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PII: S1071-5819(15)00125-1
DOI: http://dx.doi.org/10.1016/j.ijhcs.2015.08.001
Reference: YIJHC1977

To appear in: *Int. J. Human-Computer Studies*

Received date: 23 January 2015
Revised date: 3 July 2015
Accepted date: 13 August 2015

Cite this article as: Mark T. Marshall, Daniela Petrelli, Nick Dulake, Elena Not, Michele Marchesoni, Elisa Trenti, Anna Pisetti, Audio-based Narratives for the Trenches of World War I: Intertwining Stories, Places and Interaction for an Evocative Experience, *Int. J. Human-Computer Studies,* http://dx.doi.org/10.1016/j.ijhcs.2015.08.001

Audio-based Narratives for the Trenches of World War I: Intertwining Stories, Places and Interaction for an Evocative Experience

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ABSTRACT
We report in detail the co-design, setup and evaluation of a technological intervention for a complex outdoor heritage site: a World War I fortified camp and trenches located in the natural setting of the Italian Alps. Sound was used as the only means of content delivery as it was considered particularly effective in engaging visitors at an emotional level and had the potential to enhance the physical experience of being at an historical place. The implemented prototype is visitor-aware personalised multi-point auditory narrative system that automatically plays sounds and stories depending on a combination of features such as physical location, visitor proximity and visitor preferences. The curators created for the trail multiple narratives to capture the different voices of the War. The stories are all personal accounts (as opposed to objective and detached reporting of the facts); they were designed to trigger empathy and understanding while leaving the visitors free to interpret the content and the place on the bases of their own understanding and sensitivity. The result is an evocative embodied experience that does not describe the place in a traditional sense, but leaves its interpretation open. It takes visitors beyond the traditional view of heritage as a source of information toward a sensorial experience of feeling the past. A prototype was set up and tested with a group of volunteers showing that a design that carefully combines content design, sound design, tangible and embodied interaction can bring archaeological remains, with very little to see, back to life.

Author Keywords
Cultural heritage; archaeological site; embodied and tangible interaction; sound and narrative design; co-design; experience-centre design; evocative experience.

1 INTRODUCTION

"The museum's preoccupation with the information and the way it is juxtaposed to objects [...] immediately takes the museum visitor one step beyond the material, physical thing they see displayed before them, away from the emotional and other possibilities that may lie in their sensory interaction with it. […] Yet museums' preference for the information over the material, and for learning over personal experience more broadly and fundamentally conceived, may risk the production of displays which inhibit and even preclude such affective responses." (Dudley 2010)

This quote captures the view of a number of scholars in museum studies (e.g. Davidson et al. 1991, Packer & Bond 2010, Taylor 2010, Wehner & Sean 2010, vom Lehn et al. 2007) that see value in revisiting the information-centric approach of cultural heritage in favour of one that enables visitors to be in direct contact with objects and places. Instead of offering to visitors a definitive pre-packed curator-led interpretation, this new approach fosters the offering of multiple, possibly conflicting, voices and leaves the act of interpretation to the visitors acknowledging that their different personal background, expectations and needs change the way they engage with heritage holdings (Falk 2009). Indeed the museums studies literature points out the *restorative value* of an aesthetic experience that is clear of any information acquisition or learning

objective and is centred instead on the sensorial experience of being there (Kaplan et al. 1993, Packer & Bond 2010). The premise that information is not the only or most important factor impacts on the way in which designers should think about digital interaction with heritage.

In close collaboration with the Museo Storico Italiano della Guerra (Historical National Museum of War in Italy), we co-designed an evocative visitor experience, as opposed to providing technology simply delivering information in situ. We designed a bespoke system to deliver narratives within the remains of a World War I camp dug in the Alps in what today is Italy and in 1914 was part of the Austro-Hungarian Empire. The striking contrast between the natural beauty of today and the difficult life in the First World War was the setting for the challenge we faced: to bring stone paths, caverns and pits (Fig. 1) alive with the stories of the people who lived there, and to provoke empathy and understanding in visitors. By providing multiple and contrasting voices curators enable visitors to elaborate their own interpretation of war. This is the role the Museo della Guerra see for themselves today: while it was founded in the 20s to celebrate Italy's role in World War I and was later reshaped to recount the history of events, now the museum's collection offers visitors multiple points of view and different topics that convey the sense of what war meant for the whole of society. By telling the story of the prisoner camps, showing the trophies of aviators or propaganda posters, discussing how the production of armies and uniforms changed industry, or displaying the devastating effect of war on people through drawings and poems of artists, the museum enables visitors to understand and feel for themselves what war was. It drives visitors to engage with the topic at a deeper, personal level. This same approach, used to display the permanent collection within the museum walls, was adopted in designing for the outdoor setting of the trenches. We wanted to make visitors walking in the camp and trenches *feel the past* and aimed at an evocative experience that fuses the physical, sensorial and social dimensions of being there with the history of the place itself. For its evocative power we chose sound as medium of delivery.

