japanese satellite (Ben Hayoun, 2012).

The ISO has been positioned by Ben Hayoun as an ongoing project, one which will continue to tour, orbit Earth, and contribute to an imaginary about space science for the general public. The performances also transitioned from being presented by an art institution (ZERO1 Festival) to conventional rock concert contexts, and moreover claiming a representation of the performance in outer space itself through transporting the CD recording to the International Space Station. These multiple contexts and

manifestations of the ISO project provide numerous entry points for the public, both in terms of content and project visibility.

Figure 5   The ISO recording floating in the International Space Station with Italian astronaut Samantha Cristoforetti. Image courtesy Nelly Ben Hayoun Studio.

Paper Moon

Promoting science communication by conveying novel information is another way in which artworks can function as science communication. In an artwork commissioned in 2013, *Paper Moon*, Ilona Gaynor (in collaboration with graphic designer Craig Sinnamon) addressed the tangle of legal, economic, and political actions which we generate on Earth and project onto the possible property and territory of the cosmos. Or as Gaynor puts it: 'On paper, in various offices across Earth, the galaxy has become a wild west of marked territory, land grabbing and fortune hunting' (Gaynor, 2013).

The piece is a library of objects displayed in a museum–style installation (fig. 6), inviting visitors to challenge contemporary romanticised, sci–fi visions of space and begin to question the problematic emergence of monetizing and legalizing outer space. Gaynor notes in her artist statement about the piece: 'Common Law (that is to say Earth's common law) has no legal definition for what 'Outer Space' actually means, what it is, and where

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it is. The problem we face with such literal unmarked territory; is the emergent field of 'Space Law', a hybridised law built from a varying spectrum of pre–dated policy, speculation and foresight' (Gaynor 2013).

Figure 6   Installation view, Paper Moon. Image courtesy Ilona Gaynor.

   Through the various objects on the tables, visitors can investigate several current and prospective investment plots, plans and economic contingency strategies that focus on territories being cultivated, won, lost and considered by various entities around the world. Lists of companies which have speculatively purchased (most certainly illegally) real estate on the moon sits next to a custom made cake, depicting the Earth as having a core of gold, which if we could extract would be so valuable as to totally disrupt our global economy (fig. 7).

   Drawing from historical archives, news reports, scientific papers and legal texts the work is presented as a cluster of texts, maps, and small objects which coordinate various opposing plans for the realm beyond Earth. Some objects are oblique, dark statements: a standard office printer rendered useless and mute by being covered in flocking fibers, for example (fig. 8). A text of a speech for the American President to use when there is human loss of life in space is pinned to the table. By browsing the objects which both reflect the past achievements and possible futures of outer space monetization and conquest, exhibition visitors are able to formulate their own perspective of what the worth and value of space exploration as a scientific activity is. By viewing the objects in the installation or perusing the

images of the pieces online, it becomes clear that the future of this exploitation of space is no longer beholden to romantic nation–state narratives, but will be a money–driven land grab and mining expedition for rare earths and metals by corporate actors.

Figure 7   Installation detail, Paper Moon. Image courtesy Ilona Gaynor.

Figure 8   Installation detail, Paper Moon. Image courtesy Ilona Gaynor.

Conclusion

These three projects each communicate something very different about the potentials, imaginaries, and realities of science to viewers. Each piece also stands as a compelling art object or experience. This paper analyzed three artworks which represented different media (object, performance, installation) and different possible reception contexts (public space, performance venue, gallery or online) and which were developed in the past five years to illustrate the many different methodologies which art–science projects can employ to communicate scientific information to the public.

I introduced three criteria for examining art–science projects and determining if they also could serve an additional function as science communication projects. Each of these projects presented here represented a different criterion: the novel findings in the emergent field of space law presented by Ilona Gaynor's *Paper Moon*; the compelling narrative introduced by Nelly Ben Hayoun's *International Space Orchestra*; and the science–related questions which could be provoked in the public by discovering one of Karolina Sobecka's *Cloud Maker* devices, after drifting into their backyard.

In which possible ways could artists and designers further embed scientific information and narratives within publics? There are clearly many more possibilities for this in future, especially as the creation–as–artistic–research turn cements its influence. Though we have moved far beyond the era of C.P. Snow and the 'frozen smile' between arts and science, significant hurdles remain in terms of imbalances created by funding (Ede, 2002) and communication between artists and scientists being an issue (Frankel and Reid, 2008). Despite these difficulties, presenting scientific information through the prism of artistic research remains a compelling method for artists to synthesize current scientific findings, reiterate major scientific events, or develop a scientific imaginary, and for the public to not just grasp the facts, but appreciate the beauty and empathize with scientists (Ben Hayoun, 2016).

Acknowledgements

References

Albert, S. (2016) *When SciArt Goes Wrong, Says @Stellduffy: The Art is Used to Make The Science Palatable, the Science is Used to Make the Art 'Correct'*. [Online] https://twitter.com/saul/status/799285343501619200 [Accessed: December 1st, 2016].

Ben Hayoun, N. (2012) *The International Space Orchestra | Nelly Ben Hayoun.* [Online] http://nellyben.com/projects/the–international–space–orchestra/ [Accessed: December 1st, 2016].

Ben Hayoun, N. (2016) The Need for a Catharsis Into the Space Programme. Utilizing the Greek Tragedy's Coersive Systems Into Space Education and Outreach*.* In *International Astronautical Congress Proceedings*.

Diamond, S. (2008) Participation, Flow, Redistribution of Authorship. In Paul, C. (ed.), *New Media in the White Cube and Beyond*. Berkeley: University of California Press.

Ede, S. (2002) Science and the Contemporary Visual Arts*. Public Understanding of Science*, 11 (1), 65–78.

Frankel, F. and Reid, R. (2008) Big data: Distilling meaning from data. *Nature*, 455 (7209), 30.

Gaynor, I. (2013) *Paper Moon.* [Online] http://www.ilonagaynor.co.uk/Paper_Moon/ [Accessed: December 1st, 2016].

KABK (2016) *Master Artistic Research (M.Mus)*. [Online] http://www.kabk.nl/pageEN.php?id=0059 [Accessed: December 1st, 2016].

Kasprzak. M. (ed.) (2013a) *Blowup Reader: Outer Space as Extreme Scenario.* Rotterdam: V2_ Publishing.

Kasprzak, M. (ed.) (2013b) *Blowup Reader: Speculative Realities.* Rotterdam: V2_ Publishing.

Klein, J. (2010) *What is Artistic Research?* Research Catalogue. [Online] https://www.researchcatalogue.net/view/15292/15293/0/0 [Accessed: December 1st, 2016].

Shanken, E.A. (2005) Artists in Industry and the Academy: Collaborative Research, Interdisciplinary Scholarship and the Creation and Interpretation of Hybrid Forms*. Leonardo*, 38 (5), 415–418.

Snow, C.P. (1959) *The Two Cultures and The Scientific Revolution.* New York: Cambridge University Press.

Wilson, S. (2002) *Information Arts: Intersections of Art, Science, and Technology*. Cambridge: MIT Press.

The Flow and Use of Knowledge in Networks of Electric Mobility: A Theoretical Development

Nuno BOAVIDA[*][a]

[a] Universidade Nova de Lisboa

The paper discusses the main drivers of the flow and use of knowledge in decision networks of sustainable electric mobility. Electric mobility can have a significant impact in a transition to a more sustainable mobility system. There are reasons to believe that this transition can be knowledge–dependent. Examples suggest that the use of bits and concealed tacit knowledge in decision networks are significantly relevant to this transition. Literature shows that transfers of tacit knowledge occur in networks with developed individual social capital and are conditioned by earlier personal interactions. Social capital can provide centrality and power to actors in networks. It can be enhanced by developing trust and displaying and/or implying possession of knowledge relevant for present or future action. Tacit knowledge in technology innovation decisions, in particular, is thought to be significantly valued, because innovation is permeated by strong elements of uncertainty and complexity that drive actors to seek for non–explicit forms of knowledge in networks of near–peers. The paper concludes that the urge for knowledge in situations where not much can be found may drive decision–makers to over rely on partial and partisan knowledge during decision–making. The paper ends with a discussion about the need for more research concerning knowledge in emergent decision networks of electric mobility.

Keywords*: Electric vehicles; knowledge management; sustainable mobility; decision networks; technology assessment*

Introduction

The conclusions of the 2015 Climate Conference in Paris reinforced the notion that sustainable mobility strategies are important to foster low–

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[*] Corresponding author: **Nuno Boavida** | e–mail: **nuno.boavida@campus.fct.unl.pt**

carbon policies, improve energy efficiency and mitigate anthropogenic climate change. The uptake of electric propulsion engines is an essential part of a transition to a more sustainable mobility system. It has been pointed out, moreover, that 'technological niches' of green propulsion technology are potentially better placed to foster a low–carbon transition in transport systems (Geels, 2012). Dijk, Orsato, and Kemp have even argued that electric mobility has now crossed a critical threshold in this transition – not least as it benefits from high oil prices, carbon constraints and rise of organised car sharing and intermodality (Dijk, Orsato, and Kemp, 2012).

There are reasons to believe that contributions to an electric mobility transition are knowledge–dependent. In a famously failed strategy from 1973, for example, Electricité de France predicted the end of the internal combustion engine due to improvements in electrochemical generators (Callon, 1986). To support their narrative, the engineers included knowledge related to electrons, hydrogen fuel cells and zinc/air accumulators, but purposefully ignored other knowledge such as catalysts, companies' self–interests and customer preferences. Thus, engineers in fact drew on selective bits of knowledge to support their case for electric vehicles.

This paper argues that a focus on the flow and use of knowledge in networks is needed to support a transition to electric mobility. It investigates the literature of how and why knowledge is used in decisions, and discusses the nature of decision–making in technology innovation to understand implications for decision makers and other epistemological actors. The paper first presents the main literature on centrality of knowledge in decision making, and describes an operational frame of types of knowledge. It discusses how knowledge intermediators involved in networks of technology innovation can instrumentally use knowledge to empower themselves or their agendas. In the second part, the paper elaborates on the relevance of uncertainty and complexity to understand the importance of tacit knowledge to decision makers. Finally, the paper discusses the main implications to future research of using a focus on knowledge flows and use in these networks.

Knowledge in decisions of electric mobility

The recognition of the centrality of knowledge in decision–making has led researchers to reflect upon how selective knowledge reaches and influences policymakers and other stakeholders. It is known that the selective use of knowledge during decision–making processes can empower

some policy actors over others, establish the agendas, frame the problem, become part of the mythologies that shape public life and set the terms for negotiation and public discourse (Innes, 1990; Ivory, 2013). Many authors underlined the need for more research to determine the processes by which knowledge is in fact reaching, being influential or being excluded from decision–making (Stoker and Evans, 2016; Weiss, 1999; Miller, 2005).

Previous works about the role of knowledge in decisions of electric mobility have typically studied the use of explicit forms of knowledge ((Boavida, 2015; Gudmundsson and Sørensen, 2013; Sébastien and Bauler, 2013). However, these works did not account for the influence of other forms of knowledge in these decision processes. Harry Collins defined tacit knowledge as that which cannot be or has not been made explicit. He subdivided tacit knowledge into three different types: relational knowledge when it is dependent of the relations between people and arising out of social interaction; somatic knowledge when it is inscribed in the brain and body; and collective knowledge when it is a property of society rather than the individual (Collins, 2010). In some cases of technology innovation, relational knowledge can be more influential to decision–making than any other form of knowledge. For example, Nissan managers provided concealed relational knowledge to Portuguese governmental members, about the timings to launch the electric vehicle Nissan Leaf in the market and its specifications and needs. The power of these memes of concealed relational knowledge was so significant that it pushed the decision–making process towards an investment decision in charging posts for electric vehicles as soon as 2012. This knowledge bound the governmental decision to invest in chargers across the country, and even led government to neglect existent explicit knowledge (Boavida, 2015). Decisions based on partial bits of knowledge can be a significant risk and, in effect, even today the chargers are underused. Presently, we know that the use of tacit knowledge in some decisions of automotive companies has influenced electric mobility transition. For example, Tesla's decision to install superchargers in Norway ahead of demand is having a significant effect in the transition to sustainable mobility (Figenbaum, Assum, and Kolbenstvedt, 2015). What we still need to understand is the exact mechanism by which tacit knowledge can play a constructive role in this type of decisions.

Tacit knowledge in innovation networks

We know that the transfer of tacit knowledge occurs in networks with a developed individual social capital, normally through intimate personal interactions (Inkpen and Tsang, 2005). Hence, the use of tacit knowledge and, eventually, the final decision are conditioned by earlier interactions related to the creation and maintenance of network connections and relationships. Earlier interactions can include acquaintances, chats, negotiations, intrigues, calculations and persuasion acts. Through these interactions actors may gather recognition of social and capital, which grants them, at least temporarily, the authority to speak or act on behalf of another actor or force (Callon and Latour, 1981). Thus, the transfer of tacit knowledge is dependent of the personal interactions where recognition (or translation) of individual social capital occurs.

Another way to enhance social capital is by generating trust in the network (Nooteboom, 2007). Network members make inferences about trustworthiness based on the history of interaction with a partner and further draw on third parties to inform their trust judgments (Giest, 2017). According to the author, trust is a key element of networks because it forms a basis for relationships and provides the condition for cooperation and higher performance to occur. In innovation networks, trust is particularly important due to the nature of innovation efforts, with potentially high investments and long–term research efforts (Giest, 2017). Furthermore, there are two types of trust that worth mentioning in this context: there can be trust in (technical and cognitive) competence when one has a psychological state, belief or attitude towards another known individual (or institution) to fulfil expectations and its intentions to do the best of his/her competence; there is also trust in intentions when there is a belief about the will to act properly with attention, commitment and benevolence (Nooteboom, 2006). Both types of trust may be used to generate social capital and thus facilitate transfer of tacit knowledge.

More importantly, individual social capital in networks can be enhanced by display and/or implying possession of knowledge relevant for present or future action. These actions can occur using knowledge that already exists and/or that can be later created, as well as with contributions to its flow in the network and/or in the future decision–network. Innovation related networks, for example, rely on knowledge exchange for the ability to come up with new ideas and products (Giest, 2017). In these cases, knowledge becomes a valuable commodity to exchange among network members.

Thus, knowledge can enhance centrality and power to 'knowledgeable' intermediaries in decision networks.

The valorisation of tacit knowledge specifically in technology innovation networks is related to two other fundamental characteristics of innovation: uncertainty and complexity. Technology innovation is frequently associated with uncertainty because 'different people, and different organizations, will disagree as to where to place their R&D chips, and on when to make their bets' (Nelson and Winter, 1977, p. 47). Uncertainty motivates an individual to seek information, although it 'is often sought from near–peers, especially information about their subjective evaluations of the innovation' (Rogers, 2003, p. xix). Importantly, this exchange of perceptions about a new idea occurs through a convergence process involving interpersonal networks (Rogers, 2003). There are various types of uncertainty associated with the innovation process, although technological, market and regulatory uncertainties have an established status (Jalonen and Lehtonen, 2011; Sainio, Ritala, and Hurmelinna–Laukkanen, 2012). But more can be identified. For example, Carbonell and Rodríguez–Escudero (2009) considered only two aspects of uncertainty: technology novelty and technological turbulence. In a study on innovation in biomass gasification projects in the Netherlands, Meijer, Hekkert, and Koppenjan (2007) argued that technological, political and resource uncertainty are the most dominant sources of perceived uncertainty influencing entrepreneurial decision–making related to emerging renewable energy technology.

Furthermore, complexity in technology innovation can be understood as components that, when integrated together, cause difficulties for the transformation into successful products or processes (Chapman and Hyland, 2004; Rycroft, 2007; Waelbroeck, 2003; Wonglimpiyarat, 2005). Complexity can be enclosed in technologies, products, customer interfaces and organizational setups (Chapman and Hyland, 2004). It has been associated with experiences where information is incomplete or ambiguous and the consequences of actions are highly unpredictable (Aram and Noble, 1999). Therefore, it can be argued that bits and relational tacit knowledge in innovation contexts have the propensity to be significantly valorised, because technology innovation decisions are permeated by strong elements of uncertainty and complexity that drive actors to seek for non–explicit forms of knowledge among their network of near–peers.

The urge for knowledge in these types of situations, where often not much can be found, induces decision makers to over rely on knowledge gathered through trusted networks of near pears. Hence, the partial and/or

sometimes partisan use of knowledge during decision–making is a significant factor to explain the perils of decision making in networks of electric mobility for main two reasons. First, past actions built these networks in a different context from the decision. These interactions were built through social acquaintances, negotiations, intrigues, calculations and persuasion acts. Second, networks of near–pears are built on trust enhanced by vulnerable recognition of competence and/or intentions through judgments about past interactions and third parties. The problem is that competence is rather difficult to establish in uncertainty and complex environments, and trust in intentions is no more than a belief that the other will act properly with attention, commitment and benevolence. Thus, electric mobility decisions are based on knowledge assessed and valued by significantly vulnerable casual social interactions and beliefs about who to trust.

Conclusion and discussion

The uptake of electric vehicles is an essential part of a transition to a more sustainable mobility system. There are reasons to believe that the transition to electric mobility is knowledge–dependent. Several examples suggested that the use of bits and concealed tacit knowledge in decision networks are important to the success of these decisions. Transfers of tacit knowledge occur in networks with a developed individual social capital and are conditioned by earlier personal interactions. Social capital can provide centrality and power to actors in networks that will eventually constitute a decision network. More importantly, individual social capital can be enhanced by building trust with network members and by displaying and/or implying possession of knowledge relevant for present or future action. Furthermore, tacit knowledge in technology innovation decisions is thought to be significantly valorised, because innovation is permeated by strong elements of uncertainty and complexity that drive actors to seek non–explicit knowledge in their networks of near–peers. The desire for knowledge in situations where not much exists appears to explain the overreliance on partial and partisan relational tacit knowledge found in some decision–making.

More research about the use of knowledge in emergent decision networks of electric mobility is needed not only for sustainability reasons, but also to question assumptions of theories of knowledge, elaborate on evidence–based policy concepts and deepen our understanding of innovative business practices. The need for a better understanding of how

tacit knowledge flows and is used in decision–making practices of technology innovation is pressing for three main reasons. First, theories of knowledge in policymaking often presuppose voluntarist attitudes in the formulation of policies, assuming that decision makers act rationally and want to maximize the use of evidence, ignoring the primacy of politics in decision–making (Flitcroft et al., 2011). A more nuanced account of decision–making around electric mobility could significantly contribute to clarify decision makers' attitudes towards tacit knowledge and to promote more reflective practices amongst policymakers. Second, the definition of evidence in policy making can vary significantly, from rigorous scientific evidence to the selective use of information of varying and uncertain reliability used to create underpinning rationales (Flitcroft et al., 2011). This suggests the need for a closer and more rigorous examination of the types of knowledge used as evidence in decisions. It should be clear which types (and bits) of knowledge can constitute evidence not least as there is increased pressure to formulate evidence–based policies, particularly in countries with policy and research cultures oriented to transparency and rationality in the decision processes (Head, 2010; Juntti, Russel and Turnpenny, 2009; Sorrell, 2007). Last, the literature on electric mobility also lacks research about the flow and use of knowledge in business contexts where developments in transition have occurred, as previously mentioned.

The aim of future research should, therefore, be oriented to improve our understanding of how different bits and types of knowledge are deployed in strategic decision–making around new technology investments in electric mobility. It should target contrasting strategic decisions, such as the deployment of electric and diesel engines in policy and business contexts, by scrutinizing what sort of knowledge was involved in underpinning key decisions and how it was used. It can be envisaged that a careful selection of cases using social network analysis can be useful to enlighten these efforts. The cases should include considerations about the importance of the decision in triggering a sustainable transition to a new system of transportation, as well as a decision based on quantified measures (i.e. explicit knowledge) and a second one based on broader objectives to guarantee a comprehensive use of different types of knowledge.

Acknowledgements

References

Aram, E. and Noble, D. (1999) Educating Prospective Managers in the Complexity of Organizational Life. *Management Learning*, 30 (3), 321–42.

Boavida, N. (2015) *Decisions of Technology Innovation: The Role of Indicators*. Lisboa: Universidade Nova de Lisboa.

Callon, M. (1986) The Sociology of Actor–Network: The Case of the Electric Vehicle. In Callon, M., Law, J. and Rip, A. (eds.) *Mapping the Dynamics of Science and Technology: Sociology of Science in the Real World*. London: Macmillan.

Callon, M. and Latour, B. (1981) Unscrewing the Big Leviathan : How Actors Macro–Structure Reality and How Sociologists Help Them to Do so. In Knorr–Cetina, K. and Cicourel, A.V. (eds.) *Advances in Social Theory and Methodology: Toward an Integration of Micro and Macro–Sociologies*. Boston: Routledge and Kegan Paul.

Carbonell, P. and Rodríguez–Escudero, A.I. (2009) Relationships among Team's Organizational Context, Innovation Speed, and Technological Uncertainty: An Empirical Analysis. *Journal of Engineering and Technology Management*, 26 (1–2), 28–45.

Chapman, R. and Hyland, P. (2004) Complexity and Learning Behaviors in Product Innovation. *Technovation*, 24 (7), 553–561.

Collins, H. (2010) *Tacit and Explicit Knowledge*. Chicago: The University of Chicago Press.

Dijk, M., Orsato, R.J. and Kemp, R. (2012) The Emergence of an Electric Mobility Trajectory. *Energy Policy*, 52, 135–145.

Figenbaum, E., Assum, T. and Kolbenstvedt, M. (2015) Electromobility in Norway: Experiences and Opportunities. *Research in Transportation Economics*, 50, 29–38.

Flitcroft, K., Gillespie, J., Salkeld, G., Carter, S. and Trevena,L. (2011) Getting Evidence into Policy: The Need for Deliberative Strategies? *Social Science & Medicine*, 72 (7), 1039–1046.

Geels, F.W. (2012) A Socio–Technical Analysis of Low–Carbon Transitions: Introducing the Multi–Level Perspective into Transport Studies. *Journal of Transport Geography*, 24, 471–482.

Giest, S. (2017) Trust Dynamics in Innovation Networks. *Administration & Society*, 1–19.

Gudmundsson, H. and Sørensen, C.H. (2013) Some use–Little Influence? On the Roles of Indicators in European Sustainable Transport Policy. *Ecological Indicators*, 35, 43–51.

Head, B.W. (2010) Reconsidering Evidence–Based Policy: Key Issues and Challenges. *Policy and Society*, 29 (2), 77–94.

Inkpen, A.C. and Tsang, E.W.K. (2005) Social Capital, Networks, and Knowledge Transfer. *The Academy of Management Review*, 30 (1), 146–65.

Innes, J. E. (1990) *Knowledge and Public Policy: The Search for Meaningful Indicators*. New Brunswick: Transaction Publishers.

Ivory, C. (2013) The Role of the Imagined User in Planning and Design Narrative. *Planning Theory*, 12 (4), 425–41.

Jalonen, H. and Lehtonen, A. (2011) Uncertainty in the Innovation Process. In *Proceedings of the 6th European Conference on Innovation and Entrepreneurship*. Aberdeen: Academic Publishing.

Juntti, M., Russel, D. and Turnpenny, J. (2009) Evidence, Politics and Power in Public Policy for the Environment. *Environmental Science & Policy*, 12 (3), 207–215.

Meijer, I.S.M., Hekkert, M.P. and Koppenjan, J.F.M. (2007) The Influence of Perceived Uncertainty on Entrepreneurial Action in Emerging Renewable Energy Technology; Biomass Gasification Projects in the Netherlands. *Energy Policy*, 35 (11), 5836–5854.

Miller, C.A. (2005) New Civic Epistemologies of Quantification: Making Sense of Indicators of Local and Global Sustainability. *Science, Technology, & Human Values*, 30 (3), 403–432.

Nelson, R.R. and Winter, S.G. (1977) In Search of Useful Theory of Innovation. *Research Policy*, 6 (1), 36–76.

Nooteboom, B. (2006) Social Capital, Institutions and Trust. *Review of Social Economy*, 65 (1), 29–53.

Nooteboom, B. (2007) Methodological Interactionism: Theory and Application to the Firm and to the Building of Trust. *Review of Austrian Economics*, 20 (2–3), 137–153.

Rogers, E.M. (2003) *Diffusion of Innovation*. New York: The Free Press.

Rycroft, R.W. (2007) Does Cooperation Absorb Complexity? Innovation Networks and the Speed and Spread of Complex Technological Innovation. *Technological Forecasting and Social Change*, 74 (5), 565–578.

Sainio, L.–M., Ritala, P. and Hurmelinna–Laukkanen, P. (2012) Constituents of Radical Innovation: Exploring the Role of Strategic Orientations and Market Uncertainty. *Technovation*, 32 (11), 591–599.

Sébastien, L. and Bauler, T. (2013) Use and Influence of Composite Indicators for Sustainable Development at the EU–Level. *Ecological Indicators*, 35, 3–12.

Sorrell, S. (2007) Improving the Evidence Base for Energy Policy: The Role of Systematic Reviews. *Energy Policy*, 35 (3), 1858–1871.

Stoker, G. and Evans, M. (2016) *Evidence–Based Policy Making in the Social Sciences: Methods That Matter*. Bristol: Policy Press.

Waelbroeck, P. (2003) Innovations, Production Complexity and the Optimality of R&D. *Economics Letters*, 79 (2), 277–282.

Weiss, C.H. (1999) The Interface between Evaluation and Public Policy. *Evaluation*, 5 (4), 468–486.

Wonglimpiyarat, J. (2005) Does Complexity Affect the Speed of Innovation? *Technovation*, 25 (8), 865–882.

Tangible Interaction and Cultural Heritage. An Analysis of the Agency of Smart Objects and Gesture–based Systems

Daniele DURANTI[*a], Davide SPALLAZZO[b] and Raffaella TROCCHIANESI [b]

[a] Scuola IMT Alti Studi Lucca; [b] Politecnico di Milano

Drawing on a design perspective, this paper aims to analyse the agency of tangible and embodied interaction systems applied to cultural heritage and the role of design in shaping the expected behaviour of users.

Going beyond tangibility in the strict sense of touching assets, in this paper we employ a broader interpretation of tangibility, understanding it as a practice of meaning–making that requires intense bodily involvement.

In order to carry out the analysis, we adopt the concepts of delegated and conditional agency proposed by Kaptelinin and Nardi (2009), the idea that things have the ability to realize –or not– the intentions that are delegated to them by someone else (the designer).

Therefore, different types of tangible interaction systems, (1) smart replicas/originals, (2) symbolic objects (3) codified gestures and (4) performing gestures, are analysed according to their ability to realize the intentions of those who imagined, created and programmed them.

Specifically, each category is described and analysed in terms of its ability to stimulate user interaction and suggest the right behaviour to trigger interpretive content. Finally, some conclusions are presented as a starting point to orient future research.

Keywords: Agency of things; tangible interaction; interaction design; museums; cultural heritage

Introduction

Tangible interaction emerged over the years as a way of integrating digital functionalities in the real world (Ishii and Ullmer, 1997). Originally born as a field of research within Interaction Design and HCI, today tangible

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* Corresponding author: **Daniele Duranti** | e–mail: **daniele.duranti@imtlucca.it**

interaction comprises a very broad range of 'systems and interfaces relying on embodied interaction, tangible manipulation and physical representation (of data), embeddedness in real space and digitally augmented physical spaces' (Hornecker and Buur, 2006, p. 437). Tangible interaction allows people to interact with digital systems as they usually do with the physical world, namely by manipulating objects or performing gestures or bodily movements.

Together with an increased interest in the materiality of the visit experience in museums and cultural institutions more generally (Chatterjee, 2008; Dudley, 2012; Pye, 2008), tangible interaction is progressively entering the cultural heritage field through systems such as tangible tabletops (Hsieh et al., 2010) smart objects (Rawat, 2005) and smart physical places (Ciolfi and Bannon, 2005). Although these systems have different shape and aims, they all offer interactions based on the manipulation of tangible, sensorised objects (object–based interaction) or free bodily gestures and movements (gesture–based interaction).

Significant research has been conducted in the field of tangible interaction applied to cultural heritage since the early 2000s. Notable projects include SHAPE (Bannon et al., 2005), which pioneered the introduction of tangible systems in the field, and the ongoing project meSch (Material EncounterS with digital Cultural Heritage), which aims to bridge the gap between heritage and digital content (Petrelli et al., 2013a) by creating prototypes and a platform allowing cultural heritage professionals to design, construct and maintain interactive artefacts. Furthermore, several applications and systems are also emerging from the commercial field and museum practice, giving rise to a rich panorama of projects.

It should be stated that, to date, the approach has mainly been practical and focused on the design and evaluation of new systems; not many theoretical works have been developed.

The authors have sought to classify tangible interaction applications in museums in a recent article (Duranti, Spallazzo and Trocchianesi, 2016), proposing four categories to identify embedded and embodied interactions in cultural institutions: (1) smart replicas/originals, (2) symbolic objects, (3) codified gestures and (4) performing gestures, the first two primarily related to embedded interaction and the last to embodied interaction.

The category (1) 'smart replicas/originals' refers to examples that ask visitors to touch and manipulate replicas of artworks with embedded sensors or original artworks enhanced with sensing capabilities in order to

experience the sensorial aspects of the object and activate and control digital content.

Category (2), 'symbolic objects'*,* instead, comprises projects that employ smart objects, icons or elements imbued with symbolic meaning. In other words, beyond its capacity to activate content in response to manipulation, the smart object becomes symbolic in itself by virtue of its shape and evocative power.

Category (3), 'codified gestures'*,* covers examples that employ gesture–based interaction to control and activate interpretive content about the objects on display, namely projects that ask visitors to perform specific gestures in order to access digital content.

Finally, the fourth category (4), 'performing gestures'*,* includes projects that ask visitors to perform gestures which, beyond their ability to trigger digital content, are imbued with meaning in relation to the asset on display.

The four categories of tangible/embodied interaction systems were originally proposed to consider the ability of these kinds of interfaces to stimulate reflections about the intangible value of cultural assets (Duranti, Spallazzo and Trocchianesi, 2016). The main focus was to define design strategies that would add meaning, namely embedding and embodying meaning in the sensorised object and visitors' gestures.

This article examines the aforementioned categories from another point of view, specifically analysing them in terms of their ability to stimulate user interaction, suggesting what visitors should do in order to trigger content. In other words, we study the agency of tangible and embodied interaction systems and the relations they establish with visitors.

A literature review about the agency of things

The concept of 'agency' refers to the ability of an agent to act, in the sense of producing effects in the world. Traditional sociological accounts view the concept of agency as applying only to human beings (Kaptelinin and Nardi, 2009, p. 236), arguing for 'an asymmetric distribution of agency – all to human beings, none to the material world' (Pickering, 1993, p. 562). In a world in which 'modern technology behaves independently and flexibly in ways that traditional tools do not' (Kaptelinin and Nardi, 2009, p. 237), however, the vision in which it is 'only people who are doing the acting' (Shaffer and Clinton, 2006, p. 289) becomes untenable (Pickering, 1993). Various theories have therefore emerged that challenge this traditional view, albeit in different ways. Actor–network theory, for example, following

the principle of 'generalized symmetry' (Latour, 1992) 'insists there is no difference between human and non–human agents: human and nonhuman agency can be continuously transformed into one another' (Pickering, 1993, p. 565). According to other theories, the 'perfect symmetry' postulated by actor–network theory is limiting because it fails to consider the different ways human beings and things have of acting, namely the fact that 'We humans differ from nonhumans precisely in that our actions have *intentions* behind them, whereas the performances (behaviours) of quarks, microbes, and machine tools do not' (Pickering, 1993, p. 565).

Alfred Gell's anthropological theory of art, described in his book *Art and Agency* (Gell, 1998), proceeds in a similar direction. The theory attributes agency not only to people but also to works of art but, while artists can be defined as 'primary agents' by virtue of being intentional beings, art objects are considered 'secondary agents' that acquire their agency 'once they become enmeshed in a texture of social relationships' (Gell, 1998, p. 17).

Concepts related to the agency of things can also be found in the material culture research developed by the anthropologist Daniel Miller and summarized in his book *Stuff* (Miller, 2010)*.* He argues that 'in material culture we are concerned at least as much with how things make people as the other way around' (Miller, 2010, p. 42). According to this view, things have a power, that of setting the scene or 'frame': they 'make us aware of what is appropriate and inappropriate' (Miller, 2010, p. 50). An interesting aspect Miller points out is what he calls the 'humility of things', the fact that things have more capacity to determine certain behaviours 'the less we are aware of them' (Miller, 2010, p. 50).

The design and interaction design literature also offers a rich store of reflections about the *agency* of things and their ability to act. The concept of agency is explicitly analysed in the work of Kaptelinin and Nardi (2009). Applying the principles of activity theory, the scholars propose a theoretical formulation that 'retains the asymmetry of subject–object dichotomy' (Kaptelinin and Nardi 2009, p. 251) by proposing 'the notion of *levels of agency,* an understanding of agency as a dimension rather than a binary attribute' (Kaptelinin and Nardi 2009, p. 247). In other words, different agents (i.e. natural or cultural things, natural or cultural nonhuman living beings, human beings, social entities) are characterized by different levels or types of agency, namely 'conditional agency', 'need–based agency' and 'delegated agency'. 'Conditional agency' refers to the ability to produce unintended effects and applies to any type of agent. 'Need–based agency' refers instead to the agent's ability to act according to its own biological or

cultural needs, and applies to human beings, higher animals and social entities, although in different ways due to the different nature of these entities. Finally, 'delegated agency' refers to the ability of agents to 'realize the intentions' (Kaptelinin and Nardi 2009, p. 246) that are delegated to them 'by somebody or something else' (Kaptelinin and Nardi 2009, p. 248). Delegated agency applies to cultural things and living beings.

The design literature also implicitly contains other reflections on the agency of things, the ability of objects to determine specific behaviours in people and the role designers play in shaping the agency of things. For example, the notion of 'affordance', originated in ecological psychology (Gibson, 1977, 1979) and applied to design by Donald Norman (1988), suggests that, in order to design objects that are intuitive for people to use, designers should exploit 'the perceived or actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used' (Norman, 1988, p. 9).

Akrich develops another significant contribution in *The De–Scription of Technical Objects* (Akrich, 1992) when he compares the role of the designer to that of a script writer conceiving of objects which, 'like a film script, [..] define a framework of actions together with the actors and the space in which they are supposed to act' (Akrich, 1992, p. 208). This is also connected to the concept of 'persuasive design', the idea that 'design can be seen as inherently persuasive and that objects can be understood as a kind of arguments in material form' (Redström, 2006, p. 121).

While the aforementioned contributions highlight the ability of design to shape the agency of objects and the behaviour of the people who will use them, some scholars also reflect on the fact that things do not always produce the intended effects. Divergence between intended and actual effects can occur because 'there is a certain dialogue going on: the designer proposes certain things through the designed thing and the user accepts, refutes or modifies these in relation to her own position. In practice results of such dialogue can be seen in the often–unpredictable discrepancies between intended and actual use' (Redström, 2006, p. 115). Similarly, Akrich points out that 'it may be that no actors will come forward to play the roles envisaged by the designer. Or users may define quite different roles of their own' (Akrich, 1992, p. 208).

Endorsing the general position of those theories that view the concept of agency as applying also to things (Akrich, 1992; Gell, 1998; Kaptelinin and Nardi, 2009; Latour, 1992; Miller, 2010; Norman, 1988), the aim of this paper is to study the agency of tangible and embodied interaction systems

applied to cultural heritage. In particular, taking the categorization of agency proposed by Kaptelinin and Nardi (2009) as starting point, we offer an initial exploration of the nature of these kinds of artefacts as a basis for laying out the specific objectives of the analysis. In doing so, we refer to the notions of levels of agency and types of agents proposed by the two scholars we have mentioned above. To conclude, we present some reflections as a basis for orienting future research.

Analysis of the agency of different categories of tangible and embodied interaction systems

Before analysing each category of tangible and embodied interaction systems, a reflection on the nature of these kinds of interfaces is required.

Following the categorization of agents and forms of agency proposed by Kaptelinin and Nardi (2009), tangible and embodied interaction systems can be interpreted as 'Things', namely 'Cultural Things', provided with 'conditional' and 'delegated agency'. Indeed, these systems are artefacts and, as such, they are not characterized by 'need–based agency'.

Studying the agency of these things therefore means analysing their ability to realize – or not – the intentions of those who imagined, created and programmed them. But what are the intentions of designers?

Among the possible and varied intentions designers might have, in this paper we focus on two intentions we believe to be generally common to most kinds of interactive systems, namely: 1) the intention of designers to stimulate interaction with their systems; 2) the intention of designers to suggest the right behaviour for interacting with the systems and triggering their content. These aspects are analysed with reference to four paradigms of tangible interaction systems – (i) smart replicas/originals, (ii) symbolic objects (iii) codified gestures and (iv) performing gestures – with an eye to understanding how designers translate their intentions into the materiality of different categories of tangible interaction systems.

1) smart replicas/originals

The first category of tangible interaction systems includes projects that employ manipulable and sensorised original cultural assets or their copies to trigger digital interpretive content. By embedding sensors in the objects on display, designers define the behaviour of the artefact and consequently seek to delineate the behaviour of the users who will manipulate it.

The specificity of the interactive systems in this category is that, being original cultural assets or their reproductions, they have a well–defined physical shape. Given this unique trait, the design intervention can only partially intervene on the physical appearance of the interactive objects and must focus primarily on what users can do and on what they consequently attain. Especially when dealing with smart originals, designers have the duty of communicating that touching is not only allowed but required, going beyond the unspoken rule that visitors must not touch objects in museums.

Indeed, these interactive originals/copies usually need to be handled, manipulated and sometimes touched to trigger digital interpretations. An example can be found in the temporary exhibition *Fragments of memory* that displays smart originals related to farming. By touching the exhibition assets, visitors can activate light effects and cause the objects to tell the stories of farmers, evoking the atmosphere of past times.

The agency of smart originals is not always clear, since the cultural asset on display does not necessarily ask to be touched and manipulated, especially if it pertains to the category of recognised artworks such as sculptures, paintings and bas–relief which are not usually accessible to visitors. Accordingly, designers enact strategies to trigger actions such as providing written instructions or catching visitors' attentions with sounds, light effects or video–mapping.

At other times, smart objects plainly declare themselves to be interactive systems. This is the case with smart replicas, which are usually different in size and/or material from the originals and have integrated sensors and buttons. An example of this is the VIRTEX presentation method (Capurro, Nollet and Pletincks, 2015), that uses 3D–printed scaled replicas of statues, buildings and objects to control the movements of a 3D model and buttons to start videos.

Although it is evident that these objects must be handled and touched, there is a different issue designers must cope with in that the effect of manipulation is not easily intelligible. Handling a replica of a statue does not necessarily mean activating videos, triggering audio descriptions or rotating a 3D model, and it is up to designers to help users understand what actions they must perform to trigger content and what they will obtain from manipulating the smart objects.

2) symbolic objects

The second category of tangible and embodied interaction systems uses the same mechanics as the first category – manipulating objects to trigger

content – but the smart objects lose any formal reference to the objects on display. Accordingly, designers are empowered in that they can act on both the formal character of smart objects and the visitor behaviours triggered by these objects.

The projects included in this category are very diverse and adopt various strategies to trigger action. Some of them focus on the interactive object, treating it as the product of a design action and, as such, aim for high levels of communicativeness and easy handling.

Some of the objects produced by the above–cited meSch project (Petrelli et al., 2013b) follow this approach proposing co–designed smart objects. An example is *The Loupe* (Van der Vaart and Damala, 2015), an augmented reality device masked as a magnifying lens that allows visitors to access interpretive digital content about the objects on display by using it as its shape suggests. In this case, designers rely on the evocative power of a universally recognised shape, that of the magnifying lens, to make people behave as planned, namely to look at the objects on display through the lens and activate interpretive content.

Other projects employ smart objects for their evocative power, that is, their significance in relation to the objects on display. The meSch project also offers an example of this: the exhibition *The Hague and the Atlantic Wall: War in the City of Peace* at the Museon in The Hague (Marshall et al., 2016), focused on the story of the Atlantic Wall and its impact on the city and its citizens told from three different viewpoints: Dutch civilians, Dutch civil servants and German soldiers. Six objects have been selected from among those on display to tell the three stories in Dutch and English: a tea bag (Dutch) and sugar packet (English) for the civilian, a travel pass (Dutch) and armband (English) for the civil servant and, finally, a drinking mug (Dutch) and dictionary (English) for the German soldier. Stories are triggered when visitors place copies of the objects, embedded with RfID tags, over pods. There is no formal difference between this kind of smart object and those in the first category – they are actually smart replicas – but they are employed for their evocative power and not as copies of artworks. From a design perspective, there is no difference between smart replicas and symbolic objects of this kind: the differentiation lies in the curatorial choice and the meaning–making ideally triggered by interaction.

Shifting the focus to the ability of these sensorised objects to prompt users to act 'correctly', we must note that visitors' responses are not always straightforward. In analysing user interactions with the system, researchers from MeSch have found that not all visitors immediately grasped the correct

mechanics of interaction even though instructions were clearly posted in both Dutch and English. The action of placing a mug or a travel pass on a pod, the hotspot, is not natural or embedded in the objects themselves.

3) codified gestures

The third category brings us into the world of embodied interaction, as it encompasses examples that employ gesture–based interaction to control and activate interpretive content about the objects on display.

For instance, explicit and codified movements captured by sensors are at the basis of the Gallery One exhibition by Local Project at the Cleveland Art Museum (Alexander, Barton and Gesser, 2013).

The *Sculpture Lens* installation works by capturing the facial expressions of visitor and showing artworks with similar expressions, while *Strike the pose* asks visitors to assume the same pose as sculptures and paintings in the collection with the aim of achieving the most accurate pose.

In other cases, gestures lose any direct relation to the artwork and become a sort of alphabet understood by the computer. This is the case with *Etruscanning – Digital Encounters with the Regolini–Galassi Tomb,* which lets visitors move virtually within the tomb and experience a digital encounter with a highly realistic VII century B.C. construction by performing a list of codified gestures.

The designers' role lies in defining what kind of gestures visitor should perform to trigger interpretive content or modify the state of the digital system, be they related to the object on display – as in *Gallery One* – or free gestures. Designers are in charge of the aesthetics of the interaction and the expressiveness of the gestures, using visitors' bodies as an input system.

In the two projects described above, the agency of the interactive system is not well recognizable in that visitors only understand what to do after reading the instructions. There is a question about the ability of the system to easily communicate the gestures visitors must perform to obtain the desired action in the digital sphere, making them simply recognized, understood and remembered.

4) performing gestures

Gestures lose codification in the fourth category, 'performing gestures', which comprises projects that prompt visitors to perform bodily movements that are meaningful in relation to the assets on display.

Not related to an alphabet of codified gestures, these movements can be imbued with meaning and become representative and symbolic of a value connected to the artwork or cultural practices.

The *Drinking symposium* installation at the Allard Pierson Museum of Amsterdam exemplifies this category. Made of a wall projection representing virtual characters taking part in a drinking symposium in Ancient Greece, a 3D printed replica of a Greek drinking bowl (kylix) and a reproduction of a Greek daybed, it prompts users to sit on the bed and lift the kylix, both embedded with sensors. By lifting the kylix, visitors animate a virtual character that lifts his kylix, toasts and drinks wine. When the bowl is put down a woman in the virtual scene plays the flute, and when a visitor sits on the daybed one of the animated figures plays a game popular in ancient Greece (kottabos) by launching a drop of wine from his cup toward a stand in the middle of the room.

Designers are asked to go a step further than the role they play in the third category. They can define what gestures visitors will perform and, in addition, verify whether those actions are meaningful and add to the comprehension of the objects on display. On the contrary, they can begin analysing actions that might be meaningful for the asset and introduce them into the system.

The aforementioned installation clarifies this concept: the actions performed by visitors have roots in an ancient past and help them to grasp not only the aesthetic quality of the assets on display in the museum but also their intangible value, such as their use and significance as part of a ritual.

In this case the sensorised objects play an important role in suggesting to visitors what they can do, in an effort to overcome the limitations of the installations described in the third category. A daybed suggests the action of reclining and the kylix should invite people to lift it, assuming of course that visitors have the cultural background needed to easily grasp how ancient objects should be used or have been informed by bespoke paratextual apparatuses. As in the case studies discussed above, *The Drinking Symposium* triggers visitors' actions by means of labels and instructions, thereby enforcing the agency of the smart objects.

Discussion and conclusions

The analysis of the four categories of tangible interaction presented above outlines and discusses diverse ways of affecting visitor behaviour and

fostering interaction. Nevertheless, to shed light on the diversities and specificities of the four categories we need to consider in more depth *how* they achieve these effects.

All four kinds of embedded and embodied interaction systems have in common the presence of rich instructions that inform users how to behave to obtain the desired outcome. Indeed, the case studies presented above as representative of the different categories all involve a need to explicitly apprise visitors that interaction is possible and how to achieve it.

In fact, rich labels can be interpreted as a way of enforcing or substituting the agency of the interactive artefact and its effects on users.

In the first category – smart originals/replicas – instructions play the important role of telling visitors: 'Please touch, interact and manipulate without fear'. In other words, labels act on visitors by triggering interaction, as the interactive objects are normally associated with visual contemplation alone.

Labels and instructions play a slightly different role in category two: they not only clarify the function of smart objects, they also modify visitors' usual behaviour with known objects. The example of the mug to be placed on a pod is emblematic of this: without instructions, the mug does not necessarily ask to be placed in a specific spot.

Instructions play an even more central role in category three, since these systems lack objects that would somehow suggest actions. Instructions even become a sort of training aid in *Etruscanning,* modelling the correct gestures that will allow users to properly explore the virtual environment.

In the fourth category, we can distinguish between instructions that plainly communicate the actions to be performed (e.g. 'pick me up' in the *Drinking symposium*) and the paratextual apparatus aimed at providing visitors with background information about the meaning of the gesture they will perform.

This need for a rich paratextual apparatus characterising all the categories may seem to be a secondary aspect, but it may also be interpreted as a symptom of the fact that these systems are still in the initial stages of development. On the one hand, it may suggest the inexperience of visitors unused to interacting with these kinds of interactive artefacts.

On the other hand, it may also betray a certain naivety on the part of designers in creating tangible and embodied interactive systems. That is, using text and explanations to clarify how an interactive system works might mean that designers, and interaction designers in particular, failed to

correctly or fully exploit the persuasive power of design (Redström, 2006) and the agency of designed objects.

However, another possibility to consider is that systems based on embedded and embodied interaction cannot avoid the use of labels and/or a paratextual apparatus to guide users' actions.

This apparent weakness in such systems represents the starting point for a reflection on the role of designers in creating experiences based on tangible interaction. It is also the basis for future investigations aimed at shedding light on this point and defining guidelines for designers involved in the creation of such systems.

References

Alexander, J., Barton, J. and Gesser, C. (2013). Transforming the Art Museum Experience: Gallery One. In Proctor, N. (ed.) *Proceedings Museums and the Web 2013*. Toronto: Archives & Museum informatics.

Akrich, M. (1992) The De–scription of Technical Objects. In Bijker, W.E. and Law, J. (eds.) *Shaping Technology/Building Society*. Cambridge: MIT Press.

Bannon, L., Benford, S., Bowers, J. and Heath, C. (2005) Hybrid Design Creates Innovative Museum Experiences. *Communications of the ACM*, 48 (3), 62–65.

Capurro, C., Nollet, D. and Pletincks, D. (2015) Tangible Interfaces for Digital Museum Applications. In *2015 Digital Heritage Proceedings*. IEEE.

Chatterjee, H. (2008) *Touch in Museums: Policy and Practice in Object Handling.* Oxford/New York: Bloomsbury Academic.

Ciolfi, L. and Bannon, L.J. (2005) Space, Place and the Design of Technologically–Enhanced Physical Environments. In Turner, P. and Davenport, E. (eds.), *Spaces, Spatiality and Technology*. Amsterdam: Springer Netherlands.

Dudley, S.H. (ed.) (2012) *Museum Objects: Experiencing the Properties of Things*. London/New York: Routledge.

Duranti, D., Spallazzo, D. and Trocchianesi, R. (2016) Tangible Interaction in Museums and Temporary Exhibitions: Embedding and Embodying the Intangible Values of Cultural Heritage. In *Proceedings of the 6th International Forum of Design as a Process*. Valencia: Editorial Universitat Politècnica València.

Gell, A. (1998) *Art and Agency. An Anthropological Theory*. Oxford: Clarendon Press.

Gibson, J.J. (1977) The Theory of Affordances. In Shaw, R. and Bransford, J. (eds.) *Perceiving, Acting, and Knowing: Toward an Ecological Psychology*. Hoboken: John Wiley & Sons.

Gibson, J.J. (1979) *The Ecological Approach to Visual Perception*. Boston: Houghton Mifflin.

Hornecker, E. and Buur, J. (2006) Getting a Grip on Tangible Interaction: A Framework on Physical Space and Social Interaction. In Grinter, R., Rodden, T., Aoki, P., Cutrell, E., Jeffries, R. and Olson, G. (eds.), *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. New York: ACM.

Hsieh, C.K., Liu, I.L., Yu, N.H., Chiang, Y.H., Wu, H.T., Chen, Y.J. and Hung, Y.P. (2010) Yongzheng Emperor's Interactive Tabletop: Seamless Multimedia System in a Museum Context. In *Proceedings of the 18th ACM International Conference on Multimedia*. New York: ACM Press.

Ishii, H. and Ullmer, B. (1997) *Tangible Bits: Towards Seamless Interfaces between People, Bits and Atoms*. New York: ACM Press.

Latour, B. (1992) One Turn after the Social Turn. In McMullin, E. (ed.) *The Social Dimensions of Science*. Notre Dame: Notre Dame Press.

Kaptelinin, V., Nardi, B.A. (2009) *Acting with Technology: Activity Theory and Interaction Design*. Cambridge/London: MIT Press.

Marshall, M.T., Dulake, N., Ciolfi, L., Duranti, D., Kockelkorn, H. and Petrelli, D. (2016) Using Tangible Smart Replicas as Controls for an Interactive Museum Exhibition. In *Proceedings of the TEI '16: Tenth International Conference on Tangible, Embedded, and Embodied Interaction*. New York: ACM Press.

Miller, D. (2010) *Stuff*. Cambridge: Polity Press.

Norman, D.A. (1988) *The Psychology of Everyday Things*. New York: Basic Books.

Petrelli, D., Ciolfi, L., van Dijk, D., Hornecker, E., Not, E. and Schmidt, A. (2013a) Integrating Material and Digital: A New Way for Cultural Heritage. *Interactions*, 20 (4), 58–63.

Petrelli, D., Dulake, N., Marshall, M., Willox, M., Caparrelli, F. and Goldberg, R. (2013b) Prototyping Tangibles: Exploring Form and Interaction. In *Proceedings of the 8th International Conference on Tangible, Embedded and Embodied Interaction*. New York: ACM Press.

Pickering, A. (1993) The Mangle of Practice: Agency and Emergence in the Sociology of Science. *American Journal of Sociology*, 99 (3), 559–589.

Pye, E. (ed.) (2008) *The Power of Touch: Handling Objects in Museum and Heritage Context*. Walnut Creek: Routledge.

Rawat, T. J. (2005) Wonder Objects – Magic and Interactive Storytelling. In *Third International Symposium of Interactive Media Design*. New York: ACM.

Redström, J. (2006) Persuasive Design: Fringes and Foundations. *Lecture Notes in Computer Science,* 3962, 112–122.

Shaffer, D.W. and Clinton, K.A. (2006) Toolforthoughts: Reexamining Thinking in the Digital Age. *Mind, Culture, and Activity*, 13 (4), 283–300.

Van der Vaart, M. and Damala, A. (2015) Through the Loupe: Visitor engagement with a Primarily Text–based Handheld AR Application. In *2015 Digital Heritage Proceedings*. IEEE.

Highlighting Issues in Current Conceptions of User Experience Design through Bringing together Ideas from HCI and Social Practice Theory

Ruth NEUBAUER[*a], Erik BOHEMIA[a] and Kerry HARMAN [b]

[a] Loughborough University London; [b] Birkbeck University of London

A socio–technical reconceptualisation of use, and the active roles of the material and users in design prompt us to question professional designers' roles and agencies within the wider realm of social (re)production. This paper focuses on bringing together key concepts of UX design and theories of practice, and pointing out some challenges that lie ahead of professional designers in the conception of their work. Theories used in HCI and historical legacies of production models may limit a full conception of 'experience' – or a locating of the social 'motor'– that can bring change about, as well as 'hide' other factors that make up professional design. We argue that there are limitations with current theories underlying design practice, and that the commonly conceived concept of agency in design and use, and the ontological place allocations of the professional designer and the user in the mechanisms of social (re)production need to be revisited. An investigation of professional designing as a social practice can serve the purpose to illustrate alternative conceptions of agency in professional designing, and help designers to be more aware of the social dynamics in their work.

Keywords: UX; UX design; professional design practices; digital technology

Introduction

At the present moment, the realms of design are subject to much debate. Design's endeavours to be part of the larger developments of business and innovation create a pressing need to build and extend

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[*] Corresponding author: **Ruth Neubauer** | e–mail: **r.neubauer@lboro.ac.uk**

theoretical foundations (Kimbell, 2012). A feeling of crisis emerges when on the one hand designers in practice have to deal with changing production circumstances of which they are not necessarily master (Miller, 2014), and when on the other hand in theory and education, design research struggles to define its agenda, subject matters and topics (Krippendorff, 2006; Margolin, 2013).

In the field of designing for digital technology and human–computer interaction (HCI), the conceptualisation of the user has undergone change from being seen as merely a cog in a rational system to the user becoming a creative consumer (Kuutti, 2001). The rise of user experience design can be seen as part of this development, although questions are being raised about the fitness of theories underlying user–centred design to deal with the social aspects of 'experience' (McCarthy and Wright, 2004). User–centred design has a certain understanding of social existence and of human agency, which have been challenged in the social sciences, for example by concepts of the indeterminate nature of action (Suchman, 1987), the creative capacity of users in everyday activity (Warde, 2005), and the role that the material plays in how things come to be (Bijker, 1992; Latour, 1990).

When Shove, Watson, Hand, and Ingram (2007) claim that professional design practice embodies and perpetuates an outdated theoretical model of social existence and change, we take this up as a prompt to take a closer look at the ideas of professional designing. A practice–theoretical examination of professional design practice can lend itself as another angle of illustrating new sociological approaches to explaining design, innovation and social change. These different ways for conceiving design practices also enable a rethinking of 'user experience'.

This paper is the beginning of an exploration of the implications for professional design practice when the material and every day use are treated as active factors in innovation and in the process of how products and services come to be. When social scientists start redefining agency in use and consumption practices, what does this mean for professional design practices? We review relevant concepts from the social sciences and working concepts from industry practice. We want to build up the basis on which an empirical investigation can be launched.

UX design and social theories

The particular field of design we are going to focus on is UX (user experience) design. The reason for choosing UX, firstly, is that the UX

community is a very distinct community within user–centred design and HCI (human computer interaction), with its own publications, conferences and vivid debates about its purpose, realm and theoretical foundation. UX design as a distinct profession has not been around for very long, and has a relatively short history to overlook and make sense of. Secondly, one of the authors of this paper has been working in HCI and subsequently UX design for over a decade and brings therefore considerable practical knowledge of the industry and ongoing debates to this discussion.

We are taking a brief look at the guiding concepts of user experience design practice, and then, as proposed by Shove et al. (2007), we are introducing practice–focused ideas. We later start putting them into relation with each other.

UX design has got its main ancestral paths in HCI (Hassenzahl, 2008; Nielsen, 2000; Norman, 1988), and ergonomics (see Singleton, 1974), coming out of the tradition of user–centred design (see Dreyfuss, 1955). The theoretical foundations of UX are mainly located in cognitive and behavioural psychology, within the understanding that agency (the capacity to act) is located with the individual human being (see Norman, 1988; Weinschenk, 2011). Here, objects, constraints, social contexts and the human body are crucial factors, but the processing of how to proceed in the world happens in the mind, based on and surrounded by the individual experience. 'Experience' is now treated as an important asset of contemporary business strategy, materialised in the shape of experience maps and blueprints, connecting the customer experience with business opportunities (Brown, 2009, p. 126). Design activities within organisations serve the purpose of enabling better user experiences (Garrett, 2011).

Both in science and technology studies (STS) and in practice theories, social ontology (what the social is made up of) and agency are explained differently to most other social theories. Both suggest there not being a micro or a macro level of social phenomena, but that the entirety of social affairs happen along the same spatio–temporal level – there is nothing 'above' and nothing 'below' (Schatzki, 2011, p. 14). In their accounts agency does not reside with humans alone but is distributed across human–material constellations. For Schatzki, agency emerges from bundles of social practices and material arrangements. He sees social practices as nexuses of human activities – open–ended doings and sayings that are organised by understandings, teleologies (ends and tasks), and rules (Schatzki, 2011). These doings and sayings are carried out by humans which are part of

material arrangements. It is through this hanging together of material entities and practices, that social life transpires, and constitutes how things are and are going to be. Reckwitz (2003) analyses that with the claim that practical doings and sayings constitute action (as opposed to thought and cognition), practice theories position themselves as an alternative to the traditional social theories which have in their view a too 'intellectualised' understanding of social existence. Practice theories do not rely on dichotomies such as mind and body, or subject and object. The status of the respective second element (body, object), which in traditional dualism loses out against the primacy of the first element (mind, subject), is rehabilitated in practice theories' understandings of both elements being indispensable components of social existence (p. 291). Practices are a mode of ordering of everyday life (Gherardi, 2006, 2012), and the material is bound up in this organising in an integral way which is just as open and indeterminate as human action (Orlikowski, 2007). What's more, and what distinguishes practice theory also from other practice–focused concepts such as the 'communities of practice', is that the social world is not 'preconstituted' by a structuring context, but is 'actively constructed in 'situational frames'' (Gherardi, 2012, p. 26). This view makes practice theory a useful tool for analysis of everyday interactions and their ordering principles.

This paper argues that alternative theories of social existence and change, that do not accept the primacy of the human mind and of human agency in the determination of what is happening in the world (Coole and Frost, 2010; Harman, 2016; Schatzki, Knorr Cetina and Von Savigny, 2001) highlight challenges and issues in the current conceptions of user experience design. We are going to illustrate these areas of concern by bringing together practice theory ideas with concepts of user experience design. The first challenge is that 'experience' remains a largely vague concept in guiding the designing of it. Secondly, it is assumed that experience can be represented like an object. The third issue which deserves a critical look is the assumption that the user's behaviour is driven by choice, just as the design outcome. And directly related to this is, fourth, the possibility that neither use nor design outcomes work in a rational manner, and that what divides users and designers may be different elements to those commonly assumed.

What is UX?

What is UX? This question has been asked all over the web (e.g. UX Mastery, 2012) and in scholarly articles (Law et al., 2009; McCarthy and Wright, 2004) since UX existed. Hassenzahl and Tractinsky (2006) summarise as follows:

'UX is about technology that fulfils more than just instrumental needs in a way that acknowledges its use as a subjective, situated, complex and dynamic encounter. UX is a consequence of a user's internal state (predispositions, expectations, needs, motivation, mood, etc.), the characteristics of the designed system (e.g. complexity, purpose, usability, functionality, etc.) and the context (or the environment) within which the interaction occurs (e.g. organisational/social setting, meaningfulness of the activity, voluntariness of use, etc.)' (Hassenzahl and Tractinsky, 2006, p. 95).

UX clearly brings some headway in between itself and HCI's concept of user needs and the usability of systems. It is 'more than' just user needs. This expansion from the realm of traditional HCI to what UX designers are dealing with when designing for 'experience' appears to be well detailed in the elements it is made up of, but lacks an explanation of how these internal states, product characteristics, and new elements such as context, play together in a 'subjective, situated, complex and dynamic encounter' and in what way the designer should be concerned with it. The contextual factors mentioned are presented as the supplement that sets UX apart from traditional HCI, but for that matter they are explained relatively little. Designers are only reminded to 'keep in mind' the other human goals. It seems that UX designers, in their work of designing for experience, are left to fall back to methods from traditional HCI (on user needs and the usability of systems), from before the realm of design was expanded to 'user experience'. For example, it is not clear in user experience design literature whether designers design *the* user experience or *for* user experience? While some accounts clearly advocate for designers taking control over the user's experience (Garrett, 2011; Nielsen, 2000), others at least put a question mark to whether the designer can exert so much control (Hassenzahl and Tractinsky, 2006, p. 94). In any case, a claim to be able to design *the* user's experience, would be ignoring social sciences research that has been done on the situated and indeterminate character of interaction (Suchman, 1987), that interactions cannot be planned for, and would be a 'return to the simplicity of a technologically determinist position on what experience is' (McCarthy and Wright, 2004, p. 10).

Overall, there is no clear 'textbook' advice on whether and how to design the experience. The general consensus amongst practitioners about UX reflects still the concepts coming from traditional HCI (Law et al., 2009). HCI, firmly committed to usability still, is not equipped to dealing with experience, say McCarthy and Wright (2004, p. 6). It seems that this moving beyond needs, this acknowledgement that there is more than just the relationship 'human–machine', requires a theory or concepts which have not yet been found and appropriated by user experience design.

Experience as representation

Scientific theorising supports the world view that things are fixed, whereas design assumes that things are improvable and changeable (McCarthy and Wright, 2004, p. 20). Therein lies a conflict, which must sit very uncomfortably with UX design. On the one hand UX design uses HCI's theories to research user needs, which are treated as fixed, but on the other hand it attempts to improve the user experience, which is described as a 'subjective, situated, complex and dynamic encounter' (Hassenzahl and Tractinsky, 2006, p. 95). Superficially it may look like as if designers could escape this discrepancy all together, because designing is rarely treated as a scientific activity. But as soon as designers actively try to understand how an object is going to be used and experienced, they are involved in tacit or explicit representations of future action and experience – via service blueprints, experience maps, user journeys and scenarios etc. How does this fit together?

UX design's idea that experience is a situated and dynamic encounter seems to be better aligned with constructivist ideas of the social sciences, which assume that reality is a co–construction in interaction between people and artefacts (Knorr–Cetina, 1981; Suchman, 1987). Action is here described as something that emerges in practice through organising, and cannot be represented as a plan, because of the many contingencies that arise as action unfolds over time (Gherardi, 2006, p. xiii).

'There is nothing behind the appearances encountered in experience. Appearances are not simply how something manifests itself to us, at the same time 'holding back' something of itself. Experience is the area in which reality shows itself as what in itself it is.' (Schatzki, 1996, p. 28).

But we do not know what these alternative conceptions of action and experience mean for the wider practice of professional UX design which currently rely on objective representations of use and experience. UX design

as it stands has been drawing from scientific theories postulating reality as fixed, and action as guided by intention and planning (see Norman, 1988). Hassenzahl, Diefenbach and Göritz (2010) acknowledge experiences as something unique and never returning, but conclude that if it was not possible to represent experience and action, it would be the 'end of story for experience in HCI, because designing for bygone and unrepeatable experiences is futile' (p. 354). It may indeed be the end of story of experience in traditional theories used in HCI, but it may be the beginning of trying out other theories, which do accommodate change and situated fluidity in action.

Agency and experience

HCI's traditional theories presume that people act with intention. Norman (1988) describes in his '7 stages of action' how humans perceive the world, interpret it, evaluate it, form goals, make intentions, plan actions, and bodily execute their plans. HCI assumes that humans are rational agents who shape the world around them. But if we just consider how 'stuff' is involved in 'creating new practices and with them new patterns of demands' (Shove et al., 2007, p. 10) then this poses a real challenge to HCI's notion that agency is sitting with the intentions and capacities of the human mind and body alone.

In sustainability research, it was shown that energy consumption research focussed on people's attitudes and behaviour did not sufficiently explain consumption patterns (Gram–Hanssen, 2009). Instead, looking closely at how people live their practical lives, what material and what meanings are involved in everyday activities, gives a much clearer picture of how innovations are taken up by people, and sustained (Shove and Pantzar, 2005). Practice theoretical concepts trace how elements in people's lives bundle to practices and arrangements. The closer elements are linked within a practice, the more often they are repeated, and the more interlinked they are with other practices, the more likely it is that practices are sustained, and the harder it is to change them (Schatzki, 2002). As an example of a shared material across multiple practices let's envisage tooth brushes. Let's claim tooth brushes are part of the practice of tooth brushing and part of the practice of tile grout cleaning. If we wanted to support – say an innovation in cleaning teeth (maybe because we have identified a problem with the state of people's teeth) – and we looked at the social practice of

tooth cleaning and its material elements, we might find that toothbrushes have other uses too, such as household cleaning. And if tooth brushes were removed from the new method of cleaning teeth, it might lead to the use of harsher cleaning detergents on tile grouts. Or the new method might not be successfully taken up because people take for granted their grout cleaning routine as it is. In any case, the point is that it is likely that such a potential link would not show up in a behavioural analysis on users' tooth brushing routine.

If UX design really deals with 'more than' just user needs (Hassenzahl, Diefenbach and Göritz 2010), basically extending product design's realm of pure usability concerns to embracing the entire life context of product and user, then it needs to extend its methods of investigation, and look beyond users' attitudes and behaviours. Looking at people's lives, at the practices involved, including material arrangements, are much more likely to give a clear picture of why things are as they are and how they can change.

Designers and users – are we all just the same?

The statement that UX design has to move beyond treating user needs as fixed, also has a direct implication for UX design's work methods of facilitation and creation of ideas, solutions and artefacts. In HCI it is commonly assumed that designers' work is to understand users (see Portigal, 2013) and to identify users' goals, reasoning, reactions and guiding principles (see Young, 2008; Young, 2015), and to then apply this knowledge to products and services. Young (2015) calls the process of enriching products with user knowledge 'to apply empathy' and it is interesting how she proposes to do the very same thing within the organization with co–workers. A blurring of lines is beginning to show here. Why would a user–research method be applied to co–workers within the same production process? Further blurred are the lines in service design, when the talk is of 'highly complicated networks of people inside and outside the organization. The staff who interact with customers are also users […]' (Polaine, Lovlie and Reason, 2013, p. 36).

Designers and users – who are they exactly, and how is the distinction made? Perhaps it is useful to look at the history of these bounded entities, 'the designer' and 'the user': Kuutti (2001) describes how the concept of 'the user' has changed over the decades, influenced by various disciplines of study and thought: The user as a cog in the rational machine; the user as a source of error; the user as a partner in social interaction; the user as a

consumer. This continuous change in the conception of the user over time, has opened the concept up to imagining users today as active participants in the design of their everyday lives (Warde, 2005). Woolgar's investigation of design practices in a micro–computer manufacturing organisation (1991), show the boundary between the 'inside' of the organisation and the 'outside' of it as what defines the 'designer' and the 'user'. It does become obvious how deliberate this boundary is configured by the producing organisation and hence becomes a defining property of the relationship to the 'user'.

Dividing lines between designer and user are arbitrary and are perhaps better seen as relicts from production models utilised in mass production, where specialisation of work tasks meant that users were removed several links in the chain linking use with retail, production and design (Bohemia and Harman, 2008; Hysaalo, 2009). In today's world of technology design and consumption, the old bounded entities of 'user' and 'designer' are perhaps more appropriately reassigned to activities such as 'using' and 'designing', both of which involve humans, whether they are consumers of technology, or professional designers of technology.

To return to the example of 'toothbrushes': the humans who design toothbrushes and the humans who use toothbrushes are likely to overlap. There are different practices in which toothbrushes are involved; the practices of earning money, for example, and the practices of tooth brushing, or the practices of tile grout cleaning. But the humans involved can be the same. Those who want to making money out of toothbrushes may also use them to clean their teeth. And those who clean their teeth may also make money out of their fine–looking teeth. And those who use tooth brushes for teeth cleaning, may also creatively assign them to the use of tile grout cleaning, which is itself an act of designing.

But: 'If everyone is a designer, to what special expertise does the profession lay claim?' (Shove et al., 2007, pp. 136–138). The concept of design is changing, and professional design is still catching up. Perhaps it is time for professional design to look beyond the conception of the designer as the agent of design? Without challenging the need of professional design, it is certainly time to regard what professional design practice is made up of, and how its elements create design outcomes.

'Product designers rarely determine what gets made, but their working methods embody and reproduce ideas and concepts that matter for the detail of material culture and for the practices of which it is part' (Shove et

al., 2007, pp. 136–138). UX design as it stands, focuses on the product characteristics and on the users' experience. Our earlier point was, that UX design comes short of a theoretical concept that allows to focus on the social context of use. But rather than following down that road, we propose to take a step back to take a look at the social context of design, and ask: In what way are designers' own materials and tools, and designers' own tasks, rules and understandings influential on the outcomes of design?

Conclusion

We argued that there are four challenges with current conceptions of UX design, and put them in context with social theories of practice. This view on design as it stands, along with our own views and experience of the industry, prompt us to propose a further investigation into the practices of professional designing. Kimbell (2012) proposed the concepts 'design–as–practice' as a way of thinking about design and the social embeddedness of designers, and 'designs–in–practice' to emphasise how interwoven and unfinished designs (artefacts) are. In practice theory there are clear concepts of how experience as a 'situated, complex and dynamic encounter' (Hassenzahl and Tractinsky, 2006, p. 95) pans out in reality. Here is a theory offered for what UX design grapples with to define through current theories. Of course, these concepts challenge UX design's idea of the neat object of experience, as well as the individual agency ascribed to designers as the supposed agents of design. However, we have seen, for example, in sustainability research of energy (Gram–Hanssen, 2009) that common theories of use do not bring useful pathways of intervention for behaviour change. That the old boundaries between 'designer' and 'user' do not feel right anymore can be seen in the design literature devising methods that are being equally applied to people on the production–side, as well as people on the use–side (Polaine, Lovlie and Reason, 2013, p. 36; Young, 2015). We have also seen that the material has a significant role in how innovations come into being (Shove and Pantzar, 2005). Technology is social, and intrinsically linked with work practices (Orlikowski, 2007). When considering what design practices may be made up of, it may be possible to explain better the experience that designers have of their work, and of the organisation within which they work. It may be possible to explain how things sometimes end up working, and sometimes not. We propose to take this as an opportunity, and to define the questions of which the answers can support such an understanding and awareness of designing as a practice.

What elements make up professional design practices? How does agency emerge, if not from the supposed agent of design – the designer? And in what way does the designer engage in these practices? Work tools and materials, spatial positions like seating arrangements of team members, engagements with people (engineers, users, managers, etc.), varying things people want to achieve, varying rules and constraints of what is within the acceptable, and certain agreed understandings of the world… The relationships between all those elements, which are in flux, have an influence on designs. Or, as practice theory would say, all these elements make up the practices of designing, and outcomes in design emerge from the interplay of all these elements within practices. Such a description of the continuous encountering and negotiating between the elements contained in the practices of designing, can be helpful for designers in developing an awareness of their own experiences and how they are operating within design practices. Such an awareness may 'engender a deliberate process of learning from experience and of sharing and institutionalising it into actionable knowledge', which can enable the individual to actively participate within practices (Gherardi, 2006, p. 235).

References

Bijker, W. (1992) The Social Construction of Fluorescent Lighting, Or How an Artifact Was Invented in Its Diffusion Stage. In Bijker, W. and Law, J. (eds.) *Shaping Technology / Building Society*. Cambridge: MIT Press.

Bohemia, E. and Harman, K. (2008) Globalization and Product Design Education: The Global Studio. *Design Management Journal*, 3 (2), 53–68.

Brown, T. (2009) *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*. New York: HarperCollins Publishers.

Coole, D. and Frost, S. (2010) *New Materialisms: Ontology, Agency, and Politics*. Durham: Duke University Press.

Dreyfuss, H. (1955) *Designing for People*. New York: Simon and Schuster.

Garrett, J. J. (2011) *The Elements of User Experience: User–centered Design for the Web* (2nd. ed.). Berkeley: New Riders.

Gherardi, S. (2006) *Organizational Knowledge: The Texture of Workplace Learning*. Oxford: Blackwell Publishing.

Gherardi, S. (2012) *How to Conduct a Practice–based Study: Problems and Methods*. Cheltenham: Edward Elgar Publishing Limited.

Gram–Hanssen, K. (2009) Standby Consumption in Households Analyzed With a Practice Theory Approach. *Journal of Industrial Ecology*, 14 (1), 150–165.

Harman, K. (2016) Examining Work–Education Intersections: The Production of Learning Reals in and through Practice. *European Journal for Research on the Education and Learning of Adults*, 7 (1), 89–106.

Hassenzahl, M. (2008) *User Experience (UX): Towards an Experiential Perspective on Product Quality*. Paper presented at the IHM, Metz, France.

Hassenzahl, M., Diefenbach, S. and Göritz, A. (2010) Needs, Affect, and Interactive Products – Facets of User Experience. *Interacting with Computers*, 22 (5), 353–362.

Hassenzahl, M. and Tractinsky, N. (2006) User Experience – a Research Agenda. *Behaviour & Information Technology*, 25 (2), 91–97.

Hysaalo, H. (2009) A Break from Novelty: Persistence and Effects of Structural Tensions in User–Designer Relations. In Voss, A., Hartswood, M., Procter, R., Rouncefield, M., Slack, R.S. and Buescher, M. (eds.) *Configuring User–Designer Relations*. London: Springer–Verlag.

Kimbell, L. (2012) Rethinking Design Thinking: Part II. *Design and Culture*, 4 (2), 129–148.

Knorr–Cetina, K.D. (1981) *The Manufacture of Knowledge: An Essay on the Constructivist And Contextual Nature of Science*. Oxford: Pergamon.

Krippendorff, K. (2006) *The Semantic Turn: A New Foundation for Design*. Boca Raton: CRC Press.

Kuutti, K. (2001) *Hunting for the Lost User: From Sources of Errors to Active Actors – and beyond*. Paper presented at the Cultural Usability Seminar, Media Lab, University of Art and Design, Helsinki.

Latour, B. (1990) Technology is Society Made Durable. *The Sociological Review*, 38 (S1), 103–131.

Law, E., Roto, V., Hassenzahl, M., Vermeeren, A. and Kort, J. (2009) *Understanding, Scoping and Defining User eXperience: A Survey Approach*. Paper presented at the CHI 2009, Boston, MA, USA.

Margolin, V. (2013) Design Studies: Tasks and Challenges. *The Design Journal*, 16 (4), 400–407.

McCarthy, J. and Wright, P. (2004) *Technology as Experience*. London: MIT Press.

Miller, T. (2014) Cultural Work and Creative Industry. In Smith Maguire, J. and Matthews, J. (eds.), *The Cultural Intermediaries Reader*. London: SAGE.

Nielsen, J. (2000) *Designing Web Usability: The Practice of Simplicity*. Indianapolis: New Riders Publishing.

Norman, D. (1988). *The Design of Everyday Things*. New York: Doubleday.

Orlikowski, W.J. (2007) Sociomaterial Practices: Exploring Technology at Work. *Organization Studies*, 28 (9), 1435–1448.

Polaine, A., Lovlie, L. and Reason, B. (2013) *Service Design: From Insight to Implementation*. New York: Rosenfeld Media.

Portigal, S. (2013) *Interviewing Users: How to Uncover Compelling Insights*. New York: Rosenfeld Media.

Reckwitz, A. (2003) Grundelemente einer Theorie sozialer Praktiken. *Zeitschrift fuer Soziologie*, 32 (4), 282–301.