The ability to convey and evoke emotion is a fundamental aspect of sound. This aspect is regularly used in the domains of film (whether using sound effects or music) (Fahlenbrach 2008), video games (Grimshaw et al. 2008) and musical performance (Juslin 2001). Within interaction design there has also been some research into the communication of emotion using sound, for example using auditory icons to communicate emotional aspects of weather (Hermann et al. 2003) and the expression of emotion by robots (Jee et al. 2009). Researchers in the area of affective computing have also examined the use of embodied sound, such as conversational agents and emotional speech to communicate affect (Hyniewska et al. 2010). What many of these works have in common is the aim to communicate emotion, often from a source where emotion is not obviously present: from data, robots, video games, and software agents. Our aim here is to communicate emotion and create an emotional experience from a similarly unemotional entity, the remains of an archaeological site.

The auditory communicative channel offers a powerful means of both telling a story and creating a suggestive experience. As noted by Sonnenschein, "Storytelling has used sound to invoke myth, suspend reality, and create emotion since the times of fire circles in protective caves" (Sonnenschein 2001). The affective power of voice and audio storytelling has been recognized as creating a connection to the listener and is even amplified when spoken words are not coupled with the visual capture of the storyteller, creating a sense of intimacy and affective engagement (McHugh, 2014). Combining sound with location-based technologies allows us to further enhance this storytelling experience by presenting the narratives in place, creating a powerful connection between the visitor, the narrative and the place itself. This also allows us to more tangibly connect the narrative to the place, by directly referencing aspects of the environment that are only perceptible when physically there.

To do this we look at the possibility of using un-embodied sound (Winters & Wanderley, 2013). Such sounds, which include music, speech and non-speech sounds, have the power to augment the space. In our design we are concentrating on the use of sound to create a rich, evocative experience that happens in place and we make an extended use of human voices as a means to convey content (i.e. information), trigger empathy and stimulate interpretation. In combination with the act of listening in place, this has the potential to provoke an emotional response: "the affective power of sound and voice, combined with the intimacy of the listening process, means we can be moved by listening to oral history; this is turn, affects how we absorb and retain its content, as well as how we judge that content." (McHugh 2012) While in our case the recordings played are not, strictly speaking, items of oral history (i.e. they are not spoken by the person who lived the events) much effort was put into rendering the written sources as personal accounts read by professional actors; in a sense we have reconstructed samples of oral history. This was considered very important by the curators, who cared about the quality of the overall experience, but also had motivations within literature: "when an informant narrates an experience in an affecting way (i.e., with palpable emotion), listeners will register the emotion through the prism of their own lived experiences; we can infer that this personalisation will confer added impact" (McHugh 2012). The affective power of stories narrated in the first person also leaves room for personal interpretation as rather than provide dry facts about the place itself these stories talk about how the

space was lived in the past. The visitor is then free to draw conclusions and extrapolate information for themselves from the combination of the physical space and the audio content.

In the first part of this paper we examine related work on digitally enhanced visitor experiences, with a particular focus on sound-based interfaces, and discuss the challenges and opportunities in designing for outdoor heritage. We then focus on the design, set-up, and evaluation of the outdoor technological intervention deployed in a complex archaeological site within a natural environment, where a visitor-aware personalised multi-point auditory narrative automatically plays sounds and stories depending on a combination of features such as visitor location, proximity, past interaction and preferences. The evaluation carried out in the trenches shed some light on the interaction and the evocative content, as well as the importance of giving the physical place a prominent role in the creation of the overall experience.

2 PREVIOUS WORK ON USING SOUND TO DIGITALLY-ENHANCE VISITOR EXPERIENCE

Much research has taken place in HCI and heritage technologies and a complete survey is out of the scope of this paper. We are selective in our review and limit our discussion to work that shares some elements with ours, namely: the use of audio as the main medium; a design that is inclusive of group dynamics; a dimension of physical and tangible interaction; and implementing personalisation.

Audio is the medium used in LISTEN, a personalised 3D soundscape (Zimmermann & Lorenz 2008). Visitors, equipped with headphones augmented by antennas to track how they move and what they look at, walk in a space virtually divided into active zones. Each zone has a different value used to classify the visitor's behaviour, e.g. a visitor has to be close to an artwork to be classified as focussing on that piece. The system dynamically composes a soundscape of music and/or commentaries depending on the detected visitor's behaviour: visitors that are not close or are moving are classified as unfocussed and for them a soundscape is created, while visitors that are standing still and close to the artwork are classified as focussed and a narrative (e.g. the curator describing the artwork) is played over the headphones. The system, which was tested in one room of an art gallery, was appreciated by visitors, but learning how their body movements controlled the sonification was problematic, particularly with regard to how to control the change from soundscape to storytelling.