Schatzki, T.R. (1996) *Social Practices: A Wittgensteinian Approach to Human Activity and the Social*. Cambridge: Cambridge University Press.

Schatzki, T. R. (2002) *The Site of the Social: A Philosophical Exploration of the Constitution of Social Life and Change.* State College: The Pennsylvania State University Press.

Schatzki, T.R. (2011) Where the Action is (on Large Social Phenomena such as Sociotechnical Regimes). *Sustainable Practices Research Group Working Paper 1*. Manchester: University of Manchester.

Schatzki, T.R., Knorr Cetina, K. and Von Savigny, E. (2001) *The Practice Turn in Contemporary Theory*. London: Routledge.

Shove, E. and Pantzar, M. (2005). Consumers, Producers and Practices: Understanding the Invention and Reinvention of Nordic walking. *Journal of Consumer Culture*, 5 (1), 43–64.

Shove, E., Watson, M., Hand, M. and Ingram, J. (2007) *The Design of Everyday Life*. Oxford: Berg.

Singleton, W.T. (1974) *Man–Machine Systems*. England: Penguin Education.

Suchman, L. (1987) *Plans and Situated Actions: The Problem of Human–Machine Communication*. Cambridge: Cambridge University Press.

UX Mastery (2012, October 6th). What the #$%@ is UX Design? [Online] Retrieved from: https://www.youtube.com/watch?v=Ovj4hFxko7c

Warde, A. (2005) Consumption and Theories of Practice. *Journal of Consumer Culture*, 5 (2), 131–153.

Weinschenk, S. (2011) *100 Things Every Designer Needs to Know about People: What Makes them Tick?* Berkeley: New Riders.

Woolgar, S. (1991) Configuring the User: The Case of Usability Trials. In Law, J. (ed.), *A Sociology of Monsters: Essays on Power, Technology and Domination*. London: Routledge.

Young, I. (2008) *Mental Models Aligning Strategy with Human Behavior*. New York: Rosenfeld Media.

Young, I. (2015) *Practical Empathy for Collaboration and Creativity in your Work*. New York: Rosenfeld Media.

LBMGs and Boundary Objects. Negotiation of Meaning between Real and Unreal

Davide SPALLAZZO[*a] and Ilaria MARIANI[a]

[a] Politecnico di Milano

The paper reports on a study grounded on higher education didactic experiences involving around 180 BSc students in the design of Location Based Mobile Games that mix digital contents and physical artefacts.

By means of data gleaned from a three–year didactic experience, we challenge the extant assumption that LBMGs should exclusively rely on the digital/mobile component. Looking at LBMGs as situated experiences, we investigate the relevant role and agency of physical elements: How do they interact with the space? With players? How do they affect players' in–game behaviours? And players' sociality?

We focus on the agency of the above mentioned physical objects, and their ability to trigger players' actions and to persuade them to behave according to designers' expectancies. We analyse how these objects translate the fictional world into a space intertwined with the real one, rather than simply overlapped, and how they foster meaning making and context awareness acting as boundary objects that activate negotiations of meaning between real and 'unreal'.

Keywords: LBMGs; boundary objects; negotiation of meaning

Literature review and theoretical premises

Games convey meanings. They act as contexts of representation (Frasca, 2003; Salen and Zimmerman, 2004) wherein meanings are embedded (Flanagan and Nissenbaum, 2014) and grasped by players via subjective interpretation (Sicart, 2011).

Relying on these theoretical premises this contribution explores how physical game elements can serve as boundary objects in mobile

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[*] Corresponding author: **Davide Spallazzo** | e–mail: **davide.spallazzo@polimi.it**

experiences. Location Based Mobile Games (LBMGs henceforth) become the field of investigation wherein such objects force negotiation of meaning between real and unreal.

Games are complex, dynamic systems of communication (Mariani, 2016) that require players to *make sense and meaning of objects* (or depictions of them), interactions and concepts (Salen and Zimmerman, 2004). Playing a game means experiencing (1) what the game represents and (2) what the game is a representation for (Salen and Zimmerman, 2004). By their own nature, games ask players to pretend to be somewhere else, counting and advocating make–believe (Caillois, 1961 [1958]). Reproducing how real or imagined systems work, games can produce knowledge, understanding and comprehension. Moreover, inducing players to interact with specific representations, they encourage to form judgments about those systems (Bogost, 2007). Thus, games can be purposely designed to influence players by mounting arguments in a persuasive way. Unfolding processes and providing fresh perspectives, they can challenge players to question their choices and positions, change their attitudes and even behaviours (Lavender, 2011; Stokes, 2014).

Our analysis focuses on how LBMG players were invited to interact with each other, with other people, with the surrounding space, and especially on the agency (Latour, 2005) of the game elements that triggered such interactions. We study that kind of agency that Kaptelinin and Nardi (2006) define 'delegated agency', namely the ability of things or human beings to act on somebody else's behalf, namely according to designers' will. Intending agency as the 'ability to act', it can be broadly intended as the capability to produce an effect. Consequently, this ability is a property attributable to anything that exists, being objects, processes, or even ideas. Extending this reasoning to what happens into games, and looking at the interaction between players and objects as an exchange of meaning, it emerges a third pole: the designer. Every pole has its agency, even if the designer's one is embedded in the game, and it emerges through its objects/elements and mechanics.

The relationship between games and what surrounds them has been vividly established by several scholars in their foundational texts. Seminal works are Huizinga's *Homo Ludens* (1949 [1938]) that investigated the bond among play, culture and society, and Caillois' *Les Jeux et les hommes* (1961 [1958]) that exposed the role of make–believe in creating imaginary worlds. Then, several contemporary authors explored how games can extend, integrate and digitally–overlay physical spaces (von Borries et al., 2007). For

example, Montola, Waern and Stenros (2009) and De Souza e Silva (2006) investigated games that take the distance from the computer screen, getting the player back to public spaces as game venues.

Analogously, scholars as Murray (1997) and Frasca (2001) investigated agency as the way computer users participate in games as simulations; the latter vetted the role of the medium in consciousness–raising. Rather than focusing on digital games and being aware that, in Game Studies, the concept of agency origins in the video game field, we expand the reasoning on situated pervasive games, as LBMGs. We consider significant to study how they involve players into less–mediated processes wherein experiences are built by continuously engaging players with the world and operating acts of sense–making (Wright, Wallace and McCarthy, 2008). It is indeed often underestimated that non–digital and hybrid location–based games require player to move in the urban spaces and temporary detach from the usual way to move, explore, look at things but also attribute sense. In such a dynamic interplay, ordinary physical elements can be overlaid with further layers of meaning, contributing to building new awareness, and become tools people use to empower themselves (Wertsch, 1998).

However, the reasoning on physical game elements as objects that trigger players' action and activate meanings is still partly unexplored. To dig into the potential of these objects it is necessary to rehearse some foundations and how they are challenged by certain contemporary games, as LBMGs.

Play was historically defined by Huizinga ([1938] 1946, p. 13) as a 'free activity standing quite consciously outside ordinary life as being not serious', but at the same time absorbing the players intensely and utterly. Such influential formulation, however, has been extensively questioned – mainly the statement that play is separate from ordinary life (Juul, 2005; Montola, 2005; Montola, Waern and Stenros, 2009). Considering the technological growth and the increased presence of smart devices, it is not surprising how games become pervasive and more and more *present* in people's everyday life (Montola, Waern and Stenros, 2009). As a typology of pervasive games, LBMGs expand in the real context. Using context–aware mobile devices constantly connected to the Internet, LBMGs bridge the real and the digital: they are played in physical spaces that become hybrid because of the use of mobile technologies as interfaces (De Souza e Silva, 2006) that locate users and provide contextual digital information. By walking in urban spaces players dim the borders between physical and digital, and the physical sphere enters the mobile game.

Boundary objects

The role of physical game objects in LBMGs is frequently overlooked and neglected since designers mostly focus on hybridizing the real world with the fictional one through the mobile device, overlapping contextual information as well as tasks and game mechanics on reality.

In this study, we analysed games designed with the specific task of seamlessly integrating physical game elements in the play experience, mixing LBMGs, commonly technology–sustained (Montola, Sternos and Waern, 2009), with the praxis of urban games, usually empowered by physical game objects. Students were asked to imagine play experiences able to take full advantage of the two worlds players encounter: the physical one wherein they move and act, and the digital one provided by the mobile device. Therefore, physical game elements became (1) objects able to trigger players' actions and (2) boundary objects, namely elements plastic enough to adapt to the two worlds without losing a *common identity* across them (Star and Griesemer, 1989, p. 393) or at least maintaining coherence in both the realities.

Designing LBMGs students could make use of:

- objects already present in the environment (e.g. benches, lamps, trash bins, …),
- objects brought into the playground, and
- bespoke objects specifically designed to serve games.

Referencing to Star and Griesemer's (1989) preliminary classification of boundary objects, game elements in LBMGs pertain to all the four categories. They can be urban elements that designers and players can 'borrow from the pile for their own purposes' (Star and Griesemer, 1989, p. 410), transforming the urban space into their (i) 'repository'*.* Game elements can also be vague enough to allow an easy fitting in both the worlds, being configured as (ii) 'ideal boundary objects'. Furthermore, designers can attribute different meanings to the same objects according to the world wherein they are employed – (iii) 'coincident boundaries' – and finally they can be (iv) 'standardized forms'*,* objects that convey the same information regardless of the context, or quoting Latour (1986) 'immutable mobiles'. In this sense game objects bound the two worlds, acting as mediators and interfaces.

Then, according to Johnson (1997), interfaces influence our daily lives defining how we perceive our surroundings in terms of space and social interaction. On that account, particularly significant is the conceptualization

of 'social interface' advanced in 2006 by De Souza e Silva to define 'a digital device that intermediates relationships between two or more users' (pp. 261–262). The author highlights the role of the cultural context in defining interfaces, since the social meaning of an interface is not totally dependent of the technology itself, but is the result of how that interface is embedded in social practices.

Methodology

The study relies on the outcomes of three assessments conducted in the *Augmented Reality and Mobile Experience* BSc course at Politecnico di Milano, School of Design. Between the A.Ys. 2013 and 2016, about 180 students designed 44 LBMGs aimed to raise awareness on sensitive issues and societal taboos or to increase citizens' consciousness on their role in preserving and improving the quality of the district wherein they live. To design their games as ways to look at the world anew, and understand if the interaction among physical spaces, objects, passers–by and meanings was the one expected, the design followed an iterative process, consisting of cyclical periods of design, analysis and test to assess the game validity, both in terms of gameplay and meaning transfer.

We studied these LBMGs from the initial idea to the final artefact, considering the twofold perspective of designers and players. As such, LBMGs were considered as (1) systems to transfer meanings, as (2) situated experiences reducing complex issues, and as (3) tools of societal enquiry. This contribution presents a focus on how objects can facilitate these three points.

Recalling Frayling's research categories (1993), we conducted a through–design research, based on a sample of 44 games. We enquired how students designed these games creating consistent links between the real and the digital world initiated through game kits and physical objects spread in the urban space. We focused on how such links resulted able to activate the desired behaviours and interactions of players.

We documented and analysed these situated LBMGs as case studies. Our main strategies were ethnographic research and participant observation (DeWalt and DeWalt, 2002) in a period of three months for each academic year. The mixed methodology approach described in fig. 1 was employed to understand how players made sense and gleaned knowledge from the play activity and how the game elements triggered actions and enhanced the process of meaning making. To lessen biases and cross–check the results of

our qualitative observation, we asked players to compile questionnaires (Mariani, 2016; Mariani and Spallazzo, 2016) that we analysed to understand the relevance and pleasantness of the interactions with the game elements, the players' ability to grasp the message transferred by the game, and assess the overall quality of the experience.
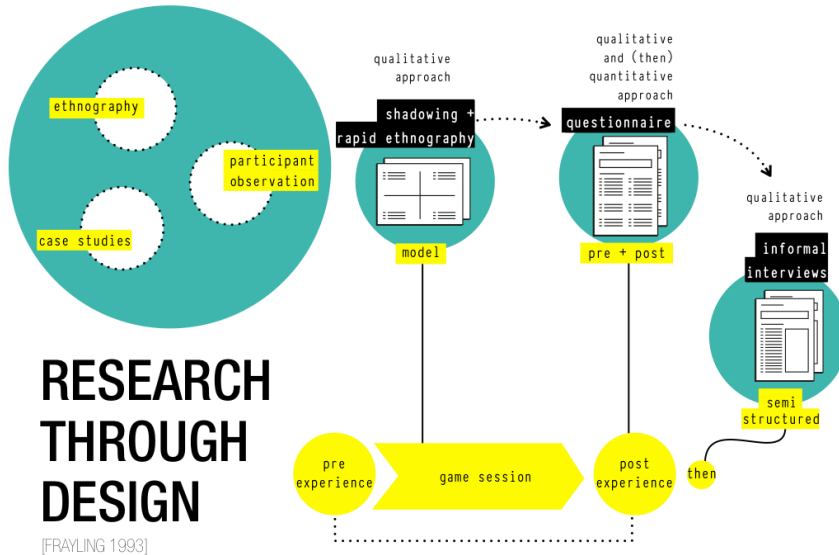

Figure 1   Strategies and tools to observe the game design process and sessions.

Triggering player's action

In understanding players' interaction during the gameplay, we recall Wright and colleagues' (2008, p. 184) reasoning on the aesthetic experience between individuals and technology, as well as the holism that characterises an activity where every game element, physical or digital, is interconnected and explicable when referenced to the whole. They play a key role in terms of transferring meanings because the way they are comprehended triggers player's actions. Players' different attribution of meanings to objects results into the construction of different strategies of actions. In doing so, each object and its interpretation impact on the overall coherence and consistency of how the game conveys its messages. The initial assumption is

that players create sense negotiating the meanings of the game objects, accordingly to their personal and cultural background; a tendency further nurtured by the nature of these games that prompt players to decode, interpret and transfer their understanding from the in–game context to the real world. Assuming that objects, player and setting contribute to activate a metaphorical dialogical or relational approach (Wright, Wallace and McCarthy, 2008, p. 184) to produce sense, in the following we study game objects focusing on their relation with (1) surroundings and (2) players.

The first level of analysis of physical game elements in LBMGs regards their relation with (1) the space wherein they are set and how they are perceived by players and non–players.

Relying on the LBMGs object of this study, we identified three main typologies of game elements:

  (a) 'Ordinary objects', perfectly integrated in the space, which become relevant and acquire a different meaning for players only.
  (b) 'Common objects' potentially perceived by both players and non–players as out of context.
  (c) 'Bespoke objects' clearly recognized as *outsiders.*

The first typology of game objects (a) identifies those physical elements, already existing in the space or placed in purpose, that do not declare themselves as part of a game. In the *Fellowship of the Umbrella* (game by Bianchini, Mor, Princigalli and Sciannamé, 2014), a game designed to sensitize players about physical disabilities and connected issues, a common trash bag left on the bin is interpreted by non–players as a forgotten object, while it gains an important role in the fictional, fairy–tale–based world wherein players are immersed. The trash bag is indeed the tool that allows the *Powerful Beech* – one of the characters – to move: by wrapping the bag around her legs the player can indeed move as in a sack race, physically experiencing the fatigue of moving (fig. 2).

This kind of objects produce different effects depending on the user: while they do not have any influence on non–players, they acquire meaning for players and act as boundary objects. They configure themselves as 'coincident boundary objects' (Star and Griesemer, 1989), objects acquiring different meanings according to the world wherein they are employed.

beech

+ has been around for long years, so he knows how to master magic and break spells
- having roots in spite of legs makes him slow

Figure 2   The description of the character and its features.

The second typology of game elements (b) identifies common objects potentially perceived as out of context. In the game *Drop.it* (game by Bandeira, Marcon, Namias and Paris, 2016) ordinary ampoules filled with water hang from trees and must be collected by players. Ampoules are objects that no one would notice as unusual in a kitchen or restaurant but that clearly do not commonly hang from trees. As such, they are perceived as out of context by both players and non–players, but only players can fully understand their contextual sense and role, while non–players can interpret the ampoules as a prank or an artistic happening. An even more evident example comes from the cited game *The Fellowship of the Umbrella* (game by Bianchini, Mor, Princigalli and Sciannamé, 2014) that lets players find a mask with snorkel – a tool for the *Magician* – in the Bovisa Campus of Politecnico, rich of beautiful lawns but with no beaches and even less the sea. Despite undoubtedly perceived as out of context, this kind of game elements does not declare themselves as part of a game activity and, while acting as 'boundary objects' for players, are not powerful enough to make non–players feel to be immersed in a playground. In other words, this kind of objects can enhance players' immersion in the hybrid world of the game, linking the real and the digital. However, it does not act in the same way on non–players that don't necessarily perceive the surroundings as a playground.

The last category (c) collects those game elements specifically designed and realized for the game and easily recognizable as part of it. An example comes from the game *The Origins of Forging* (game by Belloni, Bucalossi, Mazzoleni and Menini, 2016) that brings players back to the times of Greek

Gods in a discovery of the mythological roots of craftsmanship. As a setting for the game, designers populated the playground with cardboards representing – among others – wild animals such as wolves and bears. In this case the game elements are perceived in the same way by players and non–players, producing an identical effect in both worlds: the unique difference is that players must interact with the cardboards in order to proceed in the game, while non–players just perceive to be immersed in a playground where 'something' is happening. The game elements of this category convey the same information regardless of the context: quoting Latour (1986) they are 'immutable mobiles' that bound the two worlds, becoming means to proceed in the game for players, and traces for non–players.

Analysing the discussed typologies of physical game elements in respect to the concept of 'magic circle' (Huizinga, 1949 [1938]; Caillois, 1961 [1958]) – namely the 'space' wherein the game takes place – we can outline three different behaviours. The first typology (a) does not blur the borders of the 'circle' since players are kept separated by non–players, who are completely unaware that a game is in progress. Despite the urban space is transformed into a playground, the game keeps those features of secrecy and separateness described by Huizinga (1949 [1938]). Different considerations must be done about the second typology of game elements (b) since they undermine the concept of 'circle'. These objects are indeed perceived as out of context and even if not evidently related to a play activity, they may alert non–players that something out of ordinary is happening. The game elements belonging to the third category (c) demolish the 'magic circle' expanding it spatially (Montola, Stenros and Waern, 2009). These objects clearly declare 'this is a game' (Bateson, 1956) and, while absolving a functional role for players, they act as gates for non–players, evidences of the fictional world superimposed on the real one.

Drawing the attention to how game elements interact with players, namely the second level of analysis identified (2), we deduced a list of three main typologies of interaction:

a) 'Direct interaction' with physical objects, without metaphorical meaning.
b) 'Mediated interaction' with physical objects that have effects in the game digital dimension.
c) 'Metaphorical interaction' with physical objects that are substitute or metaphors of fictional elements.

In the first typology of interaction (a), physical objects serve a concrete function in the real world, being mechanically employed to guide players to proceed in the game. For example in *The Origin of Forgings* (game by Belloni, Bucalossi, Mazzoleni and Menini, 2016) players are asked to collect and assemble objects, in *The Treasures of Captain Torment* (game by Boni, Frizzi and Taccola, 2015) they move together within a cardboard boat, or in *SOS–Rescue Squad* (game by Panza, Pozzi, Rota and Veschi, 2016) they circumscribe rooms with tapes to keep passers–by far away: in doing so, the physical game objects have plain, evident functions and are used according to their original purposes.

Mediated interaction (b) refers to the modification of the digital dimension by means of physical game elements. Examples are objects built to be employed or even destroyed to obtain information and advance in the game. *The Rapture* (game by Conti, Saracino, Serbanescu and Valente, 2015) uses physical objects as a styrofoam car, coloured balloons and a piñata that must to be destroyed to gain codes that, once typed into the digital interface of the game, allow to proceed in the story. Analogously in *SOS–Rescue Squad* objects fabricated via rapid prototyping are used as starters, serving as receptacle of codes that, once recomposed, unlock elements in the digital dimension.

The third typology of interaction (c) is based on the concept of metaphor: objects are representative or symbolic of something else with an important fictional role. Well known are the examples of how bananas and coffees respectively become guns and poisons in several 'Assassination games' – recalling the pervasive game genre proposed by Montola, Stenros and Waern (2009, 34–35). In *SOS–Rescue Squad*, a bench encircled with tape takes the distance from its usual, social function and assumes the role of a space of non–sociality.

To conclude, physical objects as masks or identity objects can have an important function in communicating to other people that 'this is a game' and it is happening here and now (Bateson, 1972). Playing the role of elements typical of performances, these masks serve a social function: who is wearing them belongs to a group or 'community' (Caillois, 1961 [1958]). As a consequence, they evidently state the presence of the magic circle. Moreover, these recognizable identity objects increase the possibilities to achieve 'immersion' (Murray, 1997), nurturing players' awareness of being involved in the game world and its story (McMahan, 2003).

Discussing objects: ally or enemy?

In this contribution, we stressed two ways to look at LBMGs objects as activators and influencers of behaviours, and triggers of meaning–making. Accordingly, we discuss here how the agency of these objects impacted on different aspects of the gameplay, activating (1) social engagement, (2) negotiation of meaning and (3) in–game behaviours.

We noticed that social engagement occurred within the group of players and with outsiders. Some objects resulted particularly efficient in stimulating interpersonal connection: in *The Treasures of Captain Torment* the cardboard boat forces players to squeeze in a limited space. In doing so, the object enforces the sense of community and makes the game manifest to passers–by. Players' awkward behaviours are clearly accepted as part of a ludic activity. This recognition reinforces the existence of the magic circle and its separation from the ordinary. Then, other objects force the ludic boundary to expand, by making players and non–players interact (Montola, Stenros and Waern, 2009). In *The Infection* (game by Bassanese, Bonfarnuzzo, Pham and Redana, 2015), players are even required to place stickers on non–players' body to 'spread' venereal infections, going beyond our usual comfort zone by challenging our interpersonal distance.

Then, game elements, acting as boundary objects, activate negotiations of meaning between real and 'unreal', transferring and translating the fictional world into the real one. The two realities become intertwined, rather than simply overlapped. We noticed three different attitudes.

Transfer. The immersion into the fictional world (Murray, 1997) can be enforced by physical objects that clearly pertain to that world. The pirate cardboard boat, spiked gloves, winged sandals (*talaria*) crafted by designers become a concretization of the fictional world. As objects hurled in the physical world, they are boundaries between the two realms.

Translate. Designers can use objects that embed metaphorical meanings that require interpretation to be understood by players. Therefore, there is a double operation of translation: first, designers employ objects fraught with symbolic meaning, that is then deciphered by players. In the intentions of designers, a mask with snorkel symbolizes the condition of being dumb, or a bag trash put the player in the shoes of person with motor disabilities, being representations of real handicaps. The comprehension of the real purpose of these objects requires players to start a negotiation of meaning that can take the shape of a progressive disclosure, as well as of a final revelation or a *coup de théâtre* with an astonishing realization of sideways perspectives and uncommon translations.

Transfer and Translate. The attitude merges the previous ones by employing game objects that both transport the fictional world into the real one, and are fraught with meaning. The smartphone itself can be considered as example of this attitude since it's the major means of intertwining between fictional and the real worlds but has been frequently employed as whimsical object, guide in the gameplay, and narrator of the story. The styrofoam car of *The Rapture* (game by Conti, Saracino, Serbanescu and Valente, 2015) is together a concretization in the real world of the fictional one and its destruction in the game play symbolizes the blind violence of *black blocks*, that players are unwittingly personifying. In this sense, game objects can become powerful allies of designers in triggering immersion and conveying meaning.

The third point of discussion relates to the concept of persuasive design (Redström, 2006), and consists of the ability that certain objects possess to affect players in–game behaviours. Designers can craft artefacts that activate behaviours – in–game behaviours, not necessary long–lasting. This implicates on the one hand that designers have expectations for the object's ability to trigger 'correct gameplay', on the other that player's experiences require to be investigated to confront how players used and interpreted objects with the designer's expectations. That means that designers' initial expectancies can be confirmed or contradicted. It is up to the designer the task of understanding if players are attributing to the diverse objects the function expected.

To distil the concepts presented in this article we can affirm that designers should consider the aforementioned options to wisely create meaningful objects, according to the desired interactions and to the meanings to convey. Since our first year of research on LBMG that includes physical game elements situated in the space, we noticed that physical objects can assume the double role of allies or enemies, according to how they are designed and provided with meaning, as well as to how they are interpreted. We have therefore formalized our experience in a framework aimed at empowering those who design LBMG to consciously design/include these artefacts.

In–game physical objects as boundary objects act as powerful allies when they play the twofold function of bridging the fictional world with the real one, and becoming representations of the meanings designers aim to transfer. On the contrary, they can negatively affect the game by miscommunicating its contents and meanings. They can be strongly influential, because they impact on the relation among artefacts, players,

and meanings embedded. Hence, designing ignoring/neglecting the potential of such objects as sources of behaviour empowerment and their communication role can conversely work to the detriment of the play experience, configuring objects as enemies. This ambiguity is a clear problem of design that can be coped anticipating players' in–game behaviours and how the in–game information can be received and interpreted. This considering that ambiguity itself is also the delight that comes from running into the unexpected that results into unforeseen behaviours and comprehension.

References

Bandeira, F., Marcon, S., Namias, C. and Paris, M. (2016) *Drop.it* (LBMG).

Bassanese, G., Bonfaruzzo, L., Pham, C. and Redana, F. (2015) *The Infection* (LBMG).

Bateson, G. (1956) The Message 'This is Play'. *Group Processes*, 2, 145–241.

Bateson, G. (1972) *Steps to an Ecology of Mind*. New York: Ballantine Books.

Bianchini, S., Mor, L., Princigalli, V. and Sciannamé, M. (2014) *The Fellowship of the Umbrella* (LBMG).

Belloni, E., Bucalossi, C., Mazzoleni, C. and Menini M. (2016) *The Origins of Forging* (LBMG).

Bogost, I. (2007) *Persuasive Games: The Expressive Power of Videogames*. Cambridge: MIT Press.

Boni, A., Frizzi, G. and Taccola, S. (2015) *The Treasures of Captain Torment* (LBMG).

Caillois, R. (1961 [1958]) *Man, Play, and Games*. New York: The Free Press.

Conti N., Serbanescu, A., Saracino, G. and Valente, N. (2015) *The Rapture* (LBMG).

De Souza e Silva, A. (2006) From Cyber to Hybrid: Mobile Technologies as Interfaces of Hybrid Spaces. *Space and Culture*, 9 (3), 261–278.

DeWalt, K.M. and DeWalt, B.R. (2002) *Participant Observation: A Guide for Fieldworkers*. Walnut Creek: AltaMira Press.

Flanagan, M., and Nissenbaum, H. (2014) *Values at Play in Digital Games*. Cambridge: MIT Press.

Frasca, G. (2001) Rethinking Agency and Immersion: Video Games as a Means of Consciousness–Raising. *Digital Creativity*, 12 (3), 167–174.

Frasca, G. (2003) Simulation Versus Narrative. In Wolf, M.J. and Perron, B. (eds.), *The Video Game Theory Reader*. New York/London: Routledge.

Frayling, C. (1993) *Research in Art and Design*. London: Royal College of Art.

Huizinga, J. (1949 [1938]) *Homo Ludens. A Study of the Play Element in Culture.* London: Routledge and Kegan Paul.

Johnson, S. (1997) *Interface Culture: How New Technology Transforms the Way We Create and Communicate*. New York: Basic Books.

Juul, J. (2005) *Half–real: Video Games Between Real Rules and Fictional Worlds*. Cambridge: MIT Press.

Kaptelinin, V., and Nardi, B.A. (2006) *Acting with Technology: Activity Theory and Interaction Design*. Cambridge: MIT press.

Latour, B. (1986) Visualization and Cognition: Thinking with Eyes and Hands. *Knowledge and Society: Studies in the Sociology of Culture Past and Present*, 6, 1–40.

Latour, B. (2005) *Reassembling the Social: An Introduction to Actor–Network–Theory*. New York: Oxford University Press.

Lavender, T. (2011) Video Games as Change Agents—the Case of Homeless: It's no Game. *The McMaster Journal of Communication*, 7 (1), 13–36.

Mariani, I. (2016*) Meaningful Negative Experiences within Games for Social Change*. Doctoral dissertation, Politecnico di Milano.

Mariani, I. and Spallazzo, D. (2016) Empowering Games. *Interaction Design and Architectures Journal*, 28, 12–33.

McMahan, A. (2003) Immersion, Engagement and Presence. In Wolf, M.J.P. and Perron, B. (eds.) *The Video Game Theory Reader*. London/New York: Routledge.

Montola, M. (2005) Exploring the Edge of the Magic Circle: Defining Pervasive Games. In *Proceedings of DAC*.

Montola, M., Stenros, J. and Waern, A. (2009) *Pervasive Games: Theory and Design*. Burlington: Morgan Kaufmann.

Murray, J.H. (1997) *Hamlet on the Holodeck: The Future of Narrative in Cyberspace*. Cambridge: MIT Press.

Panza, M., Pozzi, L., Rota, P. and Veschi, D. (2016) *SOS–Rescue Squad* (LBMG).

Redström, J. (2006) Persuasive Design: Fringes and Foundations. In IJsselsteijn, W.A., Kort, Y.A.W. de, Midden, C., Eggen, B. and Hoven, E. van den (eds.), *Persuasive Technology, Lecture Notes in Computer Science.* Berlin: Springer.

Ryan, M. (2001) *Narrative as Virtual Reality: Immersion and Interactivity in Literature and Electronic Media*. Baltimore: Johns Hopkins University Press.

Salen, K. and Zimmerman, E. (2004) *Rules of Play: Game Design Fundamentals*. Cambridge: MIT Press.

Sicart, M. (2011) Against Procedurality. *Game Studies*, 11 (3).

Star, S.L. and Griesemer, J.R., (1989) Institutional Ecology, `Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907–39. *Social Studies of Science*, 19 (3), 387–420.

Stokes, B. (2014) *Civic Games with 'Local Fit': Embedding with Real–World Neighborhoods and Place–Based Networks*. Doctoral dissertation, University of Southern California.

von Borries, F., Walz, S.P., and Böttger, M. (eds.) (2007) *Space Time Play: Computer Games, Architecture and Urbanism: The Next Level*. Basel: Birkhäuser.

Wertsch, J.V. (1998) *Mind as Action*. New York: Oxford University Press.

Wolf, M.J. (2001) *The Medium of the Video Game*. Austin: University of Texas Press.

Wright, P., Wallace, J. and McCarthy, J. (2008) Aesthetics and Experience–Centered Design. *ACM Transactions on Computer–Human Interaction*, 15 (4), 1-18.

When Objects Tell Stories. Children Designing Future Smart Objects

Seçil Uğur YAVUZ[*a], Roberta BONETTI[a] and Nitzan COHEN[a]

[a] Free University of Bozen–Bolzano

Smart materials and microelectronics have given rise to intelligent living like products – so–called smart objects– that can sense, react and be connected. In this new realm, TANA (TAngible NArrators) research project, conducted at UNIBZ, Faculty of Design and Art, explored possible future scenarios, in which smart objects came to life in stories that were created by children, the co–designers of TANA project. This paper represents the results and analysis of co–design workshops conducted with 7–8 years old children, in order to discover smart objects' potentialities through storytelling. The workshops aimed at harnessing children's free imagination and innovative power into generating new ideas and new concepts of smart objects integrated into our daily lives. The paper reflects the results of the workshops with assumptions from both design and anthropological point of view discussing smart object agency and designer's role in this new realm.

Keywords: *Smart objects; agency; pro–active agents; fiction, co–design*

Introduction

Throughout history, objects have been always important actors within human life. They 'necessarily participate in social practices just as human beings do' (Reckwitz, 2002, p. 208), hence they are acknowledged as active entities. Through embedding digital technologies into objects, they become not only active, but also pro–active figures. Thus, this situation leads to new types of interaction modalities and social dynamics. Today we are entering a new era, where smart objects – 'autonomous physical/digital objects augmented with sensing, processing, and network capabilities' (Gerd et. al, 2010) – have been increasingly taking part in our daily lives. According to Marzano (2003) technology as 'grey–black boxes' will disappear and,

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[*] Corresponding author: **Seçil Uğur Yavuz** | e–mail: **secil.uguryavuz@unibz.it**

instead, it will be incorporated in our material environment, in forms of traditional objects becoming active and intelligent actors. We have been moving from grey–black boxes to ordinary objects with extraordinary capabilities...if then, what happens when our plate starts talking to us, telling how healthy our eating habits are, and encourages us for a better diet? Or what if our door opens to another reality, suggesting us places to visit? What happens when we start having all these quotidian objects keeping their essential functions, but being embedded with new characteristics towards being 'smart'?

Lowry (2011, p.1) says: 'all objects contain information that goes well beyond immediate use or appearance, moving the task of the designer into new realms and demanding new skills'. As smart objects have become a part of our social structure and opened up new discussions on how our relation with objects might be, designer's role has been changing towards speculating on new scenarios for future, asking the 'what if' questions, and exploring the object–human relationship that gains new characteristics and complexities. As Dunne and Raby (2013) mention, design fiction differs from the industrial production and market–oriented approach, stepping into 'the realm of the unreal' through creating design concepts that introduce new possibilities, aesthetics and notions for our future. By creating prototypes as 'performative artefacts' (Kirby, 2009), designers can simulate – utopic or dystopic– future scenarios about how our daily life might change under the influence of new technologies and hence, open up new debates.

As a design fiction experiment, TANA (TAngible NArrators) research project generated scenarios of future smart objects through the integration of children in the design process that used storytelling as an essential tool. In this paper we present how we conducted the co–design workshops, explain the methodology used during storytelling sessions and discuss the obtained results with a critical perspective, which introduces assumptions about smart object agency from both design and anthropological points of view.

Smart objects as pro–active agents

Everyday objects are catalogued and exhibited in museums, collected and studied in the field, and have always played an important part in both anthropological theory and practice. It has been argued that a person only becomes a social individual through learning and socialisation processes that take place within the material world of objects – a world characterised by

the agency of the objects as well as the actors (Bourdieu, 1972; 1975; Latour, 1987; Miller, 2001). Objects are, in this sense, an integral and inseparable aspect of all relationships. For some time anthropological research has revealed that objects have their own life cycle, almost a kind of 'career', to play out, which allows them to have a role as active social agents. Objects can have their own life stories (Appadurai, 1986), or 'biographies' in terms of their movement through a series of transformations: for example, from gifts to goods, to inalienable objects (Kopytoff, 1986). Anthropologists have argued that things can, under certain conditions, have an 'agency' whereby they may act as if they were people (Gell, 1998). As such, objects stimulate emotional responses in their users, and invite us to investigate the power of their agency by looking at the roles they play within the social contexts in which they are used.

In the same vein, the concept of 'embedded objects' conveys the importance of objects in various social contexts (Warnier,1999). Objects can also be used to both emphasise alliances and, conversely, social differences (Douglas, 1978). Previous research on different exchange systems has described in great detail how material objects may be variously or comprehensively assigned a gender, a name, a history and a ritual function– and even maintain those devised by their original owners.

Similarly, today we are facing with 'smart objects' phenomenon that lets us form new types of relationships with these objects and opens up a new perspective on object agency. Technology has been seamlessly entering our daily life objects, weaving itself into the fabric of physical world (Weiser, 1999). According to Greenfield (2006), 'ordinary objects, from coffee cups to raincoats to the paint on the walls, would be reconsidered as sites for sensing and processing information, and would wind up endowed with surprising new properties'. Thanks to emerging technologies that are continuously shrinking to be embedded into daily objects, these objects can gain additional meanings and behaviours due to their digital content.

There are different techniques to embed digital content into a physical artefact. For instance, through Radio Frequency IDentification (RFID) or Near Field Communication technology objects can be read by a reader and transmit information to its user. The transmission of data can be done via text, images or videos. Instead of being read by a mediator object, such as a mobile phone, objects themselves can include sensors and actuators that enable them to interact directly with their users. Through having the characteristic of interacting with the user, a physical object gains additional social functions, being a pro–active entity. Carabelea and Boissier (2003)

define 'pro–activity' in smart objects as a capability to assist their users in discovering information through interacting with them. Smart objects (embedded with high or low technology) can get in contact with people by using various communication modalities and hence can have the power to elicit emotions, affect our behaviour and become our companions.

Furthermore, while smart objects can receive inputs from their actual environment and transform these data into a message for their user, they can also receive or send data through the Internet, and be defined as Internet of Things (IoT). This possibility makes a smart object more potent in what it can do through being connected with other people and other objects.

TANA project

In this new realm of smart objects, TANA (TAngible NArrators) research project aims at offering alternative future scenarios through integrating children in concept and idea creation process. In this research, co–design workshops with children were the primary activities, where future scenarios were born and elaborated. Through storytelling, children built fictional scenarios for smart objects, in which they were animated and brought into life. The workshops aimed at taking advantages of children's imagination and innovative power to see what kind of smart object–human relationship could emerge, and to start a debate on this phenomenon through 'performative' mock–ups that were the results of co–design workshops.

Workshop tools and process

As co–design workshops, three storytelling sessions and one idea generation session were conducted together with 24 children (7–8 years old) in a primary school, in Trento. These sessions were lead and observed by an anthropologist and designer, and assisted by the classroom teacher.

In the first storytelling session, a card game was prepared and used in order to stimulate children to think–loud and freely express their ideas.The game included a deck of cards with 42 object illustrations and a DIN–A3 paper with keywords (Where, What, How, To Whom?) enabling the children to create stories of each selected object (fig.1).

In the second storytelling session, the children were asked to select an object in the school and imagine a story, where the object became the main character of this story. Each child selected one object and created stories while interacting with the object physically.

In the last storytelling session, a shadow theatre was constructed in order to animate classroom chairs behind a curtain. In this session, while children were making chairs act in a theatre setting, their shadows created ambiguity that triggered our creativity on imagining their form and behaviour.

Figure 1   Storytelling sessions with card game

The last session was dedicated to idea creation. 'Smart plate' was a theme that came up in the earlier storytelling sessions and which we chose to further elaborate as the main theme for this session.In idea generation session, each child worked on a smart plate idea, describing the plate's function and form through sketching.

Smart plates

As a result of idea generation session, all smart plate sketches were gathered together and five plates were designed based on those sketches. The plates were 3D modelled and produced with 3D printing technology.

The results are five smart plates that have different characteristics and functions. The first plate is called *Capiat* that can analyse the ingredients of the food and warns its user by getting wrinkles on its surface. Another plate is *Verdufrutti* that can read the fingerprint of its user and turn a simple pill shaped food into a desired one based on its user's taste. *Fegato* is an organic living structure that works like intestines digesting the rest of the

food. Hence, the user doesn't need to clean the dishes, but the plate can self–clean. The other plate, *Piatto del Giudizio*, starts expanding, when the user exceeds the amount of food that is necessary for him/her, so that the food flows down and cannot stay on the plate. And finally, *Ingrandiscibutta* plate is made of a small eco–system, in which the rest of the food becomes a fertiliser for a herb growing on the plate to be eaten for the next meal (fig.2).

Figure 2   Smart Plate Mock–ups

Public presentations

The 3D printed smart plates were shown firstly at the primary school to children who participated in the workshops and to their parents. This was the first moment when the children saw their ideas in a tangible form. Although some of them were disappointed by the fact that their ideas were turned into something else than that they were imagining, most of the children were excited about seeing the results as physical artefacts and proudly presented them to their parents. A second public presentation took place in Bolzano, at UNIBZ during a public event, where citizens visited the university to see research activities. In this presentation, while the smart plate mock–ups were exhibited on a platform, on the wall we reflected a video, in which plates were animated. While these two representations

were aiming at giving an idea about each plate, they were subtly dividing the real and fictional worlds. This presentation aimed at making visitors interact with mock–ups, and start a debate on smart objects and their role in the future.

Design reflections

It was observed that the interaction with physical objects during the workshops gave children more possibilities to be creative. By putting a glass bottle close to her/his ear, one participant imagined that the bottle was whispering a message. Rolling a spool of rope gave another child the idea that the spool could direct him to a place by leaving the rope as a track to follow. Some children started talking with objects, as they were alive, giving them names and even showing affectionate behaviours towards the object. The way that children interacted with objects was mostly through gestures. They imagined scenarios, where objects could be activated through clapping hands, jumping or caressing. These results underline the importance of embodied interaction in the design of smart objects. Therefore, our research shows that probes, mock– ups and even quotidian objects can be used in the design process in order to stimulate creativity in designing interaction for smart objects and hence can lead to serendipity that could bring new ideas.

Technological solutions for self–reflection have involved mainly in education and healthcare fields, in order to support self–training or self–therapy. However, Mols, van den Hoven and Eggen (2016) draw attention to our everyday life reflections by underlining that smart objects can fulfill this need through triggering, supporting and capturing our quotidian behaviours. This aspect is also seen in our experiment in which smart objects had reflective roles to create awareness on wellbeing or environmental issues. Objects like necklaces, taps, chairs became agents to help us to observe our behaviours. For instance, a smart chair was warning its user by shaking to make him/her stand up after a long sitting. This result reveals an understanding that smartness as a feature can turn objects into pro–active entities that help us to have more awareness on our behaviours. Hence, designing smart objects can also include 'morality' aspect that would be assigned by the designer.

Another interesting idea emerged in the workshop was to imagine smart objects as empathy tools. Empathy –the ability to share the other person's emotions and feelings (Eslinger, 1998)– is an important human behaviour

that enhances our interpersonal relationship. In our experiment, by shifting from one user to another, smart objects could transfer experiences, emotions, memories and show what the other person lived, felt or heard. For example, a child imagined smart eyeglasses that act as a mediator visualising its previous use's experiences to the new one. Odom et al. (2009) mentioned that revealing an object's past and memories could enhance its social and economic value and therefore provide a long–lasting life. Besides its empathetic role that could enhance and alter human–human relationships, smartness in an object can help us to have more information about its history, and therefore can add new values to be sustained longer.

Animism defined as the belief that a non–human entity has a soul (Tylor, 1913) today can be seen in a new reality, which is altered by emerging technologies. 'Designed animism' coined by Laurel (2009) introduces a poetical approach about objects that are in a new world where pervasive computing brings significant paradigm shifts enhancing our capabilities, perceptions and experience. In storytelling sessions, it was observed that children rendered the objects unique with personalities. A common aspect all children shared was imagining that their objects had names and age. They often had emotions and were sad, happy or tired according to how their users treated them. They mentioned that objects' emotions were neglected by their users, and because of that objects were unhappy. They created stories, where objects could travel from one user to another, because they were bored or mistreated. This aspect shows us that designing smart objects require a deeper approach in which the designer should not only create a form but rather a comprehensive personality that could interact with its user. Hence, designers' role is changing towards not only designing mere interaction, but also creating the 'anima', personalities and behaviours. Our experiment shows that storytelling method can be useful for designing and envisioning those key aspects of smart objects.

An anthropological perspective

To understand our society in an anthropological sense, we need to look at how we relate to the objects that make up our day–to–day world. We believe our research shows, contrary to current popular belief, that people are not 'controlled' by objects, including technological gadgetry, but that human agents use material things to create both new meanings and new social relations.

In educational workshops, objects have long provided useful tools and strategies not only for facilitating storytelling, learning, and creativity, but also because they help transform the social context of their users (Crotti cited in Bonetti, 2014, pp. 193–222). Extensive work has been done on how personal storytelling plays an important role in early childhood socialisation and self–construction (Miller 1994; Miller et al., 1993). Various ethnographic cases have demonstrated how digital storytelling provides powerful motivation, and the means for forming and giving voice to 'agentive selves'.

Without diminishing the key role played by the creative individual, ethnographic cases have revealed that creative phenomena take shape within social networks– in the interactions between people, ideas and objects (Bonetti, 2014). Creativity can be investigated as a historical phenomenon that is progressively built up by the social actors involved and inter–culturally.

Although digital technologies and storytelling have emerged over the last few years as powerful teaching and learning tools that engage both teachers and their students, it still remains a challenging issue to apply this approach effectively to practical settings in order to improve the creativity, innovation, and learning performances of students and children.

In our project, we discovered that everyday objects can enter into 'relationships' with their users – despite being apparently identical, mass–produced, and interchangeable– even in the case of technologically advanced items such as mobile/cell phones. The objects underwent processes of 'singularisation', thus becoming one off/unique objects (Heinich, 1993; Kopytoff, 1986). In fact, it is not only the intended function of objects which determines their importance to people, but also the ways in which they are used and narrated. If objects, therefore, are the result of social relationships, and tend to increase their value the more they are recognised, touched, named, 'socialised' and incorporated, the designing of new objects in the future should involve not just considering the value of the objects in terms of their own intrinsic qualities, or basic function, but also that value found in the experiences that they allow, and in the way they become integrated into contemporary lifestyles and social systems. Our Research clearly highlights the following key points:

1. The concept of 'object authenticity' emerged as a key component in our research. In the storytelling, the participants needed most of all to render the objects unique and singular, even if they were part of a product series. It appeared necessary for the objects to be recognised and named as

characters (anthropomorphism personalisation), and made dynamic (transformation of shape and function).

2. The relationship between people and things is not necessarily based exclusively on the possession of things, nor on intergenerational family relationships but, rather, on an open horizontal relationship between people, regardless of predetermined affiliation. The example of the eyeglasses, illustrates this: 'I'm tired (says the glasses) of being worn by grown–ups, so when I go on to the next person, I tell them the story of the people who have worn me before.' The object acts as a 'go–between' for relationships, becoming the shared point of contact that reframes the physical and social experience of the object beyond the merely sensory. The idea of new relationships occurring through the mediation of an object, transversally across different groups, is illustrated neatly in the story of 'migrant seed' child, who says she got to the classroom like a seed carried away from its field of origin, far away from her grandparents' experience.

3. Technology in educational projects such as ours allows the participants to learn from their peers, regardless of cultural background. Technology provides a shared, standardised experience, thus effectively helps to avoid the misunderstandings that have been produced in recent years by intercultural projects in which the concept of well managed diversity has been erroneously equated with emphasising the cultural–geographical origin of the children taking part. By contrast, during workshops in which teachers, facilitators and students alike engage in activities or games as 'equals', a number of outcomes can occur. For example, in our workshop, a Bulgarian child, recounted aloud a story in his mother tongue in front of his classmates. The teacher was astounded, and confessed that she hadn't even taken in that the child knew Bulgarian. This kind of self expression by minority children in their own language has been recorded many times in other courses such as this, the key factor being that participants could express their uniqueness when engaging in games that put them all on the same level.

As for the interaction between individuals and things, most notably, a kind of two–way agency emerged between children and objects: the children act towards things and, at the same time, things interact with them. For example, the Bulgarian child mentioned above told a story whereby he turned his car into a flying car, whereupon the car itself asked him to tell it a story. Later on, the fact that the child chose to tell the same story in his mother tongue when his classmates asked to hear it, shows perhaps his

desire to keep, somehow, his intimate and affectionate relationship with his object a 'secret' from them.

That objects are somehow 'alive' is manifested by the relationships the children create right away with them when they are each free to discover and choose and 'own' a real and tangible object within a school. In this case, we can truly speak of 'objects of affection' (Ray, 1944).

The objects are named as if they were people: they not only breathe, but they each tell a unique story, and they are tired of being alone and of always doing the same things. The objects, instead, want to experiment with new functions and contexts. Beyond this, there also emerges an aesthetic concept far from that to be found nowadays prevailing in the media: in the children's storytelling, these widely perceived 'despised objects' become smaller, until they meet a person to take care of them. This new person/owner will give them some magic so that even though later they might again meet people who despise them, they will be able to stay the same size. The 'beauty' of the objects lies in the fact that they can be themselves, without taking the risk of being replaced by newer or more beautiful things. 'The clock needs a friend who can protect it and understand it and who doesn't throw it in the trash for a more beautiful one.'

Our pilot project thus in some ways resembles a computer re–start, in which objects, methods and traditions that have become apparently set in stone and taken for granted, are isolated, then reconfigured and placed in new contexts and placed side by side to create novel contexts around them and in many cases used to imagine a more sustainable future.

Glasses, watches, chairs, and words, become key focal points in networks of relationships that allow us to reflect on ourselves: they, therefore, help us to know ourselves and to think about the nature of contemporary everyday life.

The example of objects that produce awareness, as in the case of the tap which with its voice indicates how much water has been consumed, every time it's turned on, is an illustration that consumers are not seen as passive and alienated subjects by the children [in that they engage in reciprocal relationships with objects, in this case a tap]. Rather, once again, the children demonstrate the ability to use objects to actively build their own social identities, their own personal worlds of meaning in the context in which they live.

Conclusion

In this experimental design research, we have witnessed that object agency that children created through storytelling gave rise to new notions about smart objects and their relationship with the user. We see how everyday objects can become smart allowing us to reflect on ourselves, help us to understand others better or open up new horizons. We believe that our experiment is an example of how 'fictioning' with the harnessed creativity and freedom of children – as equal partners – can feed our creativity to design interactive artefacts and imagine possible futures, in which technology will ubiquitously enter to our everyday life objects. This experiment underlines the fact that in this new realm designers' role has been changing towards not only designing object by its form and function, but also scripting its behaviour or assigning a personality. In this era of designing smart objects, new modes of social dynamics have been emerging, and designers should bear in mind this aspect while designing 'smartness'.

Acknowledgments

References

Appadurai, A. (1986) (ed.) *The Social Life of Things: Commodities in Cultural Perspectiv*e. New York: Cambridge University Press.

Bonetti, R. (2014) *La trappola della normalità. Antropologia ed etnografia nei mondi della scuola*. Firenze: SEID Editori.

Bourdieu, P. (1972) *Esquisse d'une théorie de la pratique précedé de Trois études d'ethnologie kabile*. Paris: Seuil.

Bourdieu, P. (1975) Méthode scientifique et hiérarchie des objectes légitime*s. Actes de la recherche en sciences sociales*, 1 (1), 4–6.

Carabelea, C. and Boissier, O. (2003) Multi–Agent Platforms on Smart Devices: Dream or Reality. In *Proceedings of the Smart Objects Conference*.

Crotti, F. (2014) *Fare etnografia a scuola con I genitori*. Firenze: Seid Editori.

Douglas, M. and Isherwood, B. (1979) *The World of Goods*. *Towards an Anthropology of Consumption*. London*:* Routledge*.*

Dunne, A. and Raby, F. (2013) *Speculative Everything: Design, Fiction and Social Dreaming*. Cambridge: The MIT Press.

Eslinger, P.J. (1998) Neurological and Neuropsychological Bases of Empathy. *European Neurology,* 39 (4), 193–199.

Gell, A. (1988) *Art and Agency: An Anthropological Theory*. Oxford: Clarendo.

Gerd, K., Kawsar, F., Fitton, D. and Sundramoor, V. (2010) Smart Objects as Building Blocks for the Internet of Things. *IEEE Internet Computing,* 14 (1), 44–51.

Greenfield, A. (2006) *Everyware: The Dawning Age of Ubiquitous Computing.* Berkeley: New Riders.

Heinich, N. (1993) Les objets–personnes : Fétiches, reliques et oeuvres d'art. *Sociologie de l'art,* 6, 25–55.

Kirby, D. A. (2009) The Future is Now: Hollywood Science Consultants, Diegetic Prototypes and the Role of Cinematic Narratives in Generating Real–World Technological Development. *Social Studies of Science*, 40 (1), 41–70.

Latour, B. (1987) *Science in Action: How to Follow Scientists and Engineers Through Society*. Harvard: Harvard University Press.

Laurel, B. (2009) Designed Animism. In Binder, T., Lowgren, J. and Malmborg, L. (eds.) (*Re)Searching the Digital Bauhaus*. London: Springer.

Lowry, G.D. (2011) Foreword. In Antonelli, P. (ed.), *Talk to Me: Design and the Communication Between People and Objects*. New York: The Museum of Modern Art.

Kopytoff, I. (1986) The Cultural Biography of Things: 'Commoditization as Process'. In Appadurai, A. (ed.), *The Social Life of Things: Commodities in Cultural Perspective.* New York: Cambridge University Press.

Marzano, S. (2003) Cultural Issues in Ambient Intelligence. In Aarts, E. and Marzano, S. (eds.), *The New Everyday: Views on Ambient Intelligence*. Rotterdam: 010 Publishers.

Miller, D. (2001) (ed.) *Home Possession: Material Culture behind Closed Doors*. Oxford: Berg.

Miller, P. (1994) Narrative Practices: Their Role in Socialization and Self–Construction. In Neisser, U. and Fivush R. (eds.), *The Remembering Self: Construction and Agency in Self Narrative*. Cambridge: Cambridge University Press.

Miller, P., Hoogstra, L., Mintz, J., Fung, H. and Williams, K. (1993) Troubles in the Garden and how They Get Resolved: A Young Child's Transformation of His Favorite Story. In Nelson, C.A. (ed.) *Memory and Affect in Development: Minnesota Symposium on Child Psychology*. Hillsdale: Erlbaum.

Mols, I., van den Hoven, E. and Eggen, B. (2016) Technologies for Everyday Life Reflection: Illustrating a Design Space. In *Proceedings of the TEI '16: Tenth International Conference on Tangible, Embedded, and Embodied Interaction*.

Odom, W., Pierce, J., Stolterman, E. and Blevis, E. (2009) Understanding Why We Preserve Some Things and Discard Others in the Context of Interaction Design. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*.

Ray, M. (1944) *Objects of My Affections*. Exhibition. Circle Gallery, Hollywood.

Reckwitz, A. (2002) The Status of the 'Material' in Theories of Culture: From 'Social Structure' to 'Artefacts'. *Journal for the Theory of Social Behaviour,* 32 (2), 195–217.

Tylor, E.B. (1913) *Primitive Culture: Researches into the Development of Mythology, Religion, Language, Art and Custom*. London: Murray.

Warnier, J–P. (1999) *Construire la culture matérielle. L'homme qui pensait avec ses doigts.* Paris: PUF.

Weiser, M. (1999) The Computer for the 21st Century. *ACM SIGMOBILE Mobile Computing and Communications Review,* 3 (3), 3–11.

Interaction Matters. A Material Agency's Perspective on Materials Experience

Stefano PARISI[*a] and Valentina ROGNOLI[†a]

ª Politecnico di Milano

   Materials are not inert substances. They can act, change, behave. It is acknowledged by both the Materials and Design community and the Human–Computer Interaction community, which recently are merging their interests into the engagement of users with physical matter, through the experiential qualities of materials. Taking into consideration the fundamental role of materiality in the definition of the product experience, the concept of Materials Experience emerged. Nevertheless, since it is restricted to a human–centered view, the framework of Materials Experience does not contemplate the relations between non–human subjects, i.e. the interaction between the materials and other artifacts, substances, organisms, and environments. The concept of material agency in non–human relations might offer a new perspective to Materials Experience.

   Recently, materials with a high degree of interactivity are emerging, showing unusual properties and establishing unique relations with users, designers, artifacts, environments. They are connected, computational, augmented, smart, self–healing, aging, and growing materials. A selection of best practices and case studies is presented, highlighting their involvement in non–human relations. As a result, we propose an expansion of the framework of Materials Experience and a paradigm that highlight the autonomous, provoked and interpreted components of materials agency.

   Keywords: Materials experience; ICS materials; material agency; non–human relations; interactive materials

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* Corresponding author: **Stefano Parisi**| e–mail: **stefano.parisi@polimi.it**
† Corresponding author: **Valentina Rognoli**| e–mail: **valentina.rognoli@polimi.it**

Introduction

Materials are not inert substances, but entities able to act, change, behave, i.e. they have 'Material Agency'. They also influence the experience that people have with artifacts through 'Materials Experience'. Nevertheless, the notion of Materials Experience appears to explicitly consider only relations between human and non–human entities, i.e. between people and the materials. It does not contemplate the role of material agency in establishing non–human relations between the materials and other non–human entities. In this paper, we focus on expanding the framework of Material Experience through the lens of Material Agency in non–human relations, and on identifying a paradigm that considers the role of material agency in defining the autonomous, induced and interpreted components of Materials Experience.

In state of the art, we introduce the most relevant theoretical contributions about the topic, and we address the research question: *how is the Materials Experience framework influenced by materials agency in non–human relations?*

To answer, we examine examples and case studies of interactive materials. We use the term 'interactive materials' with a broad meaning, including not only computational, electronic, and digital materials, but all the materials that can establish a two–way exchange of information with other human and non–human entities.

As a result, a paradigm arises, and an expansion of the Materials Experience framework is proposed and discussed. This early investigation relates to a research project about the relation between design, materials, and interaction, also referred as 'ICS_Materials', i.e. interactive, connected and smart materials (Rognoli, Arquilla and Ferrara, 2016).

State of the art

In the panorama of design, materials are a fundamental element of products. In the last 30 years, scholars moved their attention from technical properties of materials to the sensorial and experiential qualities of them (Ashby and Johnson, 2002; Cornish, 1987; Karana, Pedgley, and Rognoli, 2014; Manzini, 1986; Rognoli, 2010). Nowadays it is known that material not only needs to meet practical demands. It also offers intangible features that captivate people's appreciation and that affect the experience of an artifact beyond its functional assessment. In a few words, these can be called

'intangible characteristic of materials' (Karana, Hekkert and Kandachar, 2007; 2010), 'intangible sparks' (Karana, Pedgley and Rognoli, 2015), and 'expressive–sensorial characteristics' of materials (Rognoli, 2010).

Since materiality contributes to the definition of Product Experience (Desmet and Hekkert, 2007) the concept of Materials Experience arises as 'the experience that people have through and with the materials of an artifact' (Karana, 2009; Karana, Pedgley and Rognoli, 2014; 2015). In its very first definition, Materials Experience has been framed in a framework of intertwined and interdependent layers:

- the sensorial experience, related to how user senses materials. *We find materials cold, shiny, etc.*
- the affective experience, related to emotions elicited by the material. *Materials cause us to feel surprised, bored, etc.*
- the interpretive experience, related to the meanings evoked by the material. *We think materials are modern, cozy, etc.*

Materials Experience arises autonomously and is interpreted subjectively by people. Nevertheless, when designing a material or embodying it into an artifact, the role of designer appears to be fundamental in understanding, envisioning, and creating the Materials Experience, to provide meaningful material and product experiences to users.

Similarly, Human–Computer Interaction (HCI) community is moving its interests toward interaction and experience with materials. After having focused its investigation on the dematerialization of technologies, it is re–valuing the importance of the sensorial involvement of the user with physical matter. It is demonstrating interest towards materiality of devices, interactive artifacts, and tangible interfaces, promoting the notion of 'material turn' (Robles and Wiberg, 2010), 'material move' (Fernaeus and Sundström, 2012) and 'material lens' (Wiberg, 2014). It would be helpful to mention the research projects and studies by Anna Vallgårda about 'Computational Composites' and 'Material Programming' (Vallgårda, 2015; Vallgårda and Redström, 2007; Vallgårda and Sokoler, 2010; Vallgårda et al., 2016), Vasiliki Tsaknaki and Ylva Fernaeus about imperfection in HCI (Fernaeus et al., 2014; Tsaknaki and Fernaeus, 2016; Tsaknaki, Fernaeus and Schaub, 2014), Daniela Rosner (Ikemiya and Rosner, 2013; Rosner and Ames, 2014; Rosner and Taylor, 2012; Rosner et al., 2013) and Holly Robbins, Patrizia D'Olivo, and Elisa Giaccardi (Giaccardi et al., 2014; Robbins, Giaccardi and Karana, 2016; Robbins et al., 2015) on the topic of aging and of traces, Jenny Bergström about 'Becoming Materials' (Bergström et al., 2010) and the research of Hiroshi Ishii on 'radical atoms' (Ishii et al., 2012).
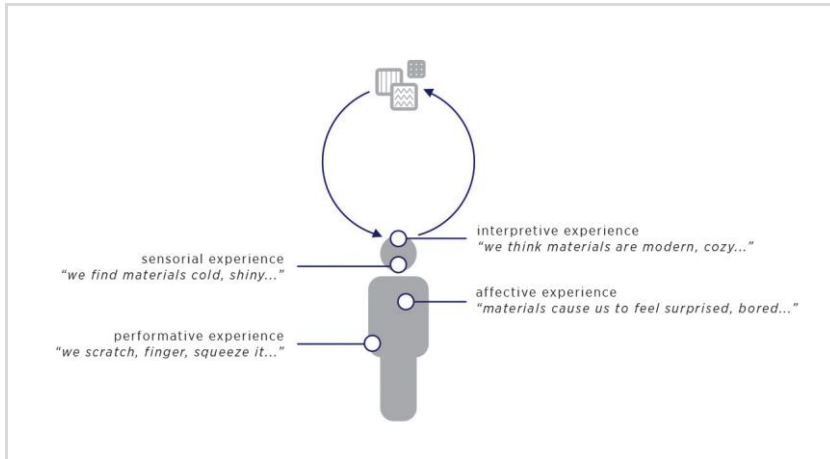
Figure 1   A conceptual framework of the levels of Materials Experience according to Karana and Giaccardi's definition (2015).

According to HCI notions and focusing on the interaction between people and things, the framework of Material Experience was recently extended by Giaccardi and Karana (2015), by adding a new level. This level is named 'performative experience' and acknowledges the active role of materials in shaping *ways of doing*, physical actions and practices. *We scratch, finger, squeeze it, etc.* (fig. 1).

The introduction of this level in the framework of Materials Experience opens to considerations on materials as a part of social and cultural practices. Indeed, this leads to a shift for designers from considering individual relationships between people and material artifacts to a whole experience, where the experiential qualities of materials allow encounters, performances, and social practices. Designers should anticipate, envision, and create a situation in which desired practices may arise and people may assimilate the material artifact, and its behavior, into their ongoing performances (Karana et al., 2016). Through this, materials are 'co–performers' of practice with people in the 'socio–ecological context' (Robbins et al., 2016).

Giaccardi and Karana's contribution to Materials Experience grounds on a non–anthropocentric or 'thing–centered' approach to design (Cila et al., 2015; Giaccardi et al., 2016), which considers the human as an element in a broader system of relations between humans and non–humans, and non–humans playing an active role in action and experience. This perspective

takes into consideration the notion of agency, that, according to Karana and Giaccardi, is not the attribution of intentionality to materials, but the acknowledgment of how humans and materials interact relationally in a productive entanglement and a mutual relation. According to Giaccardi and Karana (2015) 'neither people nor objects, but instead the mutual interaction between people and objects, gives rise to particular materials experiences.' Agency is the result of the relation between human agency, i.e. the ability and power of people to control, shape and use materials on their purpose, and material agency, i.e. the power of the non–human entities to facilitate, suggest, provoke or prevent actions. This position on the argument about where agency is situated states that agency is neither only in human nor only in material, but in both of them and in the relation between them. This is close to the positions of many authors as Merleau–Ponty (1962), Dewey (1980), Miller (1987), and on the 'theory of imbrication' (Taylor, 2001) and of 'diffused agency' (Gell, 1998).

We can state that the concept of Materials Experience grounds on the relationship between humans and non–humans. On the contrary, the concept of Agency implies also non–human relations and social interactions without the presence of human actors (Latour, 2005). As a matter of fact, 'Agency is often understood simply as the ability to act. The agent is someone, often recognized as a subject, who can undertake action' (Borgerson, 2005). The material agency is the capacity for non–human entities to act on their own, apart from human intervention (Leonardi, 2011).

From these observations, we raise a research question. *How is the Materials Experience framework influenced by materials agency in non–human relations?* To answer this question, we introduce a list of classes of interactive materials. In these materials, non–human relations through materials agency are evident. Observations on their behaviors, properties, and performances could bring to insights to answer the research questions.

Classes of interactive materials

We selected a list of interactive materials that can establish non–human relations, communicating and exchanging data with other non–human entities, i.e. other materials, technologies, artifacts, organisms and the environment. We use the term 'interactive materials' with a broad meaning, including not only computational, electronic, and digital materials, but all the materials able to respond and establish a two–way exchange of

information with other entities, influencing each other, through chemical, mechanical, electronic, and biological means. Among these materials, there are both conventional and low–tech materials, and emerging and technological ones. These materials are described in an order based on traditional classification by literature. For each of these classes of materials a description of their peculiar properties, thanks to which they can relate to non–human entities, will be provided, and examples of applications and experimentations will be described through best practices and case studies. To answer the research question, we examined the physical and temporal behaviors of these materials, their properties, and performances, highlighting their materials agency in non–human relations and considering their autonomous, induced, and interpreted components.

Aging materials

'Aging' is the natural dynamic behavior of materials due to environmental factors. It is a process that changes the physical and chemical structure of substances through time, or a whole of physical–chemical phenomena that alter properties of materials, according to specific mechanisms related to material properties. From a technical and engineering perspective, the measurement of aging and degradation is a conventional practice to define durability of materials. Durability is described as the conservation of physical and mechanical characteristics of materials and structures, and as the capacity to last through time resisting to aggressive actions of the environment, without degradation (Ostuzzi et al., 2011).

Some materials, more than others, have peculiar and unique ways to age that are evident and expressive, like patina, i.e. copper oxidation (Fontanille, 2002). *Stain Cups* are partially glazed ceramic cups by Laura Bethan Wood (www.bethanlaurawood.com/work/stain) that create a relation with the drink they contain by absorbing it in some portions of the surface, changing color through time and revealing a designed pattern. *Verderame* by Odoardo Fioravanti (www.fioravanti.eu/project/verderame) is a set of copper tiles that due to oxidation shows through time a graphic pattern.

This kind of behaviors is slow, difficult to control and to design by the human, because latent in the material and subjected to the randomness of environmental factors. Some contemporary designers have decided to embrace materials aging, by giving value to the mutations of materials provoked by time and by environmental factors and designing a graceful manner to age (Rognoli and Karana, 2014).

Figure 2   The materials of Sui Bag are able to interact with the environment with two contrasting behaviors and qualities. Master thesis project by Giulia Ardenghi, supervisor: Valentina Rognoli (Ardenghi, 2014).

Smart materials

'Smart materials' is an expression used to identify functional materials that have changeable properties, and that can reversibly change some features like shape or color in response to a physical or chemical influence, e.g. light, temperature or the application of electric field. Some of these materials are shape memory alloys, thermochromic and photochromic polymers, photoluminescent materials (Addington and Schodek, 2005; Cardillo and Ferrara, 2008; Ferrara and Bengsiu, 2013; Ritter, 2006; Rognoli, 2015). This behavior is designed, reversible, very fast in its manifestation, and repetitive.

A case study is *Sui Bag* (Ardenghi, 2014; Rognoli, 2015). Sui Bag is a project that aims to manifest the qualities of the interactive behavior of smart materials in contrast with aging materials. It is a bag conceived as a personal object accompanying the owner in daily life. Due to its materials changing over time, it elicits in the user the awareness of the incapability of controlling and predicting its changes. The concept of the bag is based on the difference of reaction to the passing time of the inner and of the outer parts of the bag, thanks to the use of two different materials. The first one, leather (Tsaknaki, Fernaeus and Schaub, 2014), is slow and irreversible. The second one, a photochromic smart yarn, is fast and reversible. The outer part was realized in vegetable–tanned leather, which ages and lasts over time, recording and accepting in an irreversible manner all the alterations, evidence, traces and imperfections due to the passage of time. Through this, it enables a slow and continuous mutation of the artifact itself. On the contrary, the inner part of the bag changes over time in a rapid and reversible manner, eliciting temporary changes, thanks to the use of

photochromic materials, i.e. smart materials able to change their chromatic optical properties according to light exposure. The final design solution of the bag can interact with the environment by receiving an irreversible and slow accumulation of traces and patina, and temporary and quick color alterations (fig. 2).

Self–healing materials

'Self–healing' or 'self–repairing materials' are synthetic substances with the ability to automatically repair any damage to themselves without an external diagnosis of the damage or human intervention. In contrast to conventional materials that degrade over time due to fatigue, environmental conditions or damages, self–healing materials counter degradation through the initiation of a repair mechanism that responds to micro–damages. This healing mechanism varies from an intrinsic repair of the material to the addition of a repair agent contained in a microscopic vessel inside the material structure. Self–healing materials cover all classes of materials, i.e. metals, ceramics, concrete, but the most common types are polymers and elastomers. In some cases, the healing process activates in response to an external stimulus, i.e. light, temperature change. One example of these materials is a self–healing Concrete developed by TU Delft (www.citg.tudelft.nl/en/research/projects/self–healing–concrete) able to repair its cracks, by embedding calcite–precipitating bacteria in the concrete mixture.

Augmented, computational and connected materials

Nowadays and even more in the future, computation surrounds us in our daily lives. Technologies are unobtrusive and seamless, almost disappearing. Thanks to the embedment of technologies and computers, materials can obtain the ability to act and to interact not only with users but also with other objects or with the environment, i.e. *machine–to–machine* behavior. The term 'augmented materials' (Razzaque, Delaney and Dobson, 2013) denotes a family of materials with general physical and computational properties, in which electronics are seamless and embedded during the fabrication of the material. Similarly, the term 'computational composites' (Vallgårda and Redström, 2007) identifies composite materials in which at least one of the components has computational capabilities. This definition acknowledges computer as a material, with specific computational properties, which might be included in a composite material to become useful in design. In a similar way, due to the diffusion of 'Smart Objects' and

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the 'Internet of Things' (Giaccardi, 2015; Kuniavsky, 2010), 'connected materials' that might act through a *machine–to–machine* behavior might emerge. Specifically, one of the aims of the *ICS_Materials* research project (Rognoli, Arquilla and Ferrara, 2016) is to investigate on this class of materials and develop a definition, framework, and strategies for them. Thanks to sensors and actuators, these materials can have a broad range of behaviors and qualities that should be decided at first stage by designers through 'material programming' (Vallgårda et al., 2016).

Growing materials

'Growing materials' are living materials or composite materials based on living organisms that use the growth of their living substrate, e.g. bacteria, microbes or fungi, as manufacturing and shaping process, i.e. 'Biodesign' (Van Der Leest, 2016; Myers, 2012). This definition covers a broad range of materials. The designer of *SuperOrganism* (www.uovodesign.com) established a close collaboration with bees in the manufacturing of small artifacts and packaging. They are made of beeswax and propolis, by providing a shape suggestion, and letting the bees build the artifact. *Bicouture* (www.biofabricate.co) is a leather–alike material obtained by bacterial cultures.

A case study is *A Matter of Time* (Parisi, 2015; Parisi, Rognoli and Ayala, 2016). A Matter of Time is a research and experimentation project on a growing material based on mycelium – also known as the roots of mushroom – and a natural substrate made of agricultural waste fibers. The project aims to understand, exploit, and implement the inner and spontaneous mechanism of growing of the material. Its manufacturing and shaping process is based on the growing of mycelium that acts as a binding agent to the natural substrate, inside a mold, for several days. The only task for the designer is to assist the material during its growing stages, e.g. by preparing a proper environment for the material to grow. Since it is a living organism, it is spontaneous, and it is not possible to have full control of it during its growing, bringing each time to different results (fig. 3).

Figure 3   The project a Matter of Time explores the potentialities of mycelium–based growing materials highlighting its spontaneity and autonomy. Master Thesis project by Stefano Parisi, supervisor: Valentina Rognoli (Parisi, 2015).

Other materials

Finally, other materials show interactivity without being part of the previous categories. One example is *Transformative Paper* by Florian Hundt, a layered structure, that reacts to environmental conditions by changing its shape thanks to the anisotropic properties of moisture expansion of papers.

Results and discussion

Although these classes of materials appear to be very different and with their own characteristics and behaviors, observing them it is possible to identify a common paradigm.

- First, the human entity sets the beginning of the process by programming, guiding or facilitating the material in its action.
- Then, the non–human entity – both the material and the environment or other non–human entities – expresses itself as actant and produces a result thanks to a latent performative pattern, which is partially innate and partially induced by the human entity.

- Finally, this behavior and its effect are perceived and interpreted by people, i.e. a human entity that have experience of it as observers.

It is evident that when designing a material or embodying it into a product, the designer's vision for the desired Materials Experience manifests through experiential qualities of the material, as well as technical properties. With interactive materials, it expresses also through the qualities of their dynamic and active behavior, in particular through their non–human interrelations. By materializing their vision of materials experience, designers transfer a set of values, beliefs, aspirations, and ideas into the materials, and, through the materials, they communicate them to society. This observation is connected to the metaphor of technology–as–text (Joerges and Czarniawska, 1998). Designers exploit the inner dynamic mechanisms of materials to convey a vision that reveals itself through the qualities of their active behavior. Materials tell us something through changes and traces. 'If no trace is produced, they offer no information to the observer and will have no visible effect on other agents. They remain silent and are no longer actors: they remain, literally, unaccountable' (Latour, 2005). Through changes and traces materials express themselves, as well as people that produced them and that use them do (Parisi and Rognoli, 2016; Robbins, Giaccardi and Karana, 2016; Robbins et al., 2015; Tsaknaki and Fernaeus, 2016).

Thus, the physical and temporal behaviour of materials and the results have peculiar features that influence the material experience. Thanks to this observation we propose to expand the framework of Materials Experience by adding another level that demonstrates the relevance of material non–human interactions in the creation of the Materials Experience. The level of Materials Experience here proposed answers to the following questions: 'How do the materials interact with the environment and other things? In which manner and with which behavior? Which are the results?' (fig. 4).
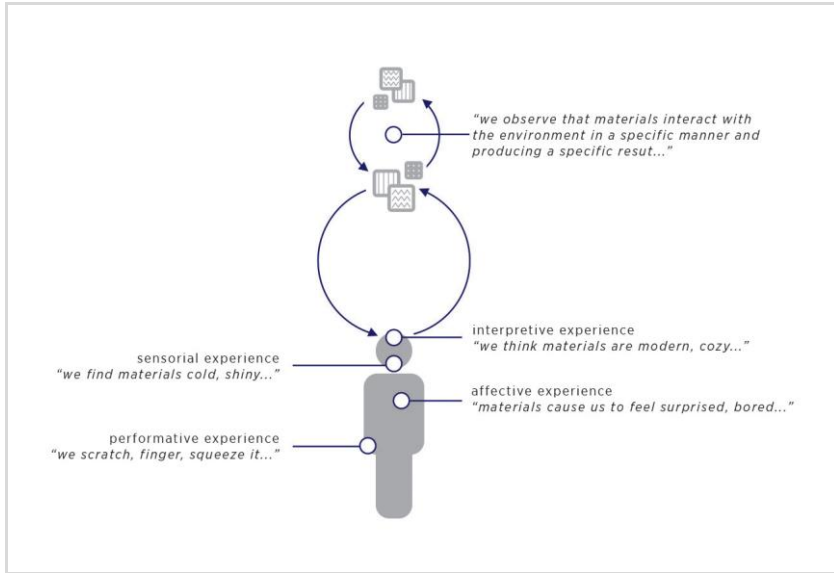
Figure 4   A proposal for expanding the Materials Experience framework by adding a level related to non–human relations of active materials.

Observing the described classes of materials, we can state that they have different behaviors and results and that we might identify a range of qualities characterizing them. These qualities are related to diverse criteria that need to be further investigated and classified:

- the speed of action
- the regularity or irregularity of actions
- the reversibility or irreversibility of mutation
- the predictability or unpredictability of actions
- fuzzy behaviors
- the repetition
- the autonomy of automatism of action
- the modality of transformation and expression, e.g. stratification, reduction, movement, sound, light, etc.

Although with interactive materials all these observations appear very evident, they may also be applied to conventional materials with a lower degree of interactivity.

In addition, we argue that it may be required to rename the levels of materials experience to make it more clear and consistent with classical

terminology and avoid misunderstanding, introducing the term 'aesthetic' instead of 'interpretative', and the term 'aesthesic' instead of 'sensorial'.

Finally, observing the paradigm, it is evident that matter is active, but cannot be independent of human intervention and interpretation. In particular, the designerly intentionality of humans appears to have the fundamental role of giving a purpose to the actions of non–human entities – by programming, designing, guiding and facilitating – transforming active matter into purposeful and specialized interactive materials, through the design process. As Manzini (1986) stated, 'matter becomes material when it is included in a design project and becomes part of a product.'

Conclusions

The aim of this research was to investigate how materials agency in non–human relations influences the framework of Materials Experience. To answer, we considered interactive materials, i.e. emerging and traditional families of materials that have the ability to establish non–human relations with other substances, organisms, and environments. These families of interactive materials were described including best practices and case studies of research projects, highlighting the different types of material behaviors, their qualities, and the results of interactions.

As a result, we identified a paradigm that puts human and non–human entities in relations, and an expansion of the Materials Experience framework, by considering non–human interactions of materials and how people perceive them through their qualities. This new experiential level, its qualities, and the paradigm need to be further developed and studied in the in the scope of the *ICS_Materials* research.

Furthermore, it contributes to the *ICS_Materials* research project examining some case studies of materials through the lens of Material Agency and Materials Experience.

References

Addington, M.D. And Schodek, D.L. (2005) *Smart Materials and Technologies for the Architecture and Design Professions*. Oxford: Architectural Press.
Ardenghi, G.M.F. (2014) *Tracce imperfette su smart materials e tradizionali: il progetto della borsa Sui*. Master Thesis in Fashion Design, School of Design of Politecnico di Milano, Italy.

Ashby, M. and Johnson, K. (2002) *Materials and Design*. Oxford: Butterworth–Heinemann.

Bergström, J., Brendon, C., Frigo, A., Mazé, R., Redström, J. and Vallgårda, A. (2010) Becoming Materials: Material Forms and Forms of Practice. *Digital Creativity*, 21 (3), 155–172

Borgerson, J. (2005) Materiality, Agency, and the Constitution of Consuming Subjects: Insights for Consumer Research. *Advances in Consumer Research*, 32, 439–443.

Cardillo, M. and Ferrara, M. (2008) *Materiali intelligenti, sensibili, interattivi*. Milano: Lupetti.

Cila, N., Giaccardi, E., Tynan–O'Mahony, F., Speed, C. and Caldwell, M. (2015) Thing–centered Narratives: A Study of Object Personas. In *Proceedings of the 3rd Seminar International Research Network for Design Anthropology*.

Cornish, E. (1987) *Materials and the Designer*. Cambridge: Cambridge University Press.

Desmet, P.M.A. and Hekkert, P. (2007) Framework of Product Experience. *International Journal of Design*, 1 (1), 57–66.

Dewey, J. (1980) *Art as Experience*. New York: Perigee Books.

Fernaeus, Y., Murer, M., Tsaknaki, V. and Solsona Belenguer, J. (2014) Handcrafting Electronic Accessories Using 'Raw' Materials. In *Proceedings of TEI '14*.

Fernaeus, Y. and Sundström, P. (2012) The Material Move. How Materials Matter in Interaction Design Research. In *Proceedings of DIS '12*.

Ferrara, M. and Bengisu, M. (2013) *Materials that Change Color*. Heidelberg: Springer.

Fontanille, J. (2002) La patina e la connivenza. In Landowski, E. and Marrone, G. (eds.), *La società degli oggetti. Problemi di interoggettività*. Roma: Meltemi.

Gell, A. (1998) *Art and Agency*. Oxford: Clarendon Press.

Giaccardi, E. (2015) Designing the Connected Everyday. *Interactions* 22 (1), 26–31

Giaccardi, E., Cila, N, Speed, C. and Caldwell M. (2016) Thing Ethnography: Doing Design Research with Non–Humans. In *Proceedings of DIS '16*.

Giaccardi, E. and Karana, E. (2015) Foundations of Materials Experience: An Approach for HCI. In *Proceedings of CHI'15*.

Giaccardi E., Karana, E., Robbins, H. and D'Olivo, P. (2014) Growing Traces on Objects of Daily Use: A Product Perspective for HCI. In *Proceedings of DIS'14*.

Ikemiya, M. and Rosner, D. (2013) Broken Probes: Toward the Design of Worn Media. *Journal of Personal and Ubiquitous Computing*, 18 (3), 671–683.

Ishii, H., Lakatos D., Bonanni L. and Labrune J. (2012) Radical Atoms: Beyond Tangible Bits, toward Transformable Materials. *Interactions*, 19 (1), 38–51.

Joerges, B. and Czarniawska, B. (1998) The Question of Technology, or How Organizations Inscribe the World. *Journal of Organization Studies*, 19 (3), 363–385.

Karana, E. (2009) *Meanings of Materials*. Saarbrücken: Lap Lambert Academic Publishing.

Karana, E., Hekkert, P. and Kandachar, P. (2010) A Tool for Meaning Driven Materials Selection*. Materials and Design*, 31 (6), 2932–2941.

Karana, E., Hekkert, P. and Kandachar, P. (2007) Material Considerations in Product Design: A survey on Crucial Material Aspects Used by Product Designers. *Materials and Design*, 29 (6), 1081–1089.

Karana, E., Giaccardi, E., Stamhuis, N. and Goossensen, J. (2016) The Tuning of Materials: A Desgner's Journey. In *Proceedings of DIS'16*.

Karana, E., Pedgley, O. and Rognoli, V. (2015) On Materials Experience. *Design Issues*, 31 (3), 16–27.

Karana, E., Pedgley, O. and Rognoli, V. (eds.) (2014) *Materials Experience: Fundamentals of Materials and Design*. Butterworth–Heinemann: Elsevier.

Kuniavsky, M. (2010) *Smart Things: Ubiquitous Computing User Experience Design*. Burlington: Morgan Kaufmann.

Latour, B. (2005) Third Source of Uncertainty: Objects Too Have Agency. In Latour, B. (2005). *Reassembling the Social. An introduction to Actor–Network–Theory.* Oxford: Oxford Univeristy Press.

Leonardi, P. (2011) When Flexible Routines Meet Flexible Technologies: Affordance, Constraint, and the Imbrication of Human and Material Agencies. *MIS Quarterly*, 35 (1), 147–167.

Manzini, E. (1986) *La Materia dell'Invenzione*. Milano: Arcadia.

Merleau–Ponty, M. (1962) *Phenomenology of Perception*. New York: Humanities Press.

Miller, D. (1987) *Material Culture and Mass Consumption*. Oxford: Berg.

Myers, W. (ed.) (2012) *Biodesign. Nature, Science, Creativity.* London: Thames & Hudson.

Ostuzzi, F., Salvia, G., Rognoli, V. and Levi, M. (2011) *Il valore dell'imperfezione*. Milano: Franco Angeli.

Parisi, S. (2015). *A Matter of Time. Tempo Processo Materia*. Master Thesis in Product Design for Innovation, School of Design of Politecnico di Milano, Italy.

Parisi, S. and Rognoli, V. (2016). Superfici Imperfette. *MD Journal*, 1, 78–91.

Parisi, S., Rognoli, V. and Ayala, C. (2016). Designing Materials Experiences Through Passing of Time. Material Driven Design Method applied to Mycelium–based Composites*. In *Proceedings of 10th International Conference on Design & Emotion*.

Razzaque, M.A., Delaney, K. and Dobson, S. (2013) Augmented Materials: Spatially Embodied Sensor Networks. *International Journal of Communication Networks and Distributed System*, 11 (4), 453–477.

Ritter, A. (2006) *Smart Materials in Architecture, Interior Architecture and Design*. Berlin: Springer Science & Business Media.

Robbins, H., Giaccardi, E., and Karana, E. (2016) Traces as an Approach to Design for Focal Things and Practices*. In *Proceedings of NordiCHI '16*.

Robbins, H., Giaccardi E., Karana, E. and D'Olivo, P. (2015) Understanding and Designing with (and for) Material Traces. *Studies in Material Thinking*, 13 (1), 1–24.

Robles, E. and Wiberg, M. (2010) Texturing the Material Turn in Interaction Design. In *Proceedings of TEI'10*.

Rognoli, V. (2010) A Broad Survey on Expressive–sensorial Characterization of Materials for Design Education. *METU Journal of Faculty of Architecture*, 27 (2), 287–300.

Rognoli, V., (2015) Dynamism and Imperfection as Emerging Materials Experiences. A Case Study. In *Proceedings of DesForm 2015*.

Rognoli, V., Arquilla, V. and Ferrara, M. (2016). ICS_Materials: interattivi, connessi e smart. *MD Journal*, 2, 44–57.

Rognoli, V. and Karana, E. (2014) Towards a new Material Aesthetic Based on Imperfection and Graceful Ageing. In Karana, E., Pedgley, O. and Rognoli, V. (eds.) (2014) *Materials Experience: Fundamentals of Materials and Design*. Butterworth–Heinemann: Elsevier.

Rosner, D.K. and Ames, M.G. (2014) Designing for Repair? Infrastructures and Materialities of Breakdown*. Proceedings of CSCW '14*.

Rosner, D.K., Ikemiya, M., Kim, D. and Koch, K. (2013) Designing with Traces. In *Proceedings of CHI'13*.

Rosner, D.K. and Taylor, A.S. (2012) Binding and Ageing. *Journal of Material Culture*, 17 (4), 405–4214.

Taylor, J.R. (2001) Toward a Theory of Imbrication and Organizational Communication. *The American Journal of Semiotics*, 17 (2), 269–298.

Tsaknaki, V. and Fernaeus, Y. (2016) Expanding on Wabi–Sabi as a Design Resource in HCI. In *Proceedings of CHI'15*.

Tsaknaki, V., Fernaeus, Y. and Schaub, M. (2014) Leather as a Material for Crafting Interactive and Physical Artifacts. In *Proceedings of DIS '14*.

Vallgårda, A. (2015) Giving form to Computational Things: Developing a Practice of Interaction Design. *Journal of Personal Ubiquitous Computing*, 18 (3), 577–592.

Vallgårda, A., Boer, L., Tsaknaki, V. and Svanæs, D. (2016) Material Programming: A New Interaction Design Practice. In *Proceedings of DIS'16*.

Vallgårda, A. and Redström, J. (2007) Computational Composites. In *Proceedings of CHI'07*.

Vallgårda, A. and Sokoler, T. (2010) A Material Strategy: Exploring Materials Properties of Computer. *International Journal of Design*, 4 (3), 1–14.

Van der Leest, E. (2016) *Form Follows Organism. The Biological Computer*. Megan Hoogenboom.

Wiberg, M. (2014) Methodology for Materiality: Interaction Design Reseach through a Material Lens. *Journal of Personal and Ubiquious Computing*, 18 (3), 625–636.

What Does Light Do?
Reflecting on the Active Social Effects of Lighting Design and Technology

Daria CASCIANI[*a] and Fulvio MUSANTE[a]

[a] Politecnico di Milano

The studies about the social effects of lighting describe lighting as an important social means and an agent that can influence people emotional, behavioural and social experiences despite cultural, social and individual differences. A cross–cultural analysis of studies about lighting report that higher lighting levels induce greater arousal, activating louder conversations or a more general communication meanwhile a domestic environment with low lighting levels influences more relaxed and intimate disclosure. Certain lighting atmospheres are appraised as more hospitable for people, while some patterns of lighting distributions can affect people proxemics.

In this paper, we investigate the active role of lighting in setting the social relationships between people by providing a theoretical framework based on an extensive literature review and by presenting the results of several designed lighting probes. From the user confrontation through qualitative and quantitative analysis, we reflect on the sociality of lighting that act for social intimacy/inclusion or social exclusion, with a subtle agency on people.

Keywords: *Lighting agency; psychosocial effects; social lighting*

Introduction

The majority of the studies related to lighting have been focused on visual performance with lighting ensuring optimal vision and comfort in carrying out visual tasks (Boyce, 2003). More than solely vision, lighting can have a physiological influence on individuals by setting their circadian rhythm (Rea, 2002). In addition to this, the visual perception is much more complex because it is influenced by cultural associations, interpretations and expectations which can derive from social and personality features

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[*] Corresponding author: **Daria Casciani** | e–mail: **daria.casciani@polimi.it**

(Veitch and Newsham, 1996). Lighting can also have psychological effects and can influence appraisal, affect and behaviours (de Kort and Veitch, 2014; Illuminating Engineering Society, 2017). Behaviours can be considered as a function of personal factors, defined by culture, memory, personality, previous experiences, and as a function of environmental factors which constitute the tactile, thermal, acoustic and visual experience of the space. Allowing the vision and perception of the environment, lighting can also contribute to affect behaviours. In this regard, several studies (Kobayashi, 2013; Magielse and Ross, 2011; Veitch and Gifford, 1996) have investigated the implications of certain luminous conditions in defining socially including / excluding spaces and social negotiations (fig. 1).
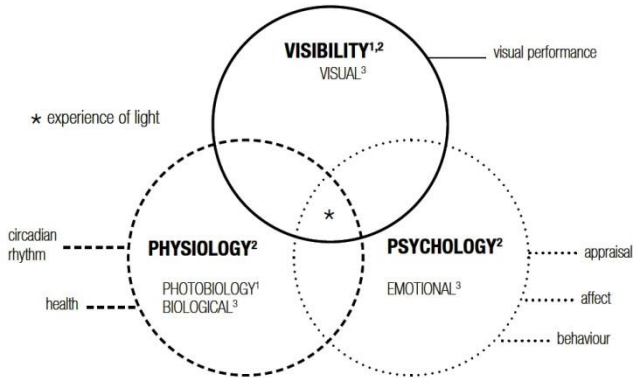

Figure 1   The multiple effects of the lighting experiences. Diagram adapted from Veitch and Newsham (1996) [1], Kobayashi (2013) [2] and Magielse and Ross (2011) [3].

Research question

Lighting, as a material and immaterial agent, is manipulated in a social way to lit places and to influence social experiences, depending on people social and cultural associations (Bille and Soresen, 2007). This paper wants to highlight the many ways lighting can influence and act on sociality (social appraisal and behaviours) with a particular focus on new lighting technologies (Solid State Lighting and Digital Controls).

Methodology

Initially, an extensive literature review was performed through scientific journals of Lighting, Interior and Interaction design, Psychology and Social Sciences, by using the keywords 'lighting', 'social interaction', 'social light', 'lighting behaviour', 'light agency'. A content analysis was operated and, even if not exhaustive, the selected references provide a robust theoretical framework to the topic.

Subsequently, three case studies (CS) has been designed and performed through experimental lighting design probes, conducted in the field and in the laboratory. Investigations were based on hybrid research techniques with both a qualitative and quantitative approach: observations documented with videos and photography, audio–recorded semi structured interviews (50 in CS1; 40 in CS2; 20 in CS3) and surveys (40 questionnaires in CS2). Those were analysed and compared to obtain a deeper understanding about the social agency of lighting in the urban environment.

Lighting and social situations

As observed in normal daily life, different social situations require different lighting conditions: people favour higher lighting levels for demanding visual tasks and lower lighting levels for non–visual activities, this depending both on social and environmental factors (Biner et al., 1989; Butler and Biner, 1987). A study of Kobayashi et al. (2001) concluded that concentration and self–controlled behaviours (e.g. working, studying) are preferred in bright environments, meanwhile active impersonal and relaxed behaviours (e.g. dining and talking with friends) are preferred in bright non–uniform lighting. Conversely, self–centred and relaxed behaviours are preferred in dim, dark and non–uniform lighting condition in no or low control situations (e.g. relaxing, talking to a friend, dining with the partner). Limitations of these studies lie in the indirect way they were performed due to the weak link between subjective appraisal and real behaviours (Hayward and Birenbaum, 1980).

Lighting, positive affect and social appraisal

Lighting can influence people positive affect, impressions and mood, which in turn could lead indirectly to more positive behaviours in social situations. Lower lighting levels (150lux versus 1500lux) and warm white light induce calmer and more relaxed feelings which also influence a positive social attitude (Baron, Rea and Daniels, 1992).

The impressions of a socially inclusive environment can be guided by the spatial distribution of light which carry both environmental information and social meanings to which people react in consistent ways. Lighting can influence the experience of the space regarding orientation, mood, wellbeing and social interaction (Flynn et al., 1973; 1979). By changing the lighting conditions (spatial distribution, lighting levels, colour temperature), people can perceive an alteration of the space (Flynn, 1977; Flynn and Spencer, 1977): in particular, the impression of publicness derives by higher lighting levels with a more uniform distribution from overhead lighting fixtures meanwhile the impression of relaxation, from warm and non–uniform wall–lighting distribution with lower levels (Flynn, 1988).

Lighting influences on social behaviour

Lighting has psycho–social effects on people by influencing spatial behaviours, proxemics and communication.

Lighting and spatial behaviour

Involuntary human phototropism is the attraction toward bright lighting sources which can direct people's eyes (Hopkinson and Longmore, 1959), lengthen the attention of students to specific tasks (Giusa and Perney, 1974), drive people movements through brighter paths (Taylor and Socov, 1974) and orient the body posture facing an illuminated area to watch the taking place action (Flynn et al., 1973).

Lighting and proxemics

From the studies about proxemics, lighting affects the perception of the personal space bubbles (Hall, 1966) by providing organised visual cues to identify the occupation of a territory (Lam, 1992).

Adams and Zuckerman (1991) investigated the influence of light on the appropriate personal distance of standing females: under lower lighting, the distances on the sides and to the rear are bigger than the ones under brighter conditions due to feelings of inappropriate intimacy. Other studies showed that the social closeness between people is achieved under dim (Werth, Steidle and Hanke, 2012) and dark lighting conditions (Gergen, Gergen and Barton, 1973; Sommer, 1969) by increasing cooperation and affiliation between individuals.

Lighting can also negatively affect the impression of anonymity: dark or dim lighting conditions can enhance self–interested and dishonest

behaviours (Zhong, Bohns and Gino, 2010) because people feel unobserved. Brightness (being under the spotlight) instead reveals behaviours to others leading to more self–controlled behaviours (Steidle and Werth, 2014).

Lighting and communication

Lighting can influence communications between individuals both in the verbal (tone of voice, fluency of speech, type of content disclosure) and nonverbal behaviours (sociofugal/sociopetal orientation, body angling, seating posture, facing position and direction, gaze orientation and eye contact, facial expressions) (Altman, 1975).

Lighting and conversational volume

Studies about the effects of lighting on speaking volume report controversial results. Students talking in a university corridor were found less noisy under dim lighting conditions (10–270lux), due to the increased feeling of intimacy, and louder in brighter lighting conditions, due to the greater arousal (Feller, 1968; Sanders, Gustanski and Lawton, 1974). Similarly, Kobayashi (2013) found that couples spoke louder in bright conditions (table 800lux and ambient 500lux) and quieter in dim conditions (table 50lux and ambient lighting 1lux) meanwhile, in extremely non–uniform lighting (candlelight: table 3lux and ambient 0.1lux), the speaking volume depended on personality. Conversely, Veitch and Kaye (1988) found that higher lighting level (1274lux) resulted in decreased volume among students talking about fictional jobs.

Lighting and communication disclosure

Controversial results were also found in studies exploring the influence of lighting in communication disclosure. Gifford (1988) found that higher illuminance levels (900lx) and a homelike setting increased the arousal, which in turn increased both general and auto–referential written communication with a known friend. Differently, lower lighting levels (150lx) increased intimate social interaction and higher disclosure in a counselling room (Miwa, 2006).

Lighting and personal distance

Carr and Dabbs (1974) found that dim lighting is preferred in situations requiring intimacy but, when intimacy is considered inappropriate (e.g. during an interview), it has negative visual (decrease in eye gaze length) and paralinguistic (increase of pauses) effects. Accordingly, Kobayashi (2013)

found that darker conditions influence an increase in eye contact and leant forward posture which is higher in male–female and female–female couples.

Case studies: from indoor to outdoor social lighting

The agency of lighting able to transform the impression from a very intimate and private, to a public, formal and detached one has been investigated in outdoor settings through a series of lighting probes, designed and prototyped using LEDs lighting sources and digital controls aided with sensors. Lighting scenarios and adaptive luminous scenes through implicit interactions (Ju and Leifer, 2008) has been tested in order to follow or support different social activities and behaviours for sociality explorations (Casciani, 2014b).

The first case study has been set up in a Living Light Lab at the Eindhoven University of Technology Campus (Living Light Lab, 2017) to explore the lighting influence in space territorialisation and personalization. Overt behaviours of 50 users were observed (focusing on body language, gestures, head movements and detournament) and 50 semi–structured interviews were conducted with audio recordings, followed by the transcript and clustering of quotations for analysis.

The same space was used to perform the second case study: seven lighting scenarios different in terms of the tonality of white (3000K –6000K) and lighting distribution (uniformity, non–uniformity and a layered approach with both dimmed ambient lighting and accent lighting) have been designed and tested with 40 participants (27 male–13 female, 77.5% students; ave. age 23 years old–55% Dutch, 12.5% Chinese, 5% Turkish). The subjective appraisal of the sociality of lighting (privacy / publicness, cosiness / detachment, safety) was assessed through a revised atmospheric survey (Vogels, 2008) 40 questionnaires were administered followed by semi–structured interviews.

Finally, in the third case study, the sociopetal/sociofugal behaviours and social proximity were investigated in the Environmental Testing Room at the Politecnico di Milano (Laboratorio Luce, 2017). Three lighting scenarios different in terms of the tonality of white lighting (3000K–5000K), distribution (direct–direct/indirect) and intensity has been prototyped under a lighting shelter with integrated sensors for monitoring presence and body posture. 20 participants in couples (14 female–6 male, 80% students; average age 25 years old–50% Italian, 15% Turkish, 5% Lebanese 5% Russian) performed role–play of different social activities (e.g. talking with a

known friend, meeting a stranger in the city, discussing for a job, counselling). They were videotaped for research purpose and interviewed about the experience (20 interviews).

Social appraisal of street lighting

The first exploration started from the notion of 'environmental experience' (Canter, 1986) that describes the space as a unit of physical attributes, emotional cognitions and human activities.
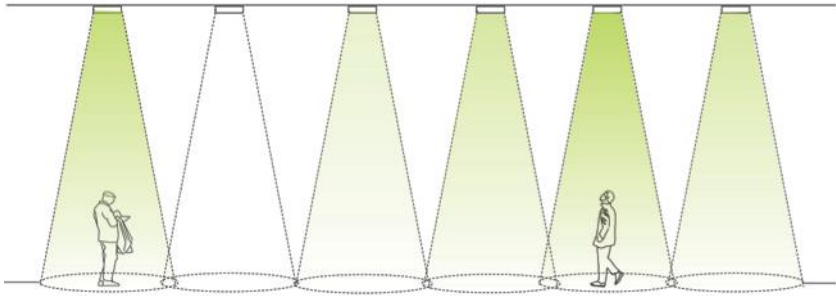

Figure 2   The lighting environmental experience set up for investigating territorial space personalization.

The influence of lighting was investigated in terms of space personalization and people territorialisation by following users movements with slow and subtle lighting events occurring in a linear causal way for navigating the space. People were detected by two sensors which in turn, triggered the lighting in relation to their position and behaviours. Lighting was turned on for welcoming people in the space, illuminating the path and showing the foreground with warm white and higher lighting levels (fig. 2).

Interviews highlighted different levels of positive impressions and approval: lighting was found to be significant in personalizing the space and giving a sense of control, evocating a positive company meanwhile having a reassuring power. Adaptive lighting was defining a subtle relationship with people through unconscious and not–invasive perception.

In many cases, people were detouring, watching around or trying to see if lighting was following them. Hence lighting determined an impression of subtle management and active personalization of the luminous atmosphere. Even implicit, the interaction with lighting was found to contribute in restoring an intimate connection with the space. Besides this, the direct bodily interaction with lighting increasing both levels and personal control,

as found by Haans and de Kort (2012), ensures security perception and comfort of the individuals, without creating embarrassment.

Social appraisal of square lighting

From the studies of Flynn performed in indoor spaces, the subjective appraisal of seven differed lighting scenarios (distribution, contrast between light and shadows and correlated colour temperature) was performed through a pairwise comparison to assess sociality in terms of safety and security perception, privacy/publicness and cosiness/detachment comfort and liveliness impressions.
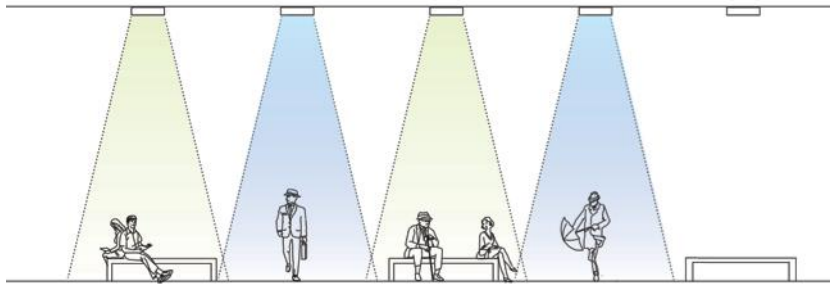

Figure 3   The lighting environmental experience set up for investigating privacy/publicness, cosiness/detachment of the different lighting conditions.

From both qualitative and quantitative results, (Casciani, 2014a; Casciani and Rossi, 2015) people found warm white lighting more suitable for socialisation and contributing to the perception of cosiness and hospitality in comparison to cold white lighting that was found too much technical and not convenient for social activities. The interviewed participants were continuously referring to past experiences and interpretation: warm lighting preference, for instance, was associated to traditional public lighting with an 'orange–yellowish colour' and to domestic lighting 'with a feel at home touch'.

The bright and uniform lighting atmosphere was associated with safety perception and extreme functionality. Differently, a layered approach with a dim ambient lighting and spotlighting on meaningful visual cues was associated with a more evocative atmosphere for social inclusion, enhancing conversation and fostering social interaction. The luminance contrast ratio of lit and dim spaces influenced higher emotional effects which were

evident during the interviews: the environment was found comfortable, interesting, mysterious and reassuring. Even if not statistically significant, the preference for more light for safety issues depended both from gender (e.g. female) and personality characteristics (femininity), meanwhile the interest and attraction toward the shadow–light juxtaposition were connected to past experiences of positive social situations: 'It reminds me the lighting you find in a club. You can focus on people and decide to be in the darkness or in the light'.

Similar trends about impressions of privacy/intimacy and interest/appeal influenced by lighting in public squares were found by Nasar and Bokharaei (2017) by using quantitative surveys mediated through virtual simulations.

Social behaviours in a public/private shelter

Based on the studies of Kobayashi (2013) and Magielse and Ross (2011), sociopetal/sociofugal behaviours, social proximity, social appraisal and lighting control consciousness occurring during the implicit interaction were investigated in the third case study. The lighting experience was designed so that if the couple was leaning backwards (social detachment), the atmosphere would change in cold white and direct/indirect lighting. If leaning forward (social proximity), the atmosphere would change in a direct warm white spotlight (fig. 4 and fig. 5).
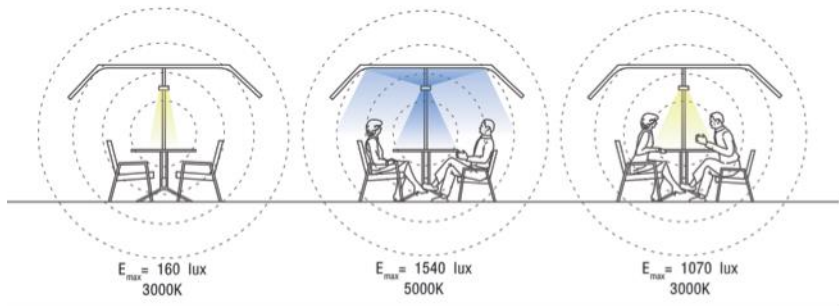

E_{max} = 160 lux
3000K

E_{max} = 1540 lux
5000K

E_{max} = 1070 lux
3000K

Figure 4   The micro–lighting environmental experience set up for investigating sociopetal/sociofugal behaviours and social proximity.

Despite the lighting system was not expressing evidently how to be controlled, a group of the participants interacted explicitly to explore it further and to understand the meaning of the lighting transformations. They were not constraining their behaviours, but rather showing interest and

testing the lighting system through explorative behaviours and gestures which made visible evidence of personal control and occupation of territory. The majority of participants were guessing, during the experience, the reason for lighting changes. The interviewed participants expected the interaction to occur through voice volume recognition, movement and distance detection but also through emotions, thoughts and mood monitoring.

During the experience, different kind of interaction occurred: indirect engagement with lighting (as it was designed), direct interaction between people triggered by lighting (talking about the meanings of the light changes), direct interaction between people and lighting triggered by the researcher (in the interview phase).

The lighting system was found supportive during the role–play by the majority of the participants, useful to assist the performance of fictional social activities in the background of the participants' attention. During the interviews, people addressed the warm lighting as more intimate, comfortable and cosier, defining a more intimate zone and a supportive atmosphere in social situations. Warm and spotlight condition were found to fit intimate situations in defining a closer relationship and shaping a more private condition. Feeling to be surrounded by darkness and to be less exposed allowed to talk more openly about personal information. The warm spotlighting condition suggested, provoked and supported more privacy, intimacy and closeness by defining a personal territory. When the dimly lit environment was brightened, it suddenly tended to invite less intimate interaction, by signalling the transition between one mood to another, as was also noted by Knapp, Hall and Horgan (2014).

Cold direct/indirect lighting was found more formal and detached, helping in maintaining the distance between individuals by showing the faces and the surroundings; people felt more exposed and revealed in a luminous condition which defined an open shared territory.

The majority of the participants said to enjoy the lighting system during the interviews: the system was found as effectively accommodating the luminous atmosphere in relation to the proxemics impressions of people, even if they reported the occurrence of too harsh and sudden lighting transformations. Interviews also revealed that the social agency of lighting in this experiment was determined by cultural association that have been accumulated through generations of past experiences. Many times, people mentioned that 'the lighting recalls about' previous lighting atmospheres in order to define if it was appreciated and supportive in the social activities.

Participants also gave suggestions and further possible applications in different settings which are out of the discussion of this paper.
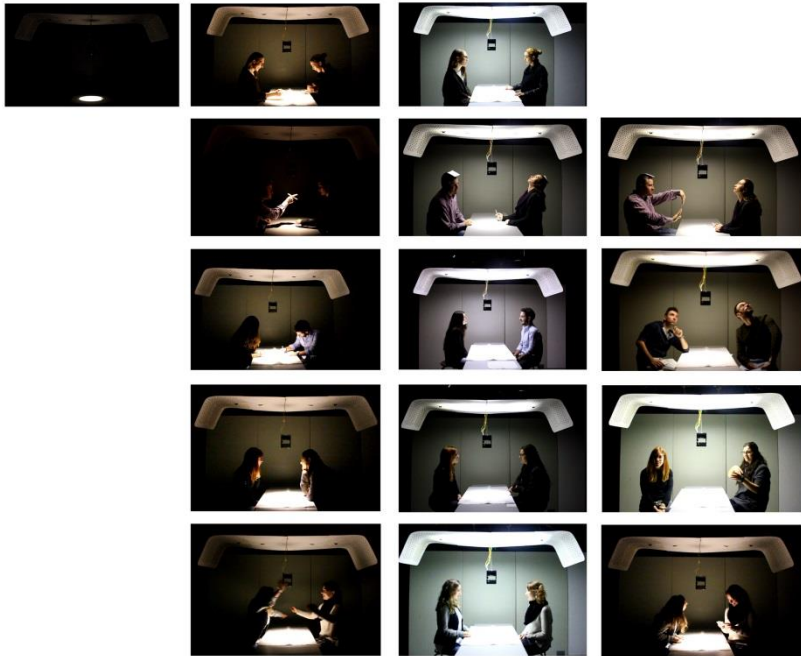

Figure 5   Some screenshot of the role–play videotapes: the first column show the scene with no people; the second column shows moments of social closeness; the third column shows situations of social detachment; the fourth column shows people exploration of the lighting systems and its functions.

A men–female couple felt embarrassment during the experiment when displaying and sharing publicly their personal and social information through lighting and showed a veiled annoyance due to the intimate lighting condition which was considered too inappropriate. In the other cases, with male–male and female–female couples, lighting was not creating problems in this regard. The personal or shared behavioural transformations disclosed by lighting were not causing evident discomfort. Other than this, the possible negative feedback determined by visual disclosure should be also considered when designing socially adaptable lighting systems.

Despite of the small number of combined couples of this experiment, according to the study of Kobayashi (2013), gender seems to differentiate impressions, attitudes and behaviours about social lighting in closeness situations.

Concluding remarks

This paper, rather than providing a conclusive answer, has an exploratory nature, by addressing a series of different perspectives and tackling various issues in the realm of psycho–social effects of lighting on sociality. The gathered insights result preliminary but useful to extend the investigation about a more human–centric perspective of LED lighting design and digital controls applications.

The majority of the reviewed studies have an international span (North America, Europe and Japan) and show similar trends toward the social agency of lighting, even though heterogeneous cultures have been involved in the mentioned studies. On the other hand, the majority of these studies were performed in controlled laboratory settings or by recreating specific indoor situations (e.g. counselling, office and conference rooms) and only a small amount were realised in real spaces to study overt behaviours and the implications of light on people sociality.

Through the case studies explorations, lighting resulted not to be the solely determinant factor to make a place more social or sociable. In fact, lighting can act as a feature which complements the environment to its social quality and use. Despite of this, certain luminous atmospheres have a social evocativeness across different cultures and can contribute to design and set more human and social oriented experiences in terms of safety, intimacy and hospitality both in indoor and outdoor settings.

In particular, warm white lighting and the lighting distribution in the space can affect the personal and interpersonal space requirements along with the territorial and social behaviours. In this, past experiences, cultural sensitivities and individual taste have a determinant role in defining the social agency of lighting atmospheres. If people can manipulate lighting assigning a social meaning. Lighting, in turn, seems to have the agency of manipulating people as well, with a subtle influence on social behaviours inducing background reactive and proactive human–light interactions (Ju and Leifer, 2008).

The results of the experimental case studies highlighted the fact that the effect of lighting is delicate, especially when social activities take place. Even

though the explorations demonstrated that lighting has a subtle influence on the social behaviours of the participants, it is still recognised in its rooted social meanings. Therefore it is also unconsciously influencing and leveraging deeper social meanings. In this regard, light acts supportively of social behaviours in specific real or fictional social applications to accommodate or compensate for more private/intimate or public/detached situations. Light acts to enforce interpersonal relationships, supports social negotiations, contributes in communicating proxemics information and defining more socially including or excluding environments.

From this paper, it is also evident that behaviours are not only socially based or bound up on cultural association but are also rooted in luminous atmosphere, conceived as the intermediate state between light, the environment and human perception. For this reason, the influence of certain 'lightscapes' (Bille and Soresen, 2007) on people behaviours should be always read as mediated by contextual, cultural, environmental, personal and social factors. Despite of this, similarities between lighting cultures and personal background in relation to the social appraisal of a lighting situation were found during the case studies, particularly in assessing the impression of intimacy, cosiness and romantic atmosphere compared to a detached, formal and tense luminous environment.

In addition to this, the case studies present an initial contribution to the design of socially adaptive public lighting in contemporary cities which advocate for a deep investigation of different environments and various other situations. This inquiry seems to be crucial in the future development of the so–called smart cities where the lighting scenarios and behaviours should be designed in order to influence, positively, the social use of the city. In fact, the research about the influence of lighting on sociality can concur to create better and more meaningful experiences through the use of new technologies (e.g. Internet of Things and digital lighting). The use of the adaptive luminous micro–environment, in particular, confronted people with a new level of awareness about future possibilities of lighting and choices which were not present before.

In this sense, further investigations, through the use of luminous 'provotypes' (Aliasgari and Clark, 2016) are seen as a possible further step of investigation to foster the social dimension of lighting in more active ways, incentivizing social uses, agency and exchanges.

References

Adams, L. and Zuckerman, D. (1991) The Effect of Lighting Conditions on Personal Space Requirements. *The Journal of General Psychology*, 118 (4), 335–340.

Aliasgari, M. and Clarck, B. (2016) Baby Steps or Stage Dive into a Critical Design Dialogue. In *ACM CHI 2016 – 34th Annual ACM Conference on Human Factors in Computing Systems*. San Jose.

Altman, I. (1975) *The Environment and Social Behavior*. Monterey: Brooks/Cole Pub. Co.

Baron, R., Rea, M. and Daniels, S. (1992) Effects of Indoor Lighting (Illuminance and Spectral Distribution) on the Performance of Cognitive Tasks and Interpersonal Behaviors: The Potential Mediating Role of Positive Affect. *Motivation and Emotion*, 16 (1), 1–33.

Bille, M. and Sorensen, T. (2007) An Anthropology of Luminosity: The Agency of Light. *Journal of Material Culture*, 12 (3), 263–284.

Biner, P., Butler, D., Fischer, A. and Westergren, A. (1989) An Arousal Optimization Model of Lighting Level Preferences: An Interaction of Social Situation and Task Demands. *Environment and Behavior*, 21 (1), 3–16.

Boyce, P. (2003) *Human Factors in Lighting*. London: Taylor & Francis.

Butler, D. and Biner, P. (1987) Preferred Lighting Levels: Variability among Settings, Behaviors, and Individuals. *Environment and Behavior*, 19 (6), 695–721.

Canter, D. (1986) Putting Situations in Their Place: Foundations for a Bridge between Social and Environmental Psychology. In Fumham, A. (ed.), *Social Behaviour in Context.* London: Allyn and Bacon.

Carr, S. and Dabbs, J. (1974) The Effects of Lighting, Distance and Intimacy of Topic on Verbal and Visual Behavior. *Sociometry*, 37 (4), 592.

Casciani, D. (2014a) Esplorando la dimensione sociale dell'illuminazione urbana. *LUCE,* 308 (52), 93–97.

Casciani, D. (2014b) *Urban Social Lighting. Exploring the Social Dimension of Urban Lighting for More Sustainable Urban Nightscapes*. Dissertation. Politecnico di Milano.

Casciani, D. and Rossi, M. (2015) Exploring the Social Dimension of Urban Lighting. In *2nd Iran Lighting Design Conference Proceedings*. Teheran.

de Kort, Y. and Veitch, J. (2014) From Blind Spot into the Spotlight. *Journal of Environmental Psychology*, 39, 1–4.

Feller, R. (1968) Effect of Varying Corridor Illumination on Noise Level in a Residence Hall*. The Journal of College Personnel*, 9 (3), 150–152.

Flynn, J. (1977) A Study of Subjective Responses to Low Energy and Nonuniform Lighting Systems. *Lighting and Design Application*, 7 (2), 6–15.

Flynn, J. (1988) Lighting Design Decisions as Interventions in Human Visual Space. In Nasar, J.(ed.), *Environmental Aesthetics. Theories, Research, & Applications*. Cambridge: Cambridge University Press.

Flynn, J. and Spencer T. (1977) The Effects of Light Source Color on User Impression and Satisfaction. *Journal of the Illuminating Engineering Society*, 6 (3), 167–169.

Flynn, J., Hendrick, C., Spencer, T. and Martyniuk, O. (1979) A Guide to Methodology Procedures for Measuring Subjective Impressions in Lighting. *Journal of the Illuminating Engineering Society,* 8 (2), 95–110.

Flynn, J., Spencer, T., Martyniuk, O. and Hendrick, C. (1973) Interim Study of Procedures for Investigating the Effect of Light on Impression and Behavior. *Journal of the Illuminating Engineering Society*, 3 (2), 87–94.

Gergen, K., Gergen, M. and Barton, H. (1973) Deviance in the Dark. *Psychology Today*, 7 (5), 129–131.

Gifford, R. (1988) Light, Decor, Arousal, Comfort and Communication. *Journal of Environmental Psychology*, 8 (3), 177–189.

Giusa, F. and Perney, L. (1974) Further Studies on the Effects of Brightness Variations on Attention Span in a Learning Environment. *Journal of the Illuminating Engineering Society*, 3 (3), 249–252.

Hall, E. (1996) *The Hidden Dimension*. Gloucester: Peter Smith Pub.

Haans, A. and de Kort, Y. (2012) Light Distribution in Dynamic Street Lighting: Two Experimental Studies on its Effects on Perceived Safety, Prospect, Concealment, and Escape. *Journal of Environmental Psychology*, 32 (4), 342–352.

Hayward, D. and Birenbaum, L. (1980) Lighting and Human Behaviour. In *Proceedings of the 19th CIE Congress*. Paris.

Hopkinson, R. and Longmore, J. (1959) Attention and Distraction in the Lighting of Work–places. *Ergonomics*, 2 (4), 321–334.

Illuminating Engineering Society (2017) *Light + Behavior: Light's Influence on Human Behavior*. [Online] Ies.org. Available at: http://www.ies.org/research/light–behavior–symp.cfm [Accessed: March 8th, 2017].

Ju, W. and Leifer, L. (2008) The Design of Implicit Interactions: Making Interactive Systems Less Obnoxious. *Design Issues,* 24 (3), 72–81.

Knapp, M., Hall, J. and Horgan, T. (2014) *Nonverbal Communication in Human Interaction*. Boston: Cengage Learning.

Kobayashi, S. (2013) Lighting Effects on Unconscious Human Behaviors. In *10th International Symposium on Sustainable Healthy Buildings Annual Spring Conference of Korea Society of Lighting & Visual Environment*. Seoul.

Kobayashi, S., Inui, M. and Nakamura, Y. (2001) Preferred Illuminance Non–Uniformity of Interior Ambient Lighting. *Journal of Light & Visual Environment*, 25 (2), 64–75.

Laboratorio Luce (2017) Laboratorio Luce – Spaces. [online] Luce.polimi.it. Available at: http://www.luce.polimi.it/en/spazi–en [Accessed: March 8th, 2017].

Lam, W. (1992) *Perception and Lighting as Formgivers for Architecture*. New York: Van Nostrand Reinhold.

Living Lab Light (2017) *Tu/e.* [online] Tue.nl. Available at: https://www.tue.nl/en/university/about–the–university/sustainability/research/living–labs/living–lab–light/ [Accessed: March 8th, 2017].

Magielse, R. and Ross, P. (2011) A Design Approach to Socially Adaptive Lighting Environment. In *Proceedings of the 9th ACM SIGCHI Italian Chapter International Conference on Computer–Human Interaction: Facing Complexity*. Alghero.

Miwa, Y. (2006) The Effects of Interior Design on Communication and Impressions of a Counselor in a Counseling Room. *Environment and Behavior*, 38 (4), 484–502.

Nasar, J. and Bokharaei, S. (2017) Impressions of Lighting in Public Squares After Dark. *Environment and Behavior*, 49 (3), 227–254.

Rea, M. (2002) Light–Much more than Vision. In *EPRI/LRO 5th International Lighting Research Symposium*. Palo Alto: The Lighting Research Office of the Electric Power Research Institute.

Sanders, M., Gustanski, J. and Lawton, M. (1974) Effect of Ambient Illumination on Noise Level of Groups. *Journal of Applied Psychology*, 59 (4), 527–528.

Sommer, R. (1969). *Personal Space: The Behavioral Basis of Design*. Englewood Cliffs: Prentice–Hall.

Steidle, A. and Werth, L. (2014) In the Spotlight: Brightness Increases Self–awareness and Reflective Self–regulation. *Journal of Environmental Psychology*, 39, 40–50.

Taylor, L. and Socov, E. (1974) The Movement of People toward Lights. *Journal of the Illuminating Engineering Society*, 3 (3), 237–241.

Veitch, J. and Gifford, R. (1996) Assessing Beliefs about Lighting Effects on Health, Performance, Mood, and Social Behavior. *Environment and Behavior*, 28 (4), 446–470.

Veitch, J. and Kaye, S. (1988) Illumination Effects on Conversational Sound Levels and Job Candidate Evaluation. *Journal of Environmental Psychology*, 8 (3), 223–233.

Veitch, J. and Newsham, G. (1996) Determinants of Lighting Quality II: Research and Recommendations. In *104th Annual Convention of the American Psychological Association*. Toronto.

Vogels, I. (2008) Atmosphere Metrics: A Tool to Quantify Perceived Atmosphere. In Westerink, J.(ed.), *Probing Experience*. Netherlands: Springer Science + Business Media B.V.

Werth, L., Steidle, A. and Hanke, E. (2012) Getting Close in the Dark: Darkness Increases Cooperation. In *Proceedings of Experiencing Light*. Eindhoven.

Zhong, C., Bohns, V. and Gino, F. (2010) Good Lamps Are the Best Police. *Psychological Science*, 21 (3), 311–314.

Actualising Agency through Smart Products: Smart Materials and Metaphors in Support of the Ageing Population

Massimo MICOCCI[*a], Gabriella SPINELLI [a] and Marco AJOVALASIT [a]

[a] Brunel University London

Technological innovation is increasingly contributing to the development of Smart Products– SPs–, meant as autonomous devices augmented by sensing, processing and network capabilities. Given the reduced familiarity that the ageing population has with technological products, it is deemed appropriate to deploy SPs to enhance the experience with technologies of this population segment. Recent studies in interaction design demonstrate how analogies and metaphors, powerful learning tools for written, verbal and visual communication, can be physically embedded into products to improve the interaction with the users. Metaphors, that can trigger established knowledge domains, allow users to create bridges between old and new products making the product more intuitive.

This study proposes that Smart Materials (SMs) may be more successful for embedding multi–sensorial metaphors into novel SPs, increasing the chance of adoption among ageing users.

A novel device has been designed using four different SMs families in order to evaluate which design would be more intuitive among the users. 62 participants (N=31 under–60 years–old and N=31 over–60 years–old) assessed the 32 interactions designed. Findings reveal how age impacts the selection of the preferred interaction and how SMs can embed metaphors to support the users re–establishing their own subjective awareness, hence control, of the world around them.

Keywords*: Smart products; ageing; agency; smart materials; metaphors*

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[*] Corresponding author: **Massimo Micocci** | e–mail: **massimo.micocci@brunel.ac.uk**

Introduction

In the last decades material sciences have made technological advancements and discoveries that have radically changed the role consumer products have in everyday life (Jung and Stolterman 2011; Kuniavsky 2010; Peters 2011). As a result, technology is progressively more embedded in daily life and products are increasingly gaining context awareness, responsiveness and cooperation abilities. It is therefore legitimate to postulate that technical products could be considered as 'agents' with regards to the increased level of self–activity they are endowed with and to the degree of actions they can perform (Rammert 2008). As reported in Rammert (ibidem), there are three levels of an action: a first one where a difference of state is produced, a second one where a difference of options is clarified, and a third one where actors can give an explanation for their actions. We can simplify the three levels as namely: I Do, I Decide, I Understand. Rammert interprets them as different levels of agency, respectively called 'causality', 'contingency' and 'intentionality'. The constellation of agencies created by the growing number of interconnected and pervasive devices are therefore considered able to maximize the exchange of information between human/human and human/environment at the basic level of causality that the human agent will eventually convert into volitional actions. Embedded intelligence may change the way designers conceptualize and develop products, as it will no longer be just about the physical form of the product, but about intangible features able to actualize the contingency and intentionality of human agency (fig. 1).
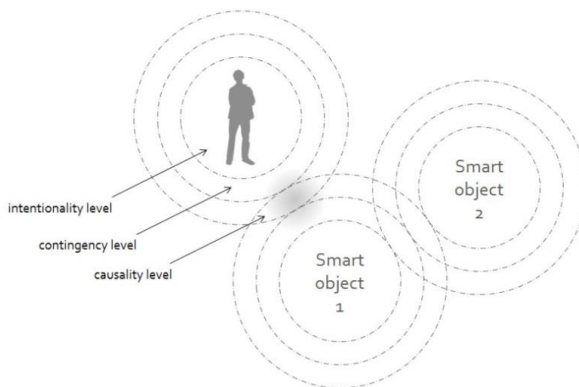

intentionality level

contingency level

causality level

Smart object 1

Smart object 2

Figure 1   Three level of 'actions' and their interplay at the 'causality level'.

In order to provide a broader understanding of this issue, Smart Materials are presented in this paper as means to unobtrusively enhance products and the environment with intelligent and seamless features that enhance technological devices with causality agency mediating the relation between user and product. The dynamic and sensory–oriented features characterizing these materials are envisioned as effective vehicle of metaphorical messages, where the information conveyed is physically represented for an intuitive understanding of the novel technology. The 'older adults' group emerged as a target group where the potential applications of Smart Materials could have a significant impact due to the changing requirements that the ageing process determines and the notorious challenges encountered by older adults when interfacing with technological products (Age U. K., 2013).

The research proposition aims to investigate how older adults could be supported through Smart Materials embedded into products that can be aware of their surroundings and take actions accordingly. The following two objectives were, therefore, defined:

- Identify whether there is a relationship between age and 'familiarity with the technology';
- Explore whether the adoption of SMs as embodied metaphors could provide benefits at a cognitive level with no distinction of age.

The investigation was conducted adopting a quasi–experiment method and testing 32 embodied analogical/metaphorical messages into a novel communicative device, a Smart Radio.

Metaphors and analogy: actualizing agency through comparison

Studies conducted on intuitiveness (Blackler and Hurtienne 2007; Blackler et al., 2011; Mohs et al., 2006), explain how the intuitive use of a product is the subconscious application of prior knowledge that leads to effective interaction. Literature reveals that the familiarity with similar technology and prior exposure to products with similar features help the overall understanding of the technology adopted with the completion of the tasks required in a more intuitive and rapid way (Blackler, Popovic and Mahar, 2010). The concept of familiarity with a certain technology and the age factor of the user involved are strictly intertwined by an inverse correlation: evidences demonstrate that the older the user, the lower his familiarity with the technology is (Blackler, Popovic and Mahar, 2010; Fisk et al., 2012). Therefore, older adults are considered users whose

understanding of novel technologies is hindered by their limited prior exposure to them. Cognitive tools for comparison such as 'analogies' and 'metaphors' are seen in this paper as a successful way to invert this trend and let older adults understand products they are not familiar with. According to the definition provided by Gentner (1983), analogies occur when a relational structure that normally is applied in one domain can be applied in another domain (e.g. 'The Xl2 star system in the Andromeda galaxy is like our solar system'), while metaphors are predominantly relational comparison with a specific focus on the attributes they match (e.g., 'She's a giraffe,' used to convey that she is tall). This attributes sharing makes metaphors relevant in terms of understanding also one experience in terms of another, considering them as cognitive phenomenon that go beyond the linguistic tricks of verbal language; Metaphors are already powerful tools in both written and verbal communication, but new ways to embody them into Smart Products should be investigated. This is the focus of the next section.
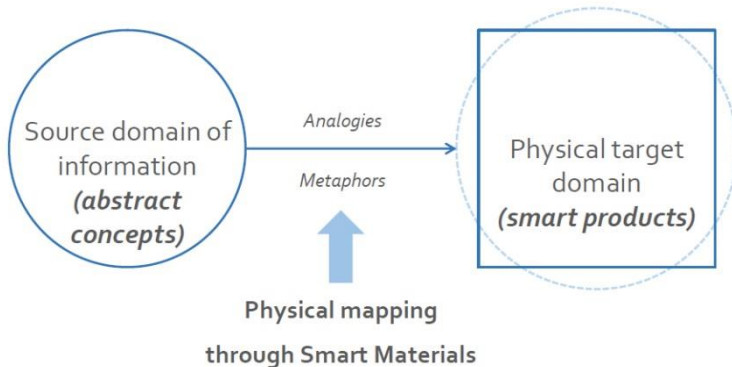

Figure 2   Mapping of knowledge across domains with Smart Materials.

Smart Materials as physical mapping of knowledge

The term 'Smart Materials' (SMs) refers to a generation of engineered materials that have changeable properties and are able to reversibly alter their shape or color in response to physical and/or chemical influences, e.g. light, temperature or the application of an electric field (Ritter 2007). The application of SMs within this paper lays in the hypothesis that the enhanced signals they help to shape are able to build a metaphorical language that involves all human senses and can therefore support older

adults in the acquisition of new knowledge. Based on the definition that in a metaphorical language inferences are created by developing a 'mapping of knowledge' from one situation to another as an act of building a conceptual correspondence between source and target domains also with tangible features (Cila, 2013; Hey et al., 2008), we propose to investigate SMs as means to physically map information from two selected domains and facilitate the representation of abstract concepts into a physical target domain (fig.2).

For exploratory purposes, four families of SMs are identified as representative of the potential visual and tangible effects the dynamic materials can achieve: 'Light Emitting Materials', 'Shape Changing Materials', 'Rheological Changing Materials' and 'Colour Changing Materials'. These four families of SMs have been embedded into the prototype of a Smart Radio. Considering that older adults find less intimidating those devices they had prior exposure with (Blackler, Popovic and Mahar, 2010), a radio appeared to be a product whose components, commands, functions are straightforward and familiar enough to let the user be focus on the interaction proposed, and overcome the cognitive and emotional limitations occurring when using a radically new device.

Main study

Prototyping the device

The Smart Radio was designed to keep only the aesthetics of a 'conventional' radio; instead of broadcasting music, the radio was hypothetically able to share information between people using it, wireless connected each other. The Smart Radio could potentially allow each user to browse among four different friends/relatives (instead of radio stations) and receive with the aim to enhance the communication between peers and provide lightweight details of the activities they are performing (fig. 3).

Messages were displayed on the top surface of the Smart Radio and they were shaped by embodied analogical/metaphorical messages based on the four families of SMs identified. Each group of materials showed eight signals, by meaning of four analogical messages and four metaphorical messages for each family of SMs for a total of 32 messages (fig. 4).
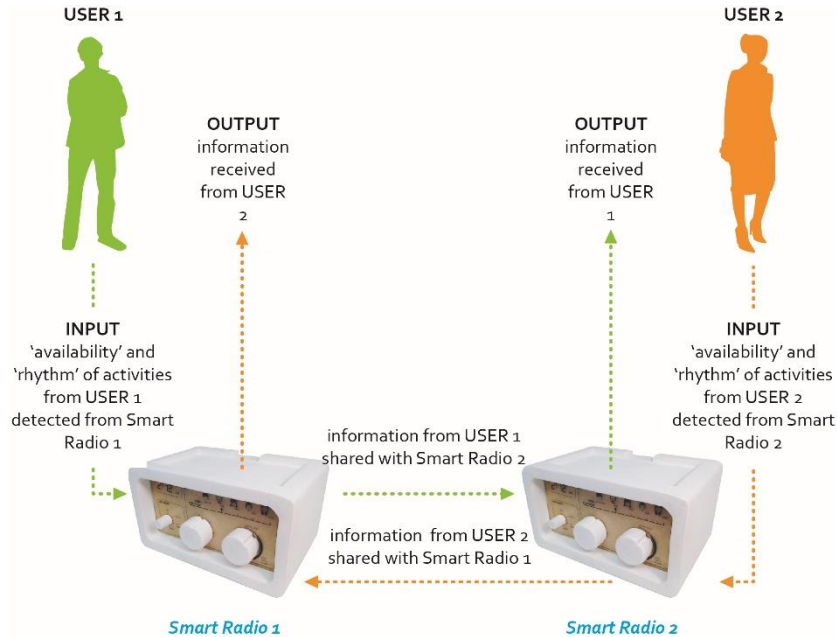
Figure 3   Functionality of a set of Smart Radios. Each device detects information about the level of activity of the user using it and broadcasts that information to a connected device.

Analogical messages were selected to communicate the 'availability of the user' from whom information are sought, represented by the dynamic on/off alternation of two symbols by means of 'ear' and 'lips' appearing on the surface of the radio:

- *Off line*: the connected device is off (ear and lips symbols are off);
- *He is listening in*: the connected device is receiving information (only ear symbol is on);
- *He can be listened to*: the connected device is sending information (only the lips symbol is on);
- *Fully active*: the connected device is both sending and receiving information (ear and lips symbols are on).

SMs were adopted to enhance the appearing symbols in order to have alternation of lighting symbols (Light Emitting Materials*)*, movable flaps revealing underneath symbols (Shape Changing Materials*)*, popping up and tangible symbols (Rheological Changing Materials*)* and appearing symbols

with a traffic light colour coding (Changing Colour Materials*)*, as shown in Figure 3.
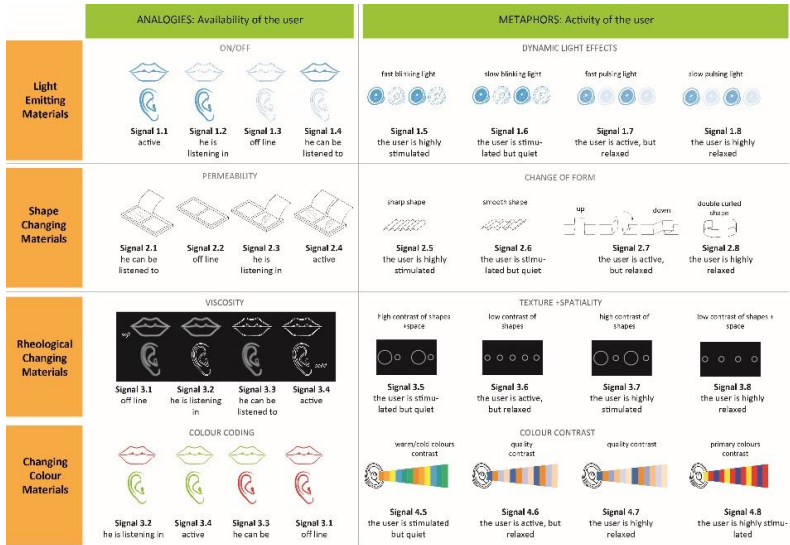

Figure 4   Matrix of the 32 signals designed with Smart Materials composing the 'Designer Model of the Function Representation'.

In order to render the desired metaphorical messages, a 'rhythm' has been used to interpret the level of 'intensity' and 'activity' performed by the users connected, namely:

- the connected user is highly stimulated (e.g. doing exercises);
- the connected user is stimulated but quiet (e.g. housekeeping, gardening, cooking);
- the connected user is active but relaxed (e.g. eating, watching television, reading a book);
- the connected user is highly relaxed (e.g. sleeping).

The level of activity of the user with Light Emitting Materials was interpreted by the alternation of blinking and pulsing light communicating whether the user is exercising (fast blinking light), walking (slow blinking light), eating (fast pulsing light) or watching television/reading/sleeping (slow pulsing light); Shape Changing Materials helped to convey the idea of the actions performed by creating a sharp shape, a smooth shape, slow pace up/down movement and a double curled shape; Rheological Changing Materials built a haptic feedback with a series of popping up 'bubbles' each

of those simulating the activities performed by the user connected, represented by a high contrast of shapes, high contrast of shape with a spatial gap in between bubbles, small bubbles with no contrast of shape, small bubbles with no contrast of shape with a spatial gap in between them; finally, Changing Colour Materials displayed messages shaped by primary colours contrast, warm/cold colours contrast and contrast of saturation, dynamically playing with the hue and brightness of colours. A 'Designer Mental model of the Function Representation' was applied as a potential association of the 32 SMs output and their meanings. This mental model linked of signifiers (SMs) and signified (activity of the user) in what the designer considered the best pair and was therefore used as initial benchmark to evaluate participants' responses. A representation of the model adopted can be seen in fig. 4, fig. 5 and fig. 6 show the prototype of the Smart Radio and the interface.

Protocol of the study

A total number of 62 participants took part in the study (male = 22, female = 40) whose age span from 21 and 84 years old (median age = 59.5). Participants were distributed in this way:

- Under–60 years old: N = 31, age span from 21 to 59 years old, mean age = 35.6 years old; male = 14, female = 17.
- Over–60 years old: N = 31, age span from 60 to 84 years old, mean age = 71.5 years old; male = 8, female = 23.

Heterogeneity in age was sought in the two samples with the intent to understand commonalities and differences in the interpretation of the given answers. Furthermore, the two age brackets selected helped to explore whether the Smart Radio, as a familiar interface, could positively impact the interpretation of the messages across generations and whether the diverse families of SMs were equally understood among age brackets. Participants were recruited within Brunel University Students (last year undergraduate students in Human Factors, PhD students in Design, staff members, and visiting students), 50+ group At Brunel University London, London Age UK branches, a nursing home in Uxbridge (London) and the Uxbridge Library.
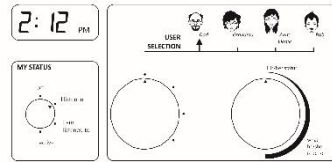
Figure 5 The prototype of the Smart Radio.

Figure 6 Display of the Smart Radio in the default modality with the three knobs indicating: the status of the device, the peers browsing and the level of information to acquire.

Participants were asked to individually fill two questionnaires: the Technology Familiarity questionnaire (TF) and the Main questionnaire.

Two independent variables were considered: the age of the participants and the familiarity with the technology, assessed with TF questionnaire based on the template designed by Blackler, Popovic and Mahar (2010) and adapted on the product category of a Digital Radio. The TF questionnaire was a self–rating questionnaire designed to ask participants about how often they used certain smart and interactive devices and technologies, and how much of the functionality of those products they used. In the questionnaire, more exposure to, and knowledge of certain products specifically selected,   produced a higher technology familiarity score. The maximum possible score on this questionnaire was 100, and the hypothetical minimum was 0. A £5 amazon voucher was given to each participant to thank them for their time and input.

The Main questionnaire included four sections, each of those referred to one of the family of SMs. In each section participants found a table with the list of the signal they were asked to assess and a list of their potential meanings. Participants were instructed to provide only one association signal/meaning and to give a score from one to three where one meant a weak, poor association, and three was a really intuitive and powerful association. They were invited to tick the column of 'others' if they found an alternative interpretation among those proposed.

 Three open questions at the end of main questionnaire were included to let participants freely discuss their preferred signals and personal comments

on the device. The participants were asked which of the signals identified better represent the availability and the level of stimulation of the connected user and how participants though the Digital Radio should be improved.

Each participant signed a formal consensus where he/she accepted to perform the test and to share his/her data for research purposes. Participants were assured no personal information would have been used and that their names would have been carefully replaced to protect their privacy.

After a detailed explanation of the test and after the TF questionnaire was filled, a simulation was performed: participants were individually asked to use the Smart Radio to select one of the four hypothetically connected users at time and receive messages from them (fig. 7) in order to 'browse' the four families of SMs and the corresponding messages. The 32 messages were individually shown simulating the interaction with the Smart Radio and participants were invited to complete the main questionnaire matching each message with a potential meaning.

Figure 7   One of the over–60 years old participant during the test.

Findings

Table 1 shows the median value of the familiarity with the product category selected. The value reveals a decreasing trend related to the growing age of the participant confirming a reduced familiarity for over–60 years–old participants also with radio–related technologies. Because of this different prior exposure to these technologies, different patterns of

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interpretation of the Smart Radio were expected between the groups investigated.

Table 1   *Median value of the Familiarity with the Technology score recorded in relation to Radio–related technologies. The value decreases as the age grows.*

Samples	N	Mean Value: age	Median Value: Familiarity with the Technology
Under 60 years–old	31	35.6	62
Over 60 years–old	31	71.5	36

Interestingly, results show a different trend. The following graphs show the percentage of participants matching the 'Designer Model of the Function Representation' (fig. 8) and the percentage of participants reporting scattered answers (fig. 9) with a distinction of the groups investigated and the SMs families assessed.

Data reveal a significant high percentage of participants matching the 'Designer Model of the Function Representation' with an always lower percentage of scattered answers recorded for each SMs family. Interestingly, the percentage of matches follows a common trend of interpretation, meaning that the Smart Radio was similarly interpreted by participants with no apparent influence of the prior exposure they had with radio–related technologies. Although no significant differences in percentage are observed within SMs families, each age bracket showed certain 'preferences' while interacting with the Smart Radio. The following similiarities in the interpretation are observed:

- Both age groups scored the highest percentage of matches in the Light Emitting Materials*;*
- Rheological Changing Materials reported the highest percentage of scattered answers in both age groups (40%);
- Moreover, the frequency of matches suggests that:
- Under–60 years old participants have an higher understanding of Shape Changing Materials than Over–60 years old people;

- Over 60–years old participants have an higher understanding on Changing Colour Materials than Under–60 years old people.
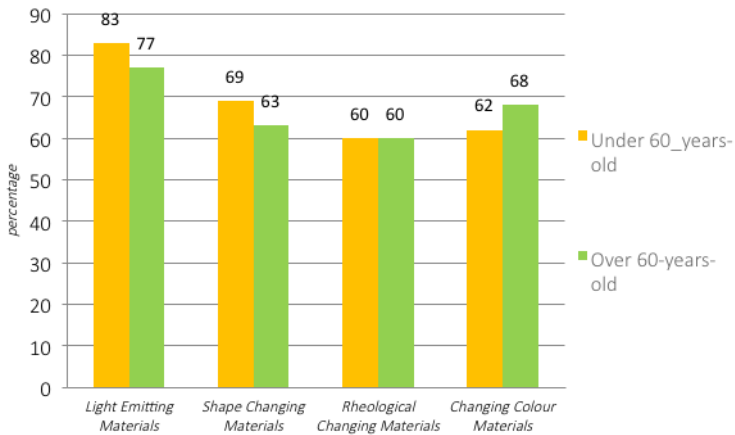

Figure 8   Percentage of participants matching the 'Designer Model of the Function Representation'.
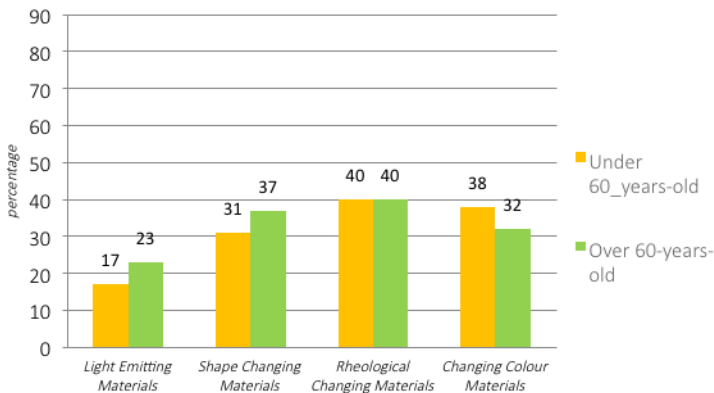

Figure 9   Percentage of participants reporting scattered answers.

Differences among the two groups observed were further explained upon the qualitative feedback recorded.

1. Light Emitting Materials*:* Under–60 year–old participants reported how easier was to discern the extreme messages among the four proposed (blinking lights as representation of 'highly stimulated' status and pulsing light as representation of 'highly relaxed') compared to the ones in the middle (Samantha, 24 years old, Female). Chul (32 years old, Male) stressed how working with lights reduces the amount of mental errors because the user does not have to spend time and think. Ivan (67 years old, Male) said: 'A combination of light and touch is good and maybe adding a vibrating signal to enhance the message would be beneficial'.

2. Changing Shape Materials were ambiguously perceived by the Under–60 years old participants, meaning that the application of these materials in terms of their kinetic properties have to be improved. William, (21 years old, Male) said that the movable flaps of the analogical messages are efficient enough to convey the message and that the symbols appear reinforced by the flaps movement. Nonetheless, Mario (27 years old, Male) said that the four metaphorical messages are really chaotic because users are not familiar with this kind of interfaces; the key aspect is then to let the materials be dynamic (Mario, 27 years old, Male and Bobby, 30 years old, Male) and to visually mimic the human physical behaviour (Mary, 28 years old, Female). Although a relatively high percentage of scattered answers (37%), Over–60 years old participants appreciated how the changing interface could maximize the way information are displayed. Allison (69 years old, Female) considered the metaphorical messages really effective, especially for their potentiality to visually represent human–like or nature–inspired behaviours: 'like a cat sleeping or a dog wagging the tail and jumping. Simple and understandable'.

3. Rheological Changing Materials were the SMs with the lowest percentage recorded (60%). Georgia (52 years old, Female) reported how the users must have an education about the new means. However, she acknowledged the relevance of the unexpected tactile experience. Both Gabriele (29 years old, Male) and Nastaran (30 years old, Female) reported how the haptic shapes have a code of interpretation not fully understood and users have to work with extreme signals and then try to understand the intermediate messages. An interesting potential is highlighted by Margaret (42 years old, Female) claiming how the haptic surfaces could accurately mimic the sense of 'action' and movement of the human body. Over–60 years old participants were intrigued by the novelty provided by the haptic interfaces but they could barely identify a

code of interpretation. Sasha (71 years old, Female) liked the movable spots: 'they are interesting because they could actually convey the stimulation of who I'm listening in'. Justin (79 years old, Male) reckoned how the tangible symbols are effectively working, mainly for visually impaired people but he explained how messages require a clarification in order to stand out, maybe with colours, and have their meaning clarified.

4. Changing Colour Materials were easily understood when embodying colour coding in the analogical section (green = go, red = not go) but as claimed by Samantha (24 years old, female), colours have different meanings in different cultures, therefore, it could be counter–productive to work on them. Johnny (25 years–old, male) suggested how colours can be improved by dynamically activating them and 'letting them move to actually see them changing'. He purposed to see the colours dynamically fading rather than have them all appearing simultaneously. Over–60 years old participants appeared concerned about the effectiveness of the application of colours, given that ageing processes affect the perception of colour coding and contrasts (Elizabeth, 76 years old, Female). Brightness of colours adopted as a way to convey different status of the user was appreciated by Ivan (67 years old, Male): he suggested clarifying the colour coding by displaying the spectrum on different bars and play with the colour intensity to create a meningful sensorial stimuli.

Discussion

In the realm of interconnected and pervasive devices that we are currently living in, it is even more likely that a single action can be executed with the intervention of hundreds of other agencies or 'hybrid constellations' as defined by Rammert (2008). The theory of 'distributed cognition' (Hutchins, 1995) and 'distributed agency' (Rammert 2008) demonstrate that human action is distributed between many concurrent socio–technical agents that contribute in the execution of an activity. The cooperation between agents maximizes the cognitive capability of the socio–technical system. If such system is well designed, technical agents will aid and support those functions that human agents may be less capable/more error prone to perform (Hollan, Hutchins and Kirsh, 2000).

The debate that this paper aims to trigger is that embedded intelligence may change the way designers conceptualize and develop products, as it will no longer be just about the physical form of the product, but about intangible features, such as the actualization of the *contingency* and

intentionality of the human agency. This would alter the 'traditional' boundaries of whom is processing information in the socio–technical system. The example provided of the Smart Radio, provides a case of a radical new product design where cognitive differences among ages are minimized and where the continuous interaction with the device may reactivate the ability of the user to reason upon his decisions.

Specifically, the interpretation of metaphors embedded with Light Emitting Materials show a surprising high peak of matches for both age groups. Under–60 years old participants reported how was easier to discern opposite messages among the four proposed in each category. A recurrent concern is observed: the changing speed and intensity of light can convey general status of activity like excitement, stimulation and relaxation, quiet status, but messages are not always clear. What the under–60 years–old participants reported explains the confusion also perceived by over–60 years–old people while interpreting these signals: they often missed a code of interpretation, such as high frequency meaning high activity, to interpret the metaphorical messages.

The interpretation of messages with Changing Shape Materials has a drastic reduction of the participants' understanding compared to the Light Emitting Materials, in both age brackets. These materials are perceived as an excellent way to mimic human behaviour and therefore depict a plethora of human status but the changing shapes as they were presented for the study resulted static and inexpressive; therefore, participants encouraged the adoption of 'time' parameter to properly discriminate among signals: a continuous changing shape with different speeds of movement would help building strong metaphors recalling anthropomorphic behaviour.

Rheological Changing Materials appeared an effective way to shape messages in a tactile way but the unfamiliarity with look–alike interfaces prevented the participants to find a proper code of interpretation. Participants found intriguing the adoption of tactile interfaces and therefore suggested to implement the efficacy of the popping up symbols. An interesting way to enrich the adoption of the Rheological Changing Materials is in the addiction of the rhythm of the pulsing symbols and the tangible reproduction of sound waves.

Participants suggested the addition of the 'time' parameter to shape powerful metaphors with Changing Colours Materials too. The way the interface was made dynamic was more important and effective than the final composition itself. The colourful patterns were not fully perceived due to the static nature of the signal designed. Participants understood the

power of this means but they suggested enhancing the contrast of colours by showing them in different time segments to depict a specific activity of the user. The over–60 years old participants stressed how was important to compare signals before attempting a proper evaluation and they suggested to improve the application of the changing colours by working with the brightness of colours rather than just colour coding.

Conclusions

This paper investigates the role of Smart Products as actuator of the human agency and explores the role of SMs and metaphorical languages to shorten the gap of understandability among under–60 and over–60 years–old people. We demonstrated how embodied metaphorical messages can effectively convey information in a more intuitive way, by providing a maximized set of stimuli. We observed that both age brackets have they preferred means of interaction: while Light Emitting Materials are preferred among under–60 years–old participants, Changing Colours Materials have a great potential within the over–60 years–old people. Nevertheless, the high correspondence of the given answers with the 'Designer Model of the Function Representation' provide an optimistic way to design inclusive Smart Products that mitigate differences in ages and make technologies more familiar even when prior exposure is limited. Feedback from participants reveal how important was the implementation of the signals based on the 'tempo' parameter, making the case for further investigations where embodied metaphors are structured to express their narrative abilities.

This study does not attempt to determine a one–to–one correlation between a certain material property and a specific user response but rather it moves towards the conceptualisation of an alternative and efficient way to elaborate information and to actualize the volitional abilities of the human agent. Interestingly, the study reveals how the combination SMs and metaphors has benefits in the way people show a common pattern in the acquisition of new knowledge, effects of lack of prior exposure to technologies could be minimized and the gap in perception among ages could be effectively bridged. Opportunities are observed in the design of smart artefacts endowed with agency; the interaction with the Smart Radio has been proved to lead toward a simplification of the relationship human/environment and a common interpretation of the changeable actions and situations emerging from the environment. The influence that

the renewed causality agency of the smart artefacts has on the human agent has been proved to effectively reactivate the ability of older adults to choose between options and attribute a meaning to their preferences; in other words, smart artefacts do have agency but their agency get value in correlation with the human agent and the re–establishment of his ability to act, decide and understand.

Acknowledgments

References

Age U. K. (2013) *Digital Inclusion Evidence Review*. [Online] Available from: http://www.ageuk.org.uk/Documents/EN–GB/For–professionals/Research/Age%20UK%20Digital%20Inclusion%20Evidence%20Review%202013.pdf?dtrk=true.

Blackler, A.L. and Hurtienne, J. (2007) Towards a Unified View of Intuitive Interaction: Definitions, Models and Tools across the World. *MMI–Interaktiv*, 1 (13), 36–54.

Blackler, A., Popovic, V. and Mahar, D., (2010) Investigating Users' Intuitive Interaction with Complex Artefacts. *Applied Ergonomics*, 41 (1), 72–92.

Blackler, A.L., Popovic, V., Lawry, S., Reddy, R., Mahar, D.P., Kraal, B. and Chamorro–Koc, M. (2011) Researching intuitive interaction. In *Diversity and Unity: Proceedings of IASDR2011*.

Cila, N. (2013) *Metaphors We Design by: The Use of Metaphors in Product Design*. Doctoral dissertation. Delft: Delft University of Technology.

Fisk, A.D., Rogers, W.A., Charness, N., Czaja, S.J. and Sharit, J. (2012) *Designing for Older Adults: Principles and Creative Human Factors Approaches*. Boca Raton: CRC Press.

Gentner, D. (1983) Structure–mapping: A Theoretical Framework for Analogy. *Cognitive science*, 7 (2), 155–170.

Hey, J., Linsey, J., Agogino, A.M. and Wood, K.L. (2008) Analogies and Metaphors in Creative Design. *International Journal of Engineering Education*, 24 (2), 283.

Hollan, J., Hutchins, E. and Kirsh, D. (2000) Distributed Cognition: Toward a New Foundation for Human–computer Interaction Research. *ACM Transactions on Computer–Human Interaction (TOCHI)*, 7 (2), 174–196.

Hutchins, E. (1995) How a Cockpit Remembers its Speeds. *Cognitive Science*, 19 (3), 265–288.

Jung, H. and Stolterman, E. (2011) Form and Materiality in Interaction Design: A New Approach to HCI. In *Proceedings of the International Conference on Human Factors in Computing Systems (CHI).* New York: ACM Press.

Kuniavsky, M. (2010) *Smart Things: Ubiquitous Computing User Experience Design*. Burlington: Elsevier.

Mohs, C., Hurtienne, J., Israel, J.H., Naumann, A., Kindsmüller, M.C., Meyer, H.A. and Pohlmeyer, A. (2006) IUUI–intuitive Use of User Interfaces. *Usability Professionals*, 6, 130–133.

Peters, S. (2011) *Material Revolution: Sustainable and Multi–purpose Materials for Design and Architecture*. Basel: Walter de Gruyter.

Rammert, W. (2008) Where the Action Is: Distributed Agency between Humans, Machines, and Programs. In Seifert, U., Huyun Kim, J. and Moore, A. (eds.), *Paradoxes of Interactivity*. Berlin: Bielefeld Verlag.

Ritter, A. (2007) *Smart Materials: In Architecture, Interior Architecture and Design*. New York: Springer.

Smart Digital Solutions and Desirable Human–Machine Interactions: A Contribution in Terms of Design Methodology

Margherita PILLAN[*a]

[a] Politecnico di Milano

Digital and interactive products and services are spreading in every field of application so producing deep changes in social organizations, in the ways we perform activities, in culture and personal mental frames. The implications of the digitalization of products and systems are vast and deep, and they should be investigated and predicted within the design process; therefore, we need to upgrade the existing interaction design methodologies so to support a critical discussion on the consequences of the design choices and to manage them.

Through the discussion of some examples, the paper illustrates the vastness of the change we face.

Furthermore, the paper deals with the issue of designing innovative paradigms of interaction and presents a classification of metaphors commonly employed in application driven digital solutions and in some artistic and game design experiments.

The conceptualization of interaction design metaphors is presented as an opportunity to upgrade the interaction design methodologies.

Keywords: *Interaction design; digital design; design methodology; metaphor*

Introduction

'We become what we behold. We shape our tools and then our tools shape us.' This sentence, often attributed to Marshall McLuhan but more probably issued by Father John Culkin, synthesizes the issue of responsibility related to the design of new products, services and systems.

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[*] Corresponding author: **Margherita Pillan** | e–mail: **margherita.pillan@polimi.it**

In traditional industrial design, designers, by innovating the forms and functions of material objects, enable new ways of perform an action or activity, and produce sense and meaning effects that may have the power to induce changes on culture and ways of thinking. In the design of interactive artefacts, designers deal with the project of innovative solutions in terms of material objects as well as of services and hybrid physical/digital systems. While in the design of physical objects and spaces designers create sense and meaning effects by acting on forms, materials, appearances of material things, in the design of interactive solutions, designers also act on the shape of interactive processes, on the responsiveness of digital solutions and on procedures, so enabling new activities through the use of the digital artefacts, and new the modalities of the interactive dialogue between the machines and the human users.

The shape of the interactive processes, (i.e., the modes of engagement that the specific characteristics of a technology based interactive solution make available to the human users), triggers emotional and cognitive reactions and, as a consequence, induces new behaviours and habits, so producing changes in our mental frames, in our attitudes and abilities.

Indeed, while we design new digital devices and services, we enable new organization of human minds and abilities, and we propose new paradigms of social interaction.

From the design tradition we learned that even the simplest objects, such as a chair, can be designed in a numberless of shapes and that the 'how' of the shape can respond to a variety of logic or poetic reasons 'why'. In the same way, for each technology based object or service, the variety of possible shapes of the interactive dialogue between the human users and a machine is very ample, and we should learn how to widen our capability to explore the realm of the possible forms of interactive processes, so to produce the desired effects of emotional and cognitive engagement.

The realm of digital and interaction design is quite new and still to be explored in its functional and formal potentials: while designers have been dealing with the material attributes of physical objects and spaces for centuries, the design of the interactive solutions is still in its early phases and introduces new dimensions of project to be taken into account with specific skills and knowledge.

The new dimensions can be indicated in terms of:
– dynamic behaviors of physical and digital products;
– interactive features of the dialogue between human–machines and human–software applications;

– pro–activity of the digital solutions, i.e. the paradigms of control offered to the user vs. the models of partial and complete automation made possible by the computing capabilities of digital technologies and AI;

– paradigms of social interaction made available by the networking potentials of the internet, i.e. the new models of human–human interaction mediated by technical solutions.

So, the expressive potentials of the digital artefacts involve the dimensions of physical/spatial attributes of things and spaces (geometrical forms, technical and sensorial qualities of materials, space arrangements), and also the immaterial but very effective dimensions of the evolution in time of functionalities and of the appearance of the designed solutions, and the action/reaction dynamics within the interactive processes.

The new creative potentials offered by digital technologies pose challenges and opportunities that must be investigated through design experiences and theoretical discussion.

The present paper is based on several design, research and education experiences carried on by the author during the last few years (Conti, Pillan and Soldati, 2014; Pillan, 2015; Pillan, Spadafora and Vitali, 2014; Spadafora, 2016), and it presents some conceptual models for the different paradigms of interactions that emerge from the analysis of case studies and from design practice; the paper intends to be a contribution to the evolution of design methodologies in the field of interaction design toward a more effective and responsible approach to the use of digital technologies.

In the design history, the renewal of formal languages and of aesthetic paradigms finds its nourishment and inspiration in the critical thinking and in the discussion on the evolution of social issues, in arts and in the free, aimless, experimentation of forms. In a similar way, in the development of a design culture about technology based applications, we must develop a conversation about the implications of the formal attributes of interactive products and services on individual capabilities and on social organization.

To nourish the inspiration in the design of the formal attributes of interaction, we must 'play' with technologies, so to explore their creative potentials, and to understand how to create effects of sense and meaning through the shape of processes and dynamic behaviours of machines and systems.

My research and this paper intend to offer a contribution to this respect.

The thoughts reported in the paper were developed in several years of research, design and education activities during which I focused on service and interaction design topics working as professor and researcher at the

Dipartimento del Design of the Politecnico di Milano, within a research laboratory dedicated to Interaction and Experience (www.interactionlab.polimi.it). These activities also include the development of smart services and systems for public and domestic spaces in an ongoing collaboration with the 'JOL S–Cube – Joint Open Lab for Smart Social Spaces' created by TIM–Telecom Italia in Milan, and aimed to the design of mobile applications and of systems based on IoTs. Furthermore, the results here reported are also based on my activity as tutor of some PhD researches focused on the development of innovative design methodologies (Spadafora, Vitali and Pillan, 2015), and on the investigation of the creative potentials of interactive media also through the production of experimental author–games (Righi Riva, 2013; Vitali, 2017).

   In the paper, through the presentation and discussion of some case studies, I provide some conceptual models that bring me to reconsider some limits of the existing mainstream methodologies for Interaction Design as a discipline, and I suggest a modified approach suitable in the design practice and in education.

The shape of interactive processes

   The questioning of the medium and long term consequences associated to the adoption of digital technologies in every domain of application is important for our future and cannot be demanded to technicians only. In the course of the time, authors such as Tomas Maldonado (Maldonado, 1999; 2005) provided contributions to this purpose within a theoretical and broad vision approach; others base their research on design experiences evidencing phenomena, such as Ulrik Ekman (Ekman, 2013) who collected an ample variety of art and design experimental activities in his book 'Throughout', and demonstrated the complex ramification of this issue.

   The history of the technologies and design shows a complex interdependence between the development of tools and technical solutions and the organization of a society expressed in terms of its cultural values (also including political assets and religious believes), human abilities and attitudes. The influence of design on social changes is mutual: being part of the evolving society, designers get inspiration from social and cultural phenomena, and, on their turn, give a personal interpretation and a critical reading of the changes in being, also influencing them through the innovation of visual styles and symbolic sense effects. This holds both for

traditional design (Chiapponi, 1999) as well as for Interaction Design (Telier, 2011).

While we design the functional, formal and interactive attributes of a product or of a service, we are not just designing practical solutions but we are also proposing a paradigm of solution that we consider as acceptable and desirable, and, as a consequence, we therefore produce a meme capable to reproduce itself and to propagate. As an instance, Wikipedia was not only important because its creation was a very disruptive contribution to the innovation of the traditional approaches to the collection and sharing of encyclopaedic contents, but also and mainly because it was an effective demo capable to explain and show the social advantages of collaborative activities and economy proposed as an alternative to the traditional approaches based on market competition and on top–down systems of value proposition (Tapscott, 2006).

In a similar way, as discussed by Ezio Manzini for the specific realm of social innovation, the experimental services have the power to produce cultural effects and enact changes in attitudes and cultures (Manzini, 2015). The services based on collaborative and participated involvement of final users, such as social housing systems and peer–to–peer transportation solutions, act as 'messengers' capable to diffuse an approach to problem solving in which customers and users are seen in terms of potential of a context and as part of the solution, and not just as recipients of a performance in response to their needs.

We should learn how to predict the long term possible consequences of our design proposals, and how to upgrade our design methodologies so to better evaluate and manage the complex tangle of side effects that are related to a specific interactive experience.

Presently, designers face the challenge of designing a new generation of physical products and systems, the so called 'smart objects', namely objects that can collect, store and exchange information between themselves and with human beings, and that can act, learn, evolve thanks to the gift of an artificial intelligence provided by the miniaturization of electronic devices and by mathematical algorithms.

In the following of this paper, I discuss the effects of the spreading of digital technologies on systems through three different case studies.

Transportation systems and cultural changes
As a first instance, we can consider the paradigms of most innovative advanced public transport systems proposed, between others, by XEROX.

These systems are based on the tracking of real behaviours of travellers and of traffic flows so to optimize the offer of transportation services with respect to the demand. The so called ITS– Intelligent Transportation Systems aim also to provide a seamless travel experience through a virtual integration of different transportation resources and these solutions would represent an extraordinary improvement with respect to the existing transportation systems, especially in countries such Italy, where the integration and optimization of different services is still far away. Their implementation is based on a very new approach to mobility, and it requires dynamic modelling of people needs and mathematical search for optimal solutions also considering constraints of common convenience and private vantages and interests.

The search of more sustainable and effective solutions for public transportation systems is one of the important issues for the near future and it is also a very complex one, requiring the development of a number of technical solutions for different branches of Engineering. On the other hand, the development of new paradigms of transportation services poses new design challenges since the new solutions imply radical changes in the way we conceive and access the public services: making them usable, acceptable and desirable is a complex goal requiring a multidisciplinary approach and an upgrade of the competences about experience, communication and service design.

In the present offer, most transportation services are steady both in terms of physical locations in space (busses and other vehicles runs always in the same itineraries) and in terms of time scheduling; the stability of the services provides a permanent context that contributes to the affordance of urban and suburban environments, and that allows people to plan their mobility strategies referring to a stationary representation of possibilities. The new systems, based mostly on a dynamic offer of services depending on the tracking of user behaviours and on service demands, can impact on the definition of the urban environments and on the way people will manage their personal organization schemes.

Furthermore, the dynamic public transportation services require a serious discussion about the rights of customers and especially of those minorities that do not manage dynamic interactive devices and that do not have a personal inclination toward a dynamic planning of their activities. So, actually, the creation of new transportation systems requires a better understanding of human diversity with respect to cognitive and decision making processes, and with respect to customer rights and common

convenience. The creation of the new scenarios is therefore a design and also a political challenge and as such should be intended and managed.

Digital commerce services and product quality

The topic of transport and mobility is not the only foundational system of our social organization that will be revolutionized in the next few years: the digitalization of services and systems is an opportunity to innovate a number of critical dimensions of societies, such as those related to the use of natural resources, to the reduction of wastes and pollution, and to the search of new industrial and business perspectives.

Digital technologies are deeply modifying the sale and distribution systems, where new players and stakeholders such as Amazon and the Chinese Alibaba gained influence and power without precedents acting as market places for the exchange of goods and services. These digital companies now act as central nodes of accumulation of data and offer business opportunities to big and small companies in terms of global marketplaces for big and little producers, but also are rapidly changing the rules of the business and endangering those that don't adapt their strategies to the new context.

While the advantages for customers provided by ecommerce services in terms of availability of goods are quite evident, I argue that we should be able to better understand and manage some less obvious implications.

The present organization of online service for selling goods tend to emphasize only the visual appearance of material products and their price of sale, so contributing to diffuse a very reductive common view of quality that, if not improved, will have long term consequences on industrial production. Indeed, the qualities and values of a material product depend on a much wider set of features that it is not possible to communicate through the use of a visual representation online. I refer, between others, to the haptic and thermal qualities of materials, to the performance of use, and to other characteristics such as the place and the process of production. Furthermore, while in physical retail stores the interaction between customers and sellers provide an opportunity of information exchange and knowledge growth, so producing more value associated to a product in terms of experience, in online commerce the interaction between customers and producers or sellers is mostly very basic and reduced to the essentials of the transaction process.

The creation and communication of value in the digital era requires new approaches based on a more systematic and comprehensive understanding

of the complex tangle of factors influencing the appreciation of a products or a service (Newberry and Farnham, 2013). Furthermore, while we develop innovative online services for commerce, we must also work to propose new technical solutions capable to support local retail stores and producers, and invent new quality oriented approaches to sale and interaction with customer.

In our research about digital services for retail, we are making research and experimental design activities toward two different directions: first, we are designing digital services to support little physical stores in their traditional business, so to produce for them new opportunities of business and of interaction with customers; second, we are working on the capability to communicate the physical and non–physical qualities of products, such as those concerning the fabrication processes and the values of the location of production, in the online interactions between customers and producers (Vitale and Pillan, 2016).

Smart products and personal information

To conclude this discussion about the implications of the interactive features of digital solutions, I refer to field of products and applications for personal monitoring and tracking.

Traditional personal products (such as watches, electrical appliances for domestic use, devices to access media and entertainment contents), are dedicated objects, limited in their functions and well framed in the semantic sense. The so called 'smart objects' instead, tend to include a high number of functionalities, are under the control of their human users, but also exchange information with the web, and can act in an automatic or proactive way. As an instance, we can compare a traditional alarm clock with a valuable alarm clock application such as 'Sleep cycle' or other similar solutions designed to be installed on a personal phone, that are capable to monitor the quality of sleep and to offer other features based on the collection of data provided by sensors. The smart alarm clocks can measure parameter such as breath rhythm and intensity, heartbeat rate, context noise and temperature, and also produce reports on the sleep process, comparing our performances with behaviours that are taken as a reference of normality. The applications for sleep monitoring can be interpreted as hybrid products, something in between a smart alarm clock and a care–giver. On one side, they offer innovative functionalities that can be used every day, i.e. the possibility to be waken up when the sleep cycle is closest to the awakening conditions within the predefined time range selected by

the user, so reducing the stress related to the awakening. On the other hand, they can be interpreted as a tool for health monitoring, since the application evaluates the quality of our sleep with respect to what is considered as statistical reference for wellbeing. As we turn off the alarm in the morning, we receive a feedback that increases our awareness but that can also affect the way we consider our health state. Furthermore, the capability of these applications to record personal data, memorize and share them on the web, poses the issue of privacy, that is a very complex one.

The smart products for self–monitoring provide useful tools to help us in developing a new awareness about our health conditions and lifestyle; they also provide useful information that can be employed by doctors and caregivers in the understanding the patient conditions and in the definition on therapeutic treatments. On the other hand, these new tools affect the way we feel our body and the relationship we have with ourselves.

Up to now, most design literature focuses on design methodologies and tools, and only few authors such as Anne Light and Claire Rowland (Rowland et al., 2015) offer contributions to a more responsible design of smart solutions.

While we develop and diffuse the new smart products, we should inquire and criticize their potential invasiveness and try to predict their long term effects. The tendency to overindulge in the number of functions embedded in a smart product is quite diffused: the concentration of functionalities affects the complexity of their use but also the quality of the experience and, potentially, our lifestyles. This trend should be better discussed in terms of desirable lifestyles and design principles.

Metaphors for interaction design

The opportunity of creating physical and virtual products that can act as active or pro–active entities is quite new in the history of human beings. On the other hand, as it is documented by a well know passage of the Greek poem Iliad, describing the two golden–robot maidservants supporting Hephaestus (Iliad, vv 417–421), human beings have always pursued the dream of building intelligent machines so to solve practical needs, but also to be delighted by pseudo–social interaction with perfect entities.

Now, the evolution of technologies makes feasible the creation of solutions capable to exchange information with us, to memorize our preferences, to anticipate our requests and to act in an autonomous way.

So, the question is: what kind of personality do we want to give to the machines we design? How can we invent new styles for interaction as we do with the material attributes of physical objects?

In the design of a material objects, such as a chair, the designer is oriented in the project activities by the practical constraints and by formal/aesthetic intentions. The complex of the requirements can be effectively synthesized by a metaphor that orients the development phases: for instance, designers designed the chairs that were *light as a feather*, or *vanishing like a ghost*, or *sensuous as a caress*.

In the design of the possible shapes of the interactive dimension of a smart product or of a service, we should be able, likewise, to imagine different possible solutions and to define suitable metaphors acting as compasses so to orient the definition of the main features of the interaction as well as the physical implementation details (Spadafora, 2016). We take as a reference, the MIT studies demonstrating that humans tend to consider proactive objects as living entities (Reeves and Nass, 1996). We designed a control panel to adjust the temperature also managing the conflictual trade off between wellbeing and energy saving (Vitali et al., 2014). We designed playful artefacts capable to tackle cognitive dissonances and to produce the experience of meaning construction through interactive engagement (Pillan et al., 2011; Vitali, 2017).

As a result, we can classify the main metaphors that characterize most of the analysed case studies into two main categories: those oriented toward function and efficiency performances, and those aimed to produce an aesthetic effect through interactive engagement.

In the first category, the design of interaction is guided by a metaphor in which the technical system is interpreted as mechanical machine, activated through triggers, and obeying to orders activated by a limited number of possible choices offered to the users in terms of commands such as:

– Cause and effect (if ... then… else…);
– Automation (do it for me);
– Reduce my physical and cognitive efforts;
– Force me to do it in this way;
– Challenge and award me;
– Drive me through an interactive experience so that I learn by doing.

The second category includes solutions in which the user is enabled to act in open–end interactions and that produce effects such as:

– Elicit my senses and emotions;
– Astound me and provide a completely new experience;

– Talk to me of something that is deeply buried inside me;
– Recover a meaningful piece of my memory;
– Challenge my brain;
– Through interactive experiences, allow me to develop better awareness of the virtual and physical world (open conclusions);
– Create open interactive contexts where I can create my personal experience (fostering ambiguity).

The metaphors of the first category drive the development of solutions such as the smart refrigerators, smart lighting and heating systems, and of locking solutions. These new devices are capable to act instead of us, and to suggest a 'convenient' behaviour. They include domestic appliances that can compile the list of goods that should be bought or send the order of purchase to Amazon, that can optimize our energy consumption, support our memory recalling the agenda of the day, and that will be able to drive us at work while we dedicate our attention to other tasks. This first category is today the dominant one, it produces useful functionalities but also a number of technological solutions that, despite their apparent practical utility, are unable to encounter the appreciation of users and that have hidden implications that should be better understood and managed.

The second category is much less consistent from the point of view of the number of available case studies, and includes poetic concepts such as 'A chair with a Soul left behind' and 'Personal Skies for Workshperes', developed by Naoto Fukasawa and presented at the MOMA in New York, and games such as 'The Graveyard' by the Tale of Tales, and 'Wheels of Aurelia' by Santaragione.

In the whole, these examples demonstrated that there are ample possibilities of shape the interactive features of digital technologies so to create meaningful design solutions also qualified in terms of sensorial and symbolic results.

Upgrading Interaction Design Methodologies

The development of interactive products and services is, most of the times, a multidisciplinary processes requiring the collaboration of designers with engineers and other experts of technology. The canonical approach to this kind of projects is based on cyclic iteration of activities including user studies, the generation of new concepts, the design of physical characteristics, the prototyping and testing. The focus is on the design of

useful new functionalities and on making them accessible, acceptable and usable.

This approach is vastly adopted for the project of little products and of complex systems. On the other hand, despite the robustness of the methodology, the failure rate of new concepts is still very high and, in several fields such as home automation, the new solutions still struggle to obtain the consensus of users, despite the apparent utility of the proposed solutions. As designers, even in the design of digital interactive products and services, we should focus on the 'shape' of the interactive processes enabled through technology, and not just on functionalities.

The tools we need are already there: the ability to envision scenarios through storytelling, video making, customer journeys, visualization process, worst case analysis, and more, are part of the standard technical skills for designers, together with the abilities to criticize existing solutions and to propose innovative concepts. What we need, is the capability to invent new paradigms for interaction and to develop an awareness of the Importance of the formal qualities of it.

The explicit representation of the design metaphors associated to the different shapes of interactions, as discussed above, offers the opportunity to make evident the implications of choices in terms of design and social meanings and consequences and, therefore, it provides a tool for the upgrading of the design practice.

References

Chiapponi, M. (1999) *Cultura sociale del prodotto*. Milano: Feltrinelli.

Conti, G., Pillan, M. and Soldati, M.G., (2014). Fashionable Techs: An Investigation on Aesthetic Issues and Project Methodologies In Fashion Design Based on Technology Innovation. In *Proceedings of CIMODE 2014, 2nd International Fashion and Design Congress*. Milan.

Ekman, U. (ed.) (2013) *Throughout. Art and Culture Emerging with Ubiquitous Computing*. Cambridge: MIT Press.

Hassenzahl, M. (2011a) User Experience and Experience Design. In Soegaard, M. And Dam, R. F. (eds.), *Encyclopedia of Human–Computer Interaction*. Aarhus: The Interaction Design Foundation.

Hassenzahl, M. (2011b) *Towards an Aesthetics of Friction.* TEDx talk. [Online] https://www.youtube.com/watch?v=ehWdLEXSoh8.

Maldonado, T. (1999) *Critica della ragione informatica*. Milano: Feltrinelli.

Maldonado, T. (2005) *Memoria e conoscenza. Sulle sorti del sapere nella prospettiva digitale*. Milano: Feltrinelli.

Manzini, E. (2015) *Design When Everybody Designs*. Cambridge: MIT Press.

Newberry, P. and Farnham, K. (2013) *A Framework for Integrating Brand, Experience, and Value*. New Jersey: Wiley.

Pillan, M., Righi Riva, P., Gatti, E. and Lupi, G. (2011) [Game mechanics] & [Phenomena in cognitive and social psychology]: Experiments in Emotional Design for Communication. In *Acts of the Swiss Design Network*.

Pillan, M., Spadafora, M. and Vitali, A.A. (2014) Foretelling and Shaping the Future of Technology: The Role of Communication Designers in the Design of Innovation. In *A Matter of Design. Proceedings of the V STS Italia Conference*. Milan: STS Italia.

Pillan M. (2015) Aesthetic and Ethic Issues in Interaction Design. In *Proceedings of the Conference DeSForM 2015 – Design and Semantics of Form and Movement. Aesthetics of Interaction: Dynamic, Multisensory*. Milan.

Reeves, B. and Nass, C. (1996) *The Media Equation*. Cambridge: MIT Press.

Righi Riva, P. (2013) *Designing Playful Artifacts: The Exploration of Play as a Process and the Limited Role of the Designe*r. PhD dissertation, Politecnico di Milano.

Rowland, C., Goodman, E., Charlier, M., Light, A. and Lui, A. (2015) *Designing Connected Products*. Sebastopol: O'Reilly Media.

Spadafora, M., Vitali, A.A and Pillan, M. (2015). Objects are Not Slaves: Envisioning an Aesthetic Approach to the Design of an Interactive Dialogue with Objects. In *Proceedings of the Cumulus Conference 2015*. Milan: Politecnico di Milano.

Spadafora, M. (2016) *Designing the Behavior of Interactive Objects.* PhD dissertation, Politecnico di Milano.

Tapscott, D. and Williams, A.D. (2006) *Wikinomics. How Mass Collaboration Changes Everything*. New York: Penguin Group.

Telier, A. (ed.) (2011) *Design Things*. Cambridge: MIT Press.

Vitale, A.S. and Pillan M. (2016) Products as Communication Platforms. Investigating and Designing the Evolution of Retail Services in the Digital Era. In *Proceedings of the 6th International Forum of Design as a Process, Systems & Design – Beyond Processes and Thinking*. Valencia: Editorial Universitat Politècnica**.**

Vitali, A.A., Spadafora, M., Nacci, A., Sciuto, D. and Pillan, M. (2014) Spell: Affecting Thermal Comfort through Perceptive Tecniques. In *Ubicomp'14 Adjunct*. Seattle: ACM.

Vitali, A.A. (2017) *Meet Me in Play. Creative Processes and Expressive Techniques in Playful Multimedia*. PhD dissertation, Politecnico di Milano.

Acts of Use from Gestell to Gelassenheit: Calculative Thinking and Exploratory Doing

Giovanni MARMONT[*][a]

[a] University of Brighton

This paper addresses the implications of open–ended instances of use and non–instrumental person–thing interactions. Central to the argument is an analysis of Heideggerian work on technology and particularly of the notions of Gestell [enframing] and Gelassenheit [releasement]. These name respectively modern technology's inherent danger – a totalising 'unconcealment' of the world as mere resources to be exploited – and a possible gateway from it – in the form of an open mode of thinking, void of calculative demands towards what is encountered. Suggesting that a possible transition from Gestell to Gelassenheit needs not be intended as an exclusively metaphysical shift, as some have argued, it will then be considered how a different way of thinking could be prepared and assisted by a different way of acting, of doing. Such radical modification would crucially require questioning the very notion of use and its hazy relation to functionality. The paper ultimately makes a case for modes of interacting with artefacts through acts of use as ends in themselves, transcending teleological explanations and not exhausted in utilitarian functionalism. It is proposed that a possible prototype for this type of inherently ludic exploratory doing might be found in the activities of French revolutionary group Situationist International.

Keywords: *Critical use; performativity; play; dérive; Gestell; Gelassenheit*

Agency: masters and slaves

Understanding artefacts as *performative*, as theorised by design historian and critic Damon Taylor (Taylor, 2011, p. i), as a much more

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complex reality than a mere stream of inert, ever–compliant utility tools, consequently puts into question the alleged agency of human actants within the mechanics of everyday life. The intention to move beyond the problematic humanist rhetoric of the intentional, self–constituting human subject has been central to the study of person–thing interactions within the fields of material culture studies and philosophy of technology as well as, of course, STS. Bruno Latour's Actor–Network–Theory (ANT) has been a prime example of such theoretical effort. Artefacts, Latour rightly notes, 'might authorise, allow, afford, encourage, permit, suggest, influence, block, render possible, forbid and so on' (Latour, 2005, p. 72). This way, the very concept of agency can be said to be somewhat shattered and made *social* – 'an association between entities' (ibidem, p. 65), some human some non–human – thus ceasing to be conceived as a *property* of a subject. Building on these theories, what follows will firstly make a case for rejecting an understanding of agency, in relation to objects, as positioned on a linear spectrum, oscillating between two polarities: on one hand, the absolute mastery of humans over instruments at their utter disposal; on the other, a gloomy dictatorship of things over supposedly passive users, slaves at the mercy of their own tools. It is instead claimed that these two allegedly opposite perspectives are far more entangled than one might assume and by no means mutually exclusive. Therefore, simply framing the issue as a matter of *degrees* of agency, on a hypothetical continuum ranging from 'complete control' to 'complete subjugation' is perhaps inadequate. It is instead proposed, as counterintuitive as it might sound, that dichotomising these two aspects is deceptive because, more often than not, we might well be both masters *and* slaves simultaneously. The construction of this argument will mostly hinge upon a reading of Heidegger's work on technology and will pave the way for a discussion on thinking and acting in relation to technology and artefacts. This will then lead to a consideration of how we might imagine, and indeed devise, alternative ways of encountering and, more generally, *being* with things when constructing acts of use as a form of exploratory playful behaviour. The paper will conclude by looking at the activity of French revolutionary group Situationist International, in order to discuss the potential implications and political relevance of everyday ludic experience.

Revealing: *Gestell*

In 1954 German philosopher Martin Heidegger first published the seminal essay *The Question Concerning Technology*, which had the intent of uncovering no less than the *essence* of technology. The first thing that must be noted is that Heidegger's analysis is not primarily concerned with technological *things* in and of themselves. Indeed, he claims:

> 'Technology is not equivalent to the essence of technology […] the essence of technology is by no means anything technological.' (Heidegger, 1977 [1954], p. 4)

Secondly, the essence of technology cannot be fully exhausted in its instrumentality, in it being an *instrumentum* (ibidem, p. 5) – i.e. a means to an end. Again, while this is indeed true for how technological *things* are encountered, it still does not identify the essence that permeates them. If this were the case, the will to assert our agency, taming technology through enhanced mastery, would be all that is required to us. Rather, such essence – that does imply instrumentality – has to be grasped as a particular 'way of revealing' [*Das Entbergen*] (ibidem, pp. 11–12). Understood in this way, technology's fundamental instrumentality is actually grounded in *causality*, intended as causing the coming to presence of something, as bringing something out of concealment. What is at stake, what is being 'unconcealed' through technological mediation, Heidegger argues, is the very world of which we are part. Crucially, then, the mode of revealing that is characteristic of technology consists in presenting the whole world as a mere stockpile of resources that human beings are encouraged to summon and exploit. This way, everything everywhere is reduced to 'standing–reserve' [*Bestand*] (ibidem, p. 17) through a process that Heidegger calls *Gestell*: 'enframing'. Technology's essence can thus be understood as the setting in motion of a constant instrumental demand that extends to the totality of the existent. An ever–quantifying way of *thinking* about the world as nothing but an endless series of in–order–to utility tools. Not exclusively technological things then, but the entire world – ourselves included, if we think about the concept of 'human resources', for instance – thus becomes revealed as a means to an end. *Everything* is enframed, everything is in question.

This seemingly inescapable, pure utilitarianism lays bare the paradox mentioned earlier in regards to the master–slave dichotomy. According to Heidegger, we are enslaved precisely through an insatiable will to absolute mastery of the world, through a 'single way of revealing' (Heidegger, 1977

[1954], p. 32). That is, our very obsession with mastery *is itself* a form of somewhat covert slavery to technological things. As Heidegger himself explicitly notes elsewhere, 'man's unconditional mastery over the earth, and the execution of this will, harbor within themselves that subjugation to technology' (Heidegger, 1993 [1981], p. 14).

Thinking: *Gelassenheit*

What we begin to see is that the chief concern in Heidegger's critique of technology is the emergence of an alienating and profoundly impoverishing mode of *thinking* – and therefore *being* in – the world we inhabit. Which of course begs the question: can an alternative to such thinking be developed and, if so, what would that be? Heidegger directly addressed these questions a few years later, in 1959, by formulating the concept of *Gelassenheit* (Heidegger, 1969 [1959]). The argument here primarily hinges upon the opposition between 'calculative thinking' – i.e. what we have seen to emerge through *Gestell* – and what Heidegger calls 'meditative thinking' (ibidem). Thinking that is 'meditative', Heidegger claims, is precisely what could enable us to overcome the reifying disclosure of the world that is proper of enframing. This is because such thinking, being radically stripped of instrumental demands towards the world that is encountered, instead remains meditatively 'open to its content, open to what is given' (ibidem, pp. 24–25). Before we proceed any further, it should be noted that the frequent and potentially equivocal use throughout this paper of the term 'meditative' [*besinnliche* – which might alternatively be rendered as 'contemplative'] shall not be mistakenly linked to popular meditation practices such as that of 'mindfulness'. That being said, engaging in the openness of this mode of thinking entails an attitude of *Gelassenheit*, often rendered in English as *releasement*. What is, then, that thinking must be released from, so to speak, for it to be open to its content and therefore meditative? Heidegger's rather cryptic response is that thinking must be rid of and disentangled from *willing*. One could perhaps say that what he has in mind here is a thinking that would be primarily concerned with itself as an undirected exploratory process, rather than with the *result* of such process. Metaphorically speaking, a similar difference might be said to exist between walking in order to reach a destination and walking as strolling, as intentionally purpose–free wandering. Still, what makes the above assertion profoundly counterintuitive is that, of course, to relinquish willful thinking – giving way to what Heidegger calls 'non–willing', or sometimes 'letting–be' –

surely requires an effort in itself: that is, to willingly renounce willing (ibidem, p.59). This admittedly abstruse argument has inevitably resulted in diverging interpretations.

Firstly, the notions of non–willing and releasement must not lead to the hasty conclusion that what Heidegger urges is a delusional form of reactionary pseudo–primitivism and unlikely return to a pre–technological age (cf. Agamben, 2009; Dreyfus and Spinosa, 2003). Indeed, Heidegger explicitly concedes that '[i]t would be foolish to attack technology blindly' (ibidem, p. 53). On the contrary, he proposes,

> '[w]e can affirm the unavoidable use of technical devices, and also deny them the right to dominate us' (ibidem, p. 54).

We can see, then, that the alternative relation to technology that Heidegger is describing is not the form of total rejection that philosopher Peter–Paul Verbeek, for instance, seems to find in the concept of *Gelassenheit* (Verbeek, 2011, p. 71). Rather, the term names a way of being at once immersed in yet unshackled by technology and technological things, a comportment of releasement *toward*, not *from* things (Heidegger, 1969 [1959], p. 54) [*Gelassenheit zu den Dingen*]. That is, Heidegger's releasement *is* a relationship with technology, albeit a different and freed one.

A second matter of controversy is that, again contrarily to what Verbeek appears to infer, Heidegger's proposition is not meant to encourage a form of mindless quietism or abstracted passivity. Not only must one *will* non–willing, as mentioned above. Also, one must not intend the process of releasement, as Verbeek does, as a purely metaphysical undertaking whereby thinking differently *alone* would suffice (Verbeek, 2011, p. 72). Granted, Heidegger's ultimate focus is indeed on the mode of thinking that could allow a richer dimension of revealing. Nevertheless, we shall see that this does not undermine the importance that acting, and therefore potential bodily person–thing engagements, has in Heidegger's *Gelassenheit*.

Acting: practical *a priori*

In order to understand the sometime downplayed role that *acting* can hold within Heidegger's framework, we should now turn to Reiner Schürmann's book *Heidegger on Being and Acting: From Principles to Anarchy* (1987 [1982]). Particularly throughout a chapter eloquently titled *Acting, the Condition for Thinking*, Schürmann discusses something that will be extremely useful to the present discussion: namely, what he calls a

'practical a priori' (Schürmann, 1987 [1982], p. 236). He notes that, in Heidegger, thinking is 'made dependent upon a practical condition' and 'does not arise without preparation' (ibidem, p. 235). When looking at the opening of *Being and Time*, for instance, one finds the two following questions and answers:

> 'Do we in our time have an answer to the question of what we really mean by the word 'being'? Not at all. […] But are we nowadays even perplexed at our inability to understand the expression 'Being'? Not at all.' (Heidegger, 2015 [1927], p. 19).

What Schürmann argues is that, while the first query concerns a purely philosophical issue, the second one 'is no longer cognitive […]. It is not even philosophical anymore' (Schürmann, 1987 [1982], p. 237). Rather, he continues, this second question points to a type of *comportment*. That is, a '*practical modification* of existence' (ibidem, p. 238 [my italic]) through a pre–philosophical *perplexity* that must be awoken as necessary condition of possibility in order to then confront the first, essentially philosophical question. This holds true for releasement as well: '[t]o understand releasement, one must be released' (ibidem, p. 236).

A transformed practical *a priori*, intended as a preparatory exercise, would arguably need to retain the traits proper of the transformed mode of thinking it aims to lead to, and indeed mirror it. Such practice would then be, as it were, a form of 'meditative practice', of contemplative doing not underpinned by instrumental demands. A 'non–willing practice' concerned with itself as an *open* process. If such a 'released practice' – a released practical *a priori* – is to be conceptualised, we shall begin to consider what this would mean in terms of the actual 'unavoidable use of technical devices' (Heidegger, 1969 [1959], p. 54). Indeed, the practice discussed here is one revolving around encounters with artefacts, around those 'acts of use' that Heidegger acknowledges to be inevitable and through which a freed relationship between persons and things might be established. How are we, then, to understand and reimagine these acts of use according to a posture of *Gelassenheit*?

Using: play

It would now seem appropriate to focus our attention onto the very notion of *use* as such, and to do so through a critical lens, in order to first disentangle it from dogmatic rhetoric. 'Use' colloquially names an action of a

subject onto an 'object', in a way that is *functional* to the achievement of an end goal. This way, the *use* of some–thing, presented as an act that is operated in order to arrive at a result, essentially identifies an act that is given legitimacy through something external to it: its purpose, its *telos*, its *function*. Thus understood, the artefact encountered inevitably remains confined to the status of 'tool', of in–order–to device. Consequently, its most important in–use feature would appear to be its efficient function–*ing*, its usefulness, in a pragmatic sense, in enabling the fulfilment of a plan. The apprehension of *use* described here seems to confirm the reach of the calculative thinking that Heidegger takes issue with and, conversely, how glaringly at odds it is with the non–willing and radically open–ended relationship with technology that he advocates.

Narrow, efficiency–obsessed understandings of functionality have been largely disputed (see, amongst many others: Adorno, 1979; Dunne and Raby, 2001; Taylor, 2011). A first liberating step, for both practitioners and design scholars, has been that of challenging the allegedly inescapable coupling of functionality with practical utility that had dominated mainstream design discourses. However, a second and even more resilient binary can perhaps be put into question now: namely, the coupling of functionality with use. Indeed, function intended as an inferred plan of action, or a 'script' (Akrich, 1992), regardless of what that plan would entail, clearly still betrays a *willing*, a calculative demand towards the artefact encountered. As Theodora Vardouli notes, however, 'there is little consensus about how the concepts of function and use relate to each other' (Vardouli, 2015, p. 1), hence the frequent assumption that the two are in fact inextricably co–dependent. Such assumption appears to be very much present in most of the practical work at which I was hinting above too, as a critique of utilitarian functionalism and rejection of efficiency has often resulted in the unfortunate removal of these projects from the sphere of everyday use and bodily action, favouring instead the highly curated settings of galleries or museums.

It is through the work of Italian philosopher Giorgio Agamben that we can instead begin to entertain a more radical understanding of *use*, as he confronts the difficulty of decoupling use and function in his book *The Use of Bodies* (2015). When discussing the Aristotelian distinction between 'productive instruments and instruments of use (which produce nothing except their use)' (Agamben, 2015, p. 12), Agamben acknowledges that

'[w]e are so accustomed to thinking of use and instrumentality as a function of an external goal that it is not easy for us to understand a dimension of use entirely independent of an end' (ibidem, p. 12).

Agamben's recourse to Aristotle provides yet another interesting insight only a few pages later, when he presents a similar distinction between *poiesis* and *praxis*: while the former is defined by the presence of an external end (a *telos*), the latter is a mode of acting that 'is in itself the end' (ibidem, p. 21). Further, Agamben finds in Lucretius an analogous theorisation of use as 'completely emancipated from every relation to a predetermined end […] beyond every teleology' (ibidem, p. 51). Here, through a fascinating reflection on the use that living beings make of their own body parts, it is suggested that the function of some–thing (a limb, in this case) is *created* through use, rather than being what guides it. This way, function can be understood as an elusive yet *distinct* stage within a process of use.

What Agamben offers through his analysis is the invaluable possibility to isolate a form of self–sufficient, radically autonomous use from the function that would otherwise eventually emerge through it (cf. Agamben, 2005, p. 64 for a similar argument). Appropriating a recurrent phrasing in Agamben's work, it could be said that, this way, function would be 'rendered inoperative' (e.g. see Agamben, 2015, p. 30). We can see how this operation points precisely to the type of 'willing non–willing' that we have sought to identify throughout. That is, the tainting emergence of function could be resolutely neutralised, or perhaps *indefinitely postponed*, through a form of *critical use* that is ceaselessly and creatively reinvented: a use that, as Vardouli notes, is ever–unfolding and spontaneously improvisational (Vardouli, 2015, p. 14). The seemingly daunting task of conceiving a form of use that is disinterested, open–ended, creative, spontaneous, actually names something as mundane as our ubiquitous interaction with technology: that is, *play*.

This assertion, however, should be treated with caution, for it could easily lead to deceiving conclusions, as the enframing of calculative thinking is always potentially at work. Firstly, the ludic engagement with artefacts that is proposed here shall not be understood as a *game*. This delicate distinction has been accurately described by Taylor. Games, he observes, 'contain a (usually explicit) script […] whereas play can be said to be much broader and open' (Taylor, 2011, p. 151). Further, play 'can be the *suspension* of goal–directed activity […]. Play can be for play's sake' (Matthews, Stienstra and Djajadiningrat, cited in Taylor, 2011, p. 151). The

practice of play – or a playful practical *a priori* – can therefore be intended as an undirected process whereby one gets willingly lost in a 'delight internal to the act' (Agamben, 2015, p. 51).

Drifting: things

A possible prototype for such fundamentally unplanned and exploratory activity could perhaps be identified in the work of French revolutionary group Situationist International (SI hereafter). Although the SI was officially active only between 1957 and 1972, their rich legacy remains highly influential across several fields, from art and architecture to cultural and political theory. The SI devised a unitary programme intended to counter the dramatically alienated practice of everyday life in modern society, advocating its radical alteration through the deliberate 'construction of *situations*' (cf. Knabb, 2006). Such *situations* essentially involved tactics for experimental comportment, often enacted by members of the group. Interestingly, as Tom Bunyard notes, '[c]onstructed situations […] were deliberately designed so as to include chance elements', which 'were held to render lived experience potentially ludic' (Bunyard, Forthcoming). This way, he continues, '[l]ife, as realised art, would become akin to play' (ibidem). Central to this work was, on one hand, a fierce criticism of modernist functionalism and 'urbanistic hyper–planning' (McDonough, 2009, p. 20) as well as, on the other hand, an attempt to reignite an element of spontaneous creativity and adventurousness within daily existence. One notable *situationist* technique is that of the *dérive*, French for 'drift'. *Dérives* 'entailed 'drifting' through the city, […] following no prior plan other than the whims and desires provoked by the local ambiences' (Bunyard, Forthcoming).

This technique, ultimately intended to afford a condition permanent play [*jeu permanent*] through an incessant 'succession of new fields of chance' (Bunyard, 2011, p.74), retains a number of obvious similarities to the form of critical use that was described earlier on. Firstly, it might not be much of a stretch to understand the strategic and therefore agenda–driven nature of *dérives* as somewhat akin to Heidegger's resolve for 'non–willing'. Secondly, we can certainly see a clear parallel with the 'openness' of *Gelassenheit*, as those who engage in *dérives* 'drop […] their other usual motives for movement and action, and let themselves be drawn by the attraction of the terrain and the encounters they find there' (Knabb, 2006, p. 62). Importantly, this points to a shift in the relation to what is encountered: that

is, it could be argued that the SI played *with* – more so than *through* – the city.

Despite their interest in artworks and architecture, the SI strangely neglected the realm of everyday use–objects. However, if we were to conceptualise a released practice in relation to technology as a form of *dérive*, the artefacts encountered through such practice would best be regarded as 'drifting companions' or 'comrades', rather than toys as 'instruments of play'. This would suggest an understanding of use as an experience grounded in a form of deep mutuality between user and 'used', the implications of which I have in part addressed elsewhere (Chapman and Marmont, Forthcoming). Although leading to very different conclusions, this form of mutuality is also remarkably reminiscent of Russian constructivist Alexander Rodchenko's appeal for artefacts to cease being 'mournful slaves' and being instead intended as 'comrades' (Kiaer, 1996, p.3)

This being said, what can be understood through Situationist work much more explicitly than through Heidegger's *Gelassenheit*, is the overt political relevance inherent in this 'playful–constructive behaviour' (Knabb, 2006, p. 62), as well as in the artefacts involved in it. The *performativity* of such artefacts would ultimately consist in the *recruitment* – the 'interpellation', in Althusserian terms (cf. Taylor, 2011, p. 54) – of a particular breed of user: a 'dissident user' that embraces the subversive power of play while refusing to relegate it to leisure time. This militantly playful practice could be instead interwoven with the very fabric of mundane activity and everyday encounters with artefacts, rather than separated from it as an 'exceptional *intermezzo*' (Huizinga, 1949, p. 9). The hope, then, is that an increasing portion of our relationship with things, with technology, could thus be deliberately transformed into a contemplative exercise, an *exploratory doing* that does not need to arrive anywhere specific. Turned, as beautifully put by Schürmann, 'into a groundless play without why' (Schürmann, 1987 [1982], p. 243).

Ultimately, what has been presented in this paper is an effort to introduce additional operational coordinates to already rich debates around the 'thick imbroglio' (Latour, 2005, p. 46) that is the realm of human acting. In particular, this study has intended to restate, more or less explicitly, the profoundly political and tactical implications that a certain approach to the issue begets.

Bibliography

Adorno, T. (1979) Functionalism Today. *Oppositions*, 17, 30–41.

Agamben, G. (2015) *The Use of Bodies*. Stanford: Stanford University Press.

Agamben, G. (2009) *What is an Apparatus? And Other Essays*. Stanford: Stanford University Press.

Agamben, G. (2005) *State of Exception*. Chicago: University of Chicago Press.

Akrich, M. (1992) The De–Scription of Technical Objects. In Bijker, W.E. and Law, J. (eds.), *Shaping Technology/Building Society: Studies in Sociotechnical Change*. Cambridge: MIT Press.

Bunyard, T. (Forthcoming) *History's Negative: Hegel, Marx and Temporality in the Work of Guy Debord and the Situationist International*. Leiden: Brill.

Bunyard, T. (2011) *A Genealogy and Critique of Guy Debord's Theory of Spectacle* (PhD Thesis). London: Goldsmiths University of London.

Chapman, J. and Marmont, G. (forthcoming) The Temporal Fallacy: Design and Emotional Obsolescence. In Egenhoefer, R.B. (ed.), *The Routledge Handbook of Sustainable Design*. Oxford: Taylor & Francis.

Dreyfus, H. and Spinosa, C. (2003) Further Reflections on Heidegger, Technology, and the Everyday. *Bulletin of Science, Technology & Society*, 23 (5), 339–349.

Dunne, A. and Raby, F. (2001) *Design Noir: The Secret Life of Electronic Objects*. Basel: Birkhäuser.

Heidegger, M. (2015 [1927]) *Being and Time*. 37th ed. Malden: Blackwell.

Heidegger, M. (1993 [1981]) *Basic Concepts*. Bloomington: Indiana University Press.

Heidegger, M. (1977 [1954]) The Question Concerning Technology. In Lovitt, W. (tran.), *The Question Concerning Technology, And Other Essays*. New York: Harper & Row.

Heidegger, M. (1969 [1959]) *Discourse on Thinking*. Harper Colophon Books. New York: Harper & Row.

Huizinga, J. (1998 [1949]) *Homo Ludens: A Study of the Play–Element in Culture*. London; Boston: Routledge and Kegan Paul.

Kiaer, C. (1996) Rodchenko in Paris. *October*, 75, 3–35.

Knabb, K. (ed.) (2006 [1981]) *Situationist International Anthology*. Berkeley: Bureau of Public Secrets.

Latour, B. (2005) *Reassembling the Social: An introduction to Actor–Network–Theory*. Oxford: Oxford University Press.

McDonough, T. (ed.) (2009) *The Situationists and The City*. London/New York: Verso.

Schürmann, R. (1987 [1982]) *Heidegger on Being and Acting: From Principles to Anarchy*. Bloomington: Indiana University Press.

Taylor, D. (2011) *Design Art Furniture and The Boundaries of Function: Communicative Objects, Performative Things* (PhD Thesis). London: University of the Arts London and Falmouth University.

Vardouli, T. (2015) Making Use: Attitudes to Human–artifact Engagements. *Design Studies, Special Issue: Computational Making*, 41, Part A, 137–161

Verbeek, P.–P. (2011) *Moralizing Technology: Understanding and Designing the Morality of Things*. Chicago: University of Chicago Press.

Author

Giovanni Marmont is an AHRC funded PhD researcher and lecturer at the University of Brighton (UK), where he is also part of the Critical Studies Research Group. His research is concerned with the political and philosophical implications of person–thing interactions, through an exploration of the performative role that objects could play in everyday practices of radical politics. Giovanni holds an MA in design from London's Central Saint Martins.

The Concept of Displacement in Prototypes for Design Research: A Proposal of a Framework for Design Research that Uses Prototypes to Investigate Possible Future Scenarios

Juan Alfonso DE LA ROSA[*a]

[a] Universidad Nacional de Colombia

The field of design is a very active one; new knowledge is constantly sought and applied in a persistent search for a better understanding of the ways the constructed human world works. The knowledge that is coming from other disciplines has become an asset for designers, a way to generate frameworks that could provide more stable design processes. But the argument over the specific knowledge that is provided by the disciplines of design is still in debate. Based on the concept of displacement (Simondon, 1958; Latour, 1990; Akrich, 1992) this paper tries to recognize how the experimental use of prototypes in design research can unveil specific knowledge about the constructed world and the interactions through it, as the systems are transformed, a type of knowledge that might be unique to the field of design and that could set a tone on the process of design research. With this argument, this paper proposes a variation on the common 'reframing' model (Alexander, 1964; Banathy, 1996) for design researchers that seek to recognize the complexity of the system surrounding a design problem and the ways in which a process of design can modify the future state of the system.

Keywords: *Displacement; complexity; technical objects; prototypes; design research; framework*

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[*] Corresponding author: **Juan de la Rosa** | e–mail: **jadelarosam@unal.edu.co**

Introduction

PhD in Design programs are united in the search for the proper ways to make the argument on the sense of something called 'Design Research' in front of other well–established communities, both in natural sciences and social sciences. On a newly developed role (Belderbos and Verbeke, 2005; Nilsson and Dunin–Woyseth, 2012; 2014) students and researchers must face the idea of new knowledge based on the use of design as a method.

Since most of the work of the designers is a search for understanding of the current state of the system that contains the design problem and the patterns and trends that could bring clues on how that system is going to react to the insertion of a specific piece of constructed reality, we constantly fight with the uncertainty of the non–existent yet, both of objects, affordances and the future system.

The intention of this paper is to try to propose one possible scenario for the design researches to search for new knowledge from a different perspective. If design is the planning for the construction of a desired state of reality (Simon, 1996), how can we investigate the real consequences of the designed, or the affordances that will rise from them? How can we understand the complexity of the system we are transforming while we are transforming it? For that this paper proposes a framework that uses prototyping as probes into the future system and ways to collect data back from it.

This framework rises on the conjunction of three main concepts mentioned before and that are fundamental to explain the relationships between humans (and other actors) and the constructed world. These concepts are the tacit and embodied knowledge; the displacement on technical objects; and the idea of complex systems and wicked problems in the field of design.

These initial concepts share the intention of explaining different human phenomena and are all connected to the idea of design. The first one relates to the construction of the world and how technical objects act as mediators in human relationship with the world; what represents a significant part of the work of designers. The second concept is used to explain the way we experience and apprehend the world around us, and how we gain knowledge out of that experience. The third concept is intrinsically connected with the way designers perceive the world and our constant role to reveal what lays underneath. Complexity is a natural state of design, and designers are trained to build and deal with complexity. By putting all these

concepts together this paper tries to achieve a broader perspective of the role of design and a possible higher level of understanding of knowledge.

As a foot note and advise, this paper is intended as a provocation to start an academic conversation about a subject that is still on a conceptual level. As an example, the main three concepts that support this framework are coming from different areas of knowledge and schools of thought; but through the role of design of bridging between disciplines, knowledge and reality, they can come together to explain the type of work that we do and the possible knowledge that can arise from the design research process.

The other type of knowledge

How do we know what we know? How do we build knowledge of the world around us? Is it just a matter of scientific method and logic or is there something else to understand on that process?

One reflection about this subject comes from the phenomenologists, especially Heidegger and those who followed him. In one of his more famous conferences, Heidegger (1971, p. 150) proposes the idea that the only way for use to understand the world that surrounds us is to build on it. The action of building is essential in our process of recognition of the world. He states: 'The bridge swings over the stream 'with case and power'. It does not just connect banks that are already there. The banks emerge as banks only as the bridge crosses the stream. The bridge designedly causes them to lie across from each other', exemplifying how does the process of construction of the world reveals the world itself. For him, this physical action of building (transforming) the world around us is the only way we have, to gain some knowledge about the world, as we cannot think on something that we haven't experience.

Later, another French phenomenologist, Maurice Merleau–Ponty influenced by the work of the same Heidegger (Gallagher, 2010), proposed a concept that he defined as 'embodied knowledge', referring to the idea that there is a specific type of knowledge that is built on our physical relationship with the world, one that requires our body, our hands, to experience the different factors implied in our experience of the world. For Merleau–Ponty (1969) we are band to understand the world as part of it; our physical existence on the world cannot be eliminated from the way we perceive and understand the world. This form of knowledge based on experience according to Merleau–Ponty is essential to our recognition of the world and based on our bodily existence; as the blind man who reaches into the world

with a cane, we recognize our surrounding as an experience at hand, a result of our senses. The studies of Merleau–Ponty concept became a reference point for contemporary studies (Berthoz and Petit, 2008; Gallagher, 2005; Noë, 2004; Shusterman, 2008) because of the serious analysis performed by the author of the different perspectives of cognitive science and psychology.

This concept of embodiment of the knowledge was also used by Polanyi (1967) as a component of his definition of the tacit knowledge. Even though Polanyi's concept of tacit knowledge seems broader than just the knowledge of the thing as we experience it, there is a clear connection between the two concepts. For Polanyi, the tacit knowledge differs from the explicit knowledge as the tacit one is not transferable as a set of instructions, it is possible to describe it, but the only way in which we can really access it is by experience. Part of this process of achieving this type of knowledge is related to our physical experience of the world and our bodily existence.

Polanyi (2015) recognizes this different type of knowledge, an embodied one, which deals with the complexity of human experience. Tacit knowledge is not only difficult to communicate is difficult to study, since there is not a way to explain it on a propositional form. Explicit, or proper, knowledge exists in propositional form; it can be organized, transfer and saved. We can build on it as reference for other generations, but experience of the world does not work like that.

Chilean biologists Maturana and Varela (1987, p. 26) proposed a different concept. They use the term 'autopoiesis' as a search for a biological phenomenology of knowledge. As autopoitetic organisms we are responsible for our own construction and we are owners of our specific knowledge; the only way for them to gain knowledge is also trough the human experience of the world, because knowing and doing are intrinsically connected, they stated: 'This circularity, this connection between action and experience, this inseparability between a particular way of being and how the world appears to us, tell us that every act of knowing bring forth a world… All this can be summed up in the aphorism 'All doing is knowing, and all knowing is doing'.'

That idea of autopoiesis clearly relates to an experiential way of knowledge, one that cannot be found through theoretical propositions and requires the recognition of everyone's experience of the 'thing' as a way of gaining knowledge of it. Later, Varela joined efforts with the philosopher Eva Thompson and the psychologist Eleanor Rosch, to work on the concept of embodiment as a direct reference to the work of Merleau–Ponty. In their book (Varela, Thompson, and Rosch 1992, p. 42) they propose a different

path from the one of cognitive sciences on which, according to the authors, cognition is 'Information processing as symbolic computation – rule–based manipulation of symbols' and go into a search for a more humanistic notion of knowledge.

This idea of embodied knowledge might be one of the main ideas of design: we may do search for contextual understanding of the problem, we do primary and secondary research on our process of design as a way to understand the current state, but certainly one of the things that makes the process different is that we recognize that there is going to be a someone using what we do, someone experiencing the world though the objects (or images, or environments, or strategies…) we create, and the only way to access this knowledge is through the actual experience of those objects; that lead us to the second concept, the displacement.

The concept of displacement and the technical objects

We build knowledge on the world through experience, we relay in our senses to get a glimpse of the world around us. But it is not necessarily through direct contact. As in the example of the blind man and the stick of Merleau–Ponty, our world is mediated through the objects we create as part of this experience of the world. The concept of displacement comes from the idea of our connection with and through those objects we create.

To better understand the concept of displacement it is important to recognize the bases of it. In 1958 Gilbert Simondon published his essay *On the Mode of Existence of Technical Objects*, where he reflected on the different implications of the objects we create in the world through technical means; he defined those as technical objects, recognizing that they were separated from the objects of nature, so they presented a different relationship with our human existence and perception. These objects for Simondon are extensions of human nature, they allow us to adapt and transform the surrounding world.

In this intrinsic relationship with humanities and technology Simondon (1958, p.18) recognizes the power of a technical object to transform society and therefore create a new environment for an evolved iteration of the object: 'On the other hand, the object has acquired its coherence on the industrial level, where the system of supply and demand is less coherent than the object's own system. Needs are molded by the industrial technical object, which thereby acquires the power to shape a civilization.'

These technical objects, born from the age of industrialization, are basically, the initial concern of modern design; only through this process of serial production design was able to define its reason of existence in the world. The need for a plan, the knowledge of materials and the constant desire to acknowledge the role of humans (users) as part of the production process defined designers as the ones in charge of shaping out these new technical objects into the world.

Design and the technical objects

Design has set one of its main roles as mediator of human relationships with (and through) the real world, and therefore designers learned how to make these objects meaningful for others. Trying to understand how people perceived, communicate or interact to turn that knowledge into tangibles. But these objects are not just that, they don't just connect or mediate, they shape realities, transforming the way we inhabit the world, the way we perceive our reality.

Designers try to understand the nature of these mediating objects, the way to build them and what they represent for different people; build frameworks to understand the journey that users may take on these metaphorical roads and methods to try to remember all the different parts of this process. But when we consider these designed objects as mediators, we must recognize that they force us to see the world in a particular way, like Heidegger's example of the bridge. Designed objects (or technical objects), therefore, not only work in their very functional way of connection and interaction, they reveal the underlying reality, as they are set in place.

Current technology has had another effect: as it develops, the power of these new objects becomes clearer; in fact, we can even start to recognize a digital conscious that emerges from these new devices. This idea of artificial intelligence that has gone around human minds for decades is something you can now feel as real. This characteristic of new technical objects makes more evident the agency they have always carried.

On this respect, Latour (2005) following this conception of technical objects as active part of our relationship with the world, proposes an understanding of these objects as new actors of society, important pieces on a network of knowledge and social construction of reality. The agency of objects becomes clear on his approach to the Actor–Network theory (ANT), where he defines these technical objects as far more than just empty vessels

of mediation for humanity, more than just the means of production or interaction of a society.

These new actors of the social scene have the ability to shape the way we live and communicate, our perception of the world and our notion of a future. Technological advance has facilitated our perception of the importance of these objects in our relationship with the world (Lévy, 1995). Their agency is not just because of the empowerment that digital technology has brought, they have always carried a huge role in our lives, but it is definitely through technological evolution that we are able to perceive their importance.

Latour (2010), also proposes the everlasting changing nature of objects, not defined by their main purpose, but open to a perpetual relation of co–evolution with humanity and cognition. In his conference, he points out '…the question is not how to open objects but why they have been thought to be closed?'

Callon (1991, p. 137), in his approach to the ANT recognizes the power of technical objects on human relationships with the world; he concludes his argument with a reference to Akrich (1989) text, saying: 'to sum up, artefacts are not the enigmatic and remote objects to which they are often reduced. When they come into contact with their users, they are carried on a wave of texts which bear testimony to the scars of their textualizations that accompanied their design and displacement.'

This power of transformation of technical objects, this agency on the human (and non–human) social network, when mixed with the public nature of design, proposes a change on the way we see and study objects as designers. They cannot be understood only by the way they have been used or by their production process. We have to recognize their power to shape and transform society.

Displacement on a socio–technical network

There is a conversation that emerges from the objects we create as actors on a bigger socio–technical network. This conversation is based on the same principle defined by Simondon, Latour and Akrich. Initially, Simondon (1958) recognized a distance between technical objects, constructed to address standardized needs, and the actual needs of users; this distance becomes a constant force pulling objects and user to constantly transform and evolve to fill that gap.

This (physical) conversation between actors is also recognized by Latour (1990) when he addresses the idea of technical objects. Designers (or 'innovators' as Latour points out) face constantly this issue as they recognize the distance between the object and the arising needs or affordances of users. In his example of the 'Hotel Key', Latour (1990, p. 105) presents a case in which the need to resolve this distance is the main reason to come up with new actors (or objects) to fill the gaps and create new connections and 'It does this by recording the ways in which a (syntagmatic) displacement in the associations is 'paid for' by a (paradigmatic) displacement in the substitutions.' Part of this innovation process is the main concern of designers, unveiling the connections that are created in this complex network and recognizing the designed object on its reality.

It is very common for designers to consider users on an isolated process, where they are disconnected from the real network and stripped from their possibility to interact as they would do on real life. Akrich (1992, pp. 208–209) recognizes the need for designers to actually go and see this network in order to understand the real connections of those objects. She points out: 'Instead we have to go back and forth continually between the designer and the user, between the world inscribed in the object and the world described by its displacement.'

Therefore, an approach like the one used by the User Centered Design, that relies on questions and research apart from the real object and its network, might not be appropriate to recognize the real design possibilities of new objects; so, what would be a better approach to do this? How could we use this sense of displacement of the objects to create better–defined objects that hold a sense of consistency with their reality?

We could find a possible approach on the idea presented by Galey and Ruecker (2010) of how a prototype argues. Usually designers don't encounter their users until the final state of the process; they rely on the research they have done and the tests they can run. But these tests are usually used a simple way to validate the design process rather than a moment to re–understand those objects. But what if prototyping could propose a different way to approach the real network that is created between the actors of this relationship?

If we understand that in every technical object (even the prototyped ones) there is a displacement on the way they connect to other actors, there is a chance for us to gain a better understanding of the system on every iteration of the design process that finishes with the construction of a prototype.

In this idea, displacement becomes a fundamental part of the way designers build knowledge of the world. It allows us to see that the search of designers is not for 'the solution' of a problem, but for a better understanding of the possible ways on which these 'solutions' are going to be connected to the world. As Akrich (1992, p. 208) states 'A large part of the work of innovators is that of 'inscribing' this vision of (or prediction about) the world in the technical content of the new object.'

Dealing with complexity

The final concept is complexity. Design discipline has recognized that tangible solutions are always part of a complex network of actors, therefore, dealing with complexity becomes part of design job (Flood and Carson, 2013). Every design process should understand the world around the problem in order to foresee the possible future of the 'designed objects'.

Complexity is part of understanding the network of humans and non–humans as an ecosystem in continuous movement and evolution. Since humans and objects, as we have seen, keep moving inside this network in their need to fill the gap created by the displacement on their relationships, new systemic interactions arise and the need for designers to try to map and understand these relationships.

Designers are called to choose complexity, or wicked problems (Rittel and Webber, 1973), to understand the possible scenarios of the future thing, and this is an iterative process of re–understanding of the system on which we are working. This idea was explained by Alexander (1964, p. 116) when he talks about the process of decomposition of the problem into more understandable pieces, so we can later generate a synthesis based on the analysis of those fragments: 'The designer as a form–maker is looking for integrity (in the sense of singleness); he wishes to form a unit, to synthesize, to bring elements together. A design program's origin, on the other hand, is analytical, and its effect is to fragment the problem.'

Banathy (1996, p. 73) proposes a similar process but with de addition of a second level of iteration. For him, this first iteration of divergence and convergence is intended to reveal different parts of the process and the idea for the future scenario. He states: 'We first diverge as we consider a number of inquiry boundaries, a number of major design options, and sets of core values and core ideas. Then we converge, as we make choices and create an image of the future system.'

This process of design, one that assumes the possibility of a more complex analysis of the problem, is basic for designers, while other models search for the certainty on the decisions, design is always looking for ways to embrace the natural uncertainty of human processes.

Discussion: A model of design applied to design research

These three concepts may exemplify a big part of the design process and the actions that are involved on it. Designers are in part responsible of the constructed world, not only of the shape of these objects, but also of the understanding of the ways on which these objects could connect as part of a complex socio–technical network.

Going back to a reframe model (Alexander, 1964), the process starts with a 'design problem' and diverges from it with the intention of recognizing the possible connections outside. That divergence is an analytical process that leads to a synthesis that converges into the most accurate solution. This basic principle of design as a constant process of recognition of the complexity implicit on every human relationship is what, historically, has won a place for design methods on many different disciplines and a logical step to apply as a model to produce new knowledge on design research.

The limitation with Alexander's model is that it searches for the most accurate solution, and assumes that synthesizing the characteristics of the problem could define an optimal solution that fulfills the needs of all the users. This model not only eliminates the possible uncertainty of the non–existent–yet and the possible relationships to be defined with its future users, but also reduces the process of analysis to a formal search for possible solutions and the synthesis as the selection of the best fit.
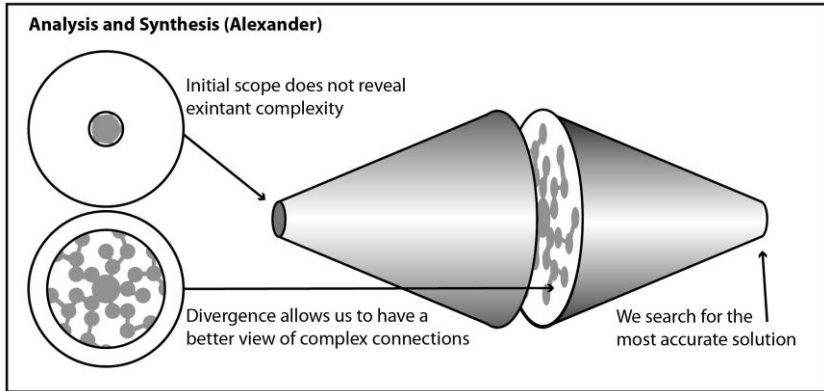
Figure 1   *A representation of the model of Alexander, where new connections are discovered on the process of analysis.*
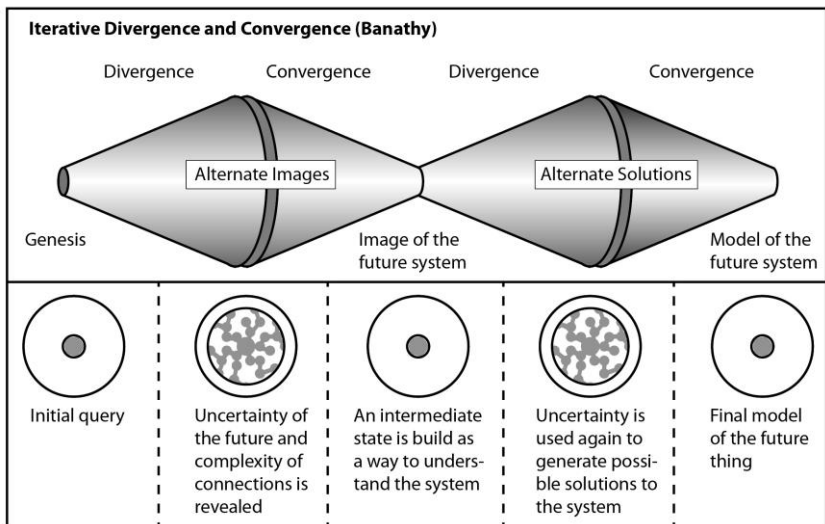

Figure 2   *A representation of the model of Banathy: the iterative process helps on a better understanding of the complexity of the system and foresees the scenario for the future thing.*

The model proposed by Banathy brings some interesting additions; first, using an analogy to optics presents the concepts of divergence and convergence to explain the process, making a reference to the things we see. Opening our scope of the problem allow us to see the complex

connections of our initial request or desire reality, possible users and the socio–economic network where it is going to be set, produced, distributed and disposed. The second addition is the concept of iteration, for Banathy, the process of design always requires iteration; a first one to recognize the problem (and the system in which it is contained) and a second one to create a model of the future thing (fig. 2). That is a third addition to the model, Banathy clearly sees that design is about conceiving the non–existent–yet and bring it to the world.

DIVERGENCE & CONVERGENCE MODEL FOR DESIGN RESEARCH
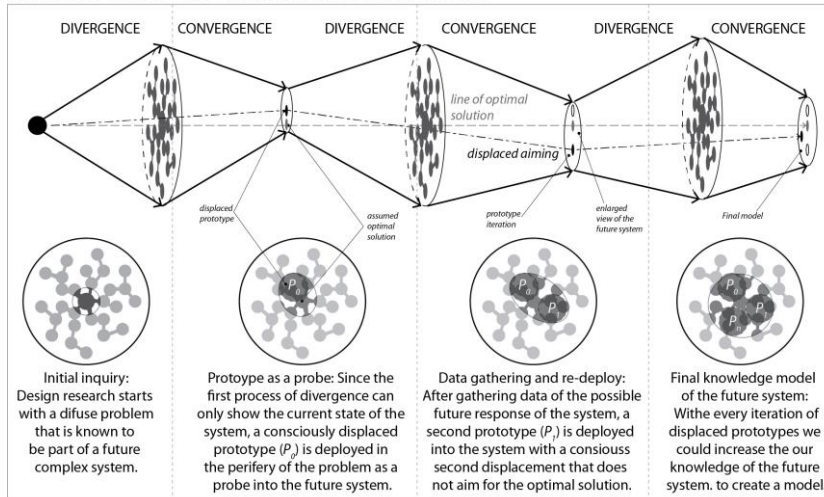
Figure 3   On every iteration a new prototype is built with and approach that does not target the expected solution but a displaced one that could bring a better understanding of the problem and a foreseen a possible future state of the system.

The problem still, as mention before, of some design methodologies is that they search for the ideal solution, when in reality, regardless of the extend of surveys and analysis you performed of the future users of your product, or the theories of communication or ergonomics that you use it doesn't provide tools to foresee the actual affordances of your result. This displacement, the distance that every new actor in the socio–technical network has with the designed objects, with the desires of the client, with the intentions of the designer, and with the needs of the user, as we established before, is vital to the evolution of the object and to the construction of conversations.

But the displacement is not something only existent on the final product of design process, on each iteration that converge into a model, a sketch, a representation, a prototype, there is a displaced result to that 'ideal' final product.

For research purposes, we could understand every prototype as more than a previous stage on a process of depuration of the final result, instead, as an object of conversation that unveils the possible connections to be created on a real physical relationship with the users and with other objects. Here is the final concept, when the design researcher understands that on every possible scenario where a prototype is set into the world and it is possible for user to interact with it, displacement is going to unveil new embodied knowledge, then it can become an object for research.

The prototype then, stops trying to aim to the ideal solution, and consciously aims to the periphery of the problem on an attempt, not to solve the problem, but to recognize the emergence of new knowledge on the physical interactions of users with it. On a model like this, each instance seeks to increase our understanding of the possible future shifts that this object could generate and in the same process a new understanding of the problem itself.

Prototyping then becomes not a matter of fidelity or resolution, but an inquiry on the modes of existence of the objects on the world and on the way that design can create new knowledge of these socio–technical relationships. This model of design research allows designers to use their own model and methods (especially the idea of prototyping) as a way to find new knowledge, one that other disciplines and models do not take in account, one situated on the real world.

References

Akrich, M. (1989) De la position relative des localités. Systèmes électriques et réseaux socio–politiques. *Cahiers du Centre d'Etudes pour l'Emploi*, 32, 117–166.

Akrich, M. (1992) The De–scription of Technical Objects. In Bijker, W. E. and Law, J. (eds.), *Shaping Technology/Building Society: Studies in Sociotechnical Change*. Cambridge: MIT press.

Alexander, C. (1964) *Notes on the Synthesis of Form*. Cambridge: Harvard University Press.

Banathy, B. A. (1996) Information-based Design of Social Systems. *Behavioral Science*, 41 (2), 104–123.

Belderbos, M. and Verbeke, J. (eds.) (2005) *The Unthinkable Doctorate*. Brussels: Hoger Instituut voor wetenschap en kunst–Sint Lucas.

Berthoz, A. and Petit, J. L. (2008) *The Physiology and Phenomenology of Action*. Oxford: Oxford University Press.

Callon, M. (1991) Techno–economic Networks and Irreversibility. In Law, J. (ed.), *A Sociology of Monsters: Essays on Power, Technology and Domination*. London: Routledge.

Flood, R. L. and Carson, E. (2013) *Dealing with Complexity: An Introduction to the Theory and Application of Systems Science*. New York: Springer Science & Business Media.

Galey, A. and Ruecker, S. (2010) How a Prototype Argues. *Literary and Linguistic Computing*, 25 (4), 405–424.

Gallagher, S. (2005) *How the Body Shapes the Mind*. Oxford: Clarendon Press.

Gallagher, S. (2010) Merleau–Ponty's Phenomenology of Perception. *Topoi*, 29 (2), 183–185.

Heidegger, M. (1971) Building Dwelling Thinking. In *Poetry, Language, Thought*, trans. A. Hofstadter, New York: Harper and Row.

Latour, B. (1990) Technology is Society Made Durable. *The Sociological Review*, 38 (S1), 103–131.

Latour, B. (2005) *Reassembling the Social: An Introduction to Actor–Network–Theory*. Oxford: Oxford University Press.

Latour, B. (2010) *Offene Objekte*. IKKM Jahrestagung 2010 [Online video]. April 29th. Available from: https://vimeo.com/15451465.

Lévy, P. (1995) *Qu'est–ce que le virtuel?*. Paris: Éditions La Découverte.

Maturana, H. R. and Varela, F. J. (1987) *The Tree of Knowledge: The Biological Roots of Human Understanding*. Boston/London: New Science Library/Shambhala Publications.

Merleau–Ponty, M. (1969) *Phénoménologie de la perception*. Paris: Gallimard.

Nilsson, F. and Dunin–Woyseth, H. (2012) Doctorateness in Design Disciplines. Negotiating Connoisseurship and Criticism in Practice–related Fields. *FORMakademisk–Research Journal for Design and Design Education*, 5 (2), 1–11.

Nilsson, F. and Dunin–Woyseth, H. (2014) Design Education, Practice, and Research: On Building a Field of Inquiry. *Studies in Material Thinking*, 11, 1–17.

Noë, A. (2004) *Action in Perception*. Cambridge: MIT press.

Polanyi, M. (1967) *The Tacit Dimension*. Garden City: Anchor Books.

Polanyi, M. (2015) *Personal Knowledge: Towards a Post–critical Philosophy*. Chicago: University of Chicago Press.

Rittel, H. W. and Webber, M. M. (1973) Planning Problems are Wicked Problems. *Polity*, 4 (2), 155–169.

Shusterman, R. (2008) *Body Consciousness: A Philosophy of Mindfulness and Somaesthetics*. Cambridge: Cambridge University Press.

Simon, H. A. (1996) *The Sciences of the Artificial*. Cambridge: MIT press.

Simondon, G. (1958) *Du mode d'existence des objets techniques: thèse complémentaire pour le doctorat ès lettres présentée à la Faculté des Lettres de l'Université de Paris*. Paris: Aubier.

Varela, F. J., Thompson, E. and Rosch, E. (1992) *The Embodied Mind: Cognitive Science And Human Experience.* Cambridge: MIT press.

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