HyperAudio personalises narratives and uses audio as key medium of delivery (Petrelli & Not 2005). Visitors are equipped with a mobile device and wear headphones; the system tracks their position within a museum and dynamically composes the narratives depending on where the visitor is, what has been seen before, and some initial features such as the type of visitors (e.g. a school class vs. free visit), how much time they had available, and if this was the first visit or a return. The length and type of content delivered is calculated on the basis of a user model based on these features; the system also automatically provides additional content to visitors staying in place after the first content has finished playing under the assumption that the visitor is interested in the exhibit. The same content is played if the visitor explicitly selects it on the screen of the mobile device.

The output in ec(h)o (Wakkary & Hatala 2007) is auditory too, but the interaction differs as it is controlled by an interactive cube the visitors receive at the entrance to the space and hold in their hand during the visit. Visitors freely navigate the space and approach an exhibit where they explore the content available for it by turning the interactive cube. By making use of a 3D sound model, three options are played at each stop via 'prefaces' that represent the essence of the content that would be played if that option was selected; the direction of the sound (left, right or centre) hints at which side the cube must be turned to select it. The evaluation showed appreciation for the playfulness of the cube although the interaction seemed to distract from the intended objective of learning. Visitors liked the tangibility of the interface while the headphones were deemed uncomfortable.

As in LISTEN, HyperAudio and ec(h)o, we too designed a space that reacts to visitors' movements. Our reactive space is similar to LISTEN but simpler; we too use proximity (close and far) as a trigger but ignore the "staying still" component. Similarly to LISTEN, we use ambient sound to support an unfocussed activity (approaching the narrative point) and voices for times of attentive listening. As in ec(h)o we offer visitors the possibility of choosing what to listen to, but we offer a simpler method of doing so, through selecting a card. This makes our work different from Hyperaudio where it is the system, not the visitor, that chooses what to play next. The result of our simplified design is a straightforward interaction; indeed no usability issues emerged in our study. A further point of distinction is that in our design we adopt ambient sound as opposed to individual listening via headphones.

In SottoVoce (Szymanski et al. 2007) eavesdropping on what others in your party are listening to in addition to your own audio-guide mitigates the social separation induced by headphones. Visitors are equipped with mobile devices; an experiment

was carried out comparing a setting were the loudspeaker of the device was used to deliver the sound to the visiting pair, to another in which each visitor had headphones and each individual could listen to their own commentary or dynamically switch to and share the commentary being heard by their partner. The mode of sound delivery, group loudspeaker vs. partners eavesdropping, affected the visit behaviour. When in loudspeaker mode visitors focussed on what was displayed on the screen of the mobile device and stayed close to the sound source while partners linked via the same audio on their headphones had a more dynamic visit driven by each other's interest in the exhibits. In our design we use loudspeakers but rather than being carried by the visitors, they are in place and signal a point of interest. We see the constraint to stay close to the loudspeaker to listen as positive as it invites visitors to pause and concentrate on the message being delivered.

Clear instructions on what to do were the mild provocation in (Fosh et al. 2013) that invited visitors to physically engage with the pieces in a sculpture garden. The experience was designed to be personal: instructions to put on and take off the headphones clearly marked this as individual time for those visitors that came in pairs. When wearing headphones the visitors were instructed to do something around the sculpture, sometimes observing it in a special way, sometimes acting out; they were expected to follow the instructions and engage with the sculpture as instructed while a piece of music was played. The interaction was concluded by a commentary that explained the sculpture. Findings suggested the physical actions and the music were instrumental to allowing visitors to engage intellectually and emotionally. Being provided with an explanation of what they were seeing only after they experienced the sculpture was also found to be a good design decision. This marks the difference with our work, as we use voices not to explain or instruct, but for storytelling and to trigger empathy while leaving the visitors free to make sense of the experience in their own way.

In Reminisce (Ciolfi & McLoughlin 2012) mobile technology was used to exploit the sense of place for visitors to a living history museum - a park where rural life is represented by means of historical everyday buildings and enactments. Audio snippets of fictional characters' memories were used as a trail of discovery around the park by means of material tokens, e.g. a small piece of turf picked up in a house would direct visitors to another building and another snippet of memory. Visitors were invited to leave their own memories for others to listen to. Memory as key for personal interpretation is shared by our design too, but we take the concept a step further offering multiple, contrasting voices for the same place. In this way we wish to enable visitors to appropriate the visit following their own sensibilities and interests.

In contrast to previous examples where exhibits are at the centre of the visit, archaeological sites may be particularly challenging as very little is left to see and experience. Contextualised sound, such as animal calls from the place where the cattle market was, have been used to complement information on a mobile device (Ardito et al. 2012): the evaluation with school pupils at an archaeological site demonstrated that sound, played through the device loudspeaker, supported a quicker and better understanding of the site and improved learning. We too have a bare outdoor setting, and face the challenge of bringing it to life using sound. However, instead of creating a soundscape that complements content on a screen we use voices to tell stories in place making use of the emotion that a personal affecting account can generate in the listener (McHugh 2012).

A further experiment with sound outdoor was conducted in a zoo (Ogden et al. 1993). A set of 27 sensors and 111 loudspeakers were placed around the zoo and close to the animals' cages; two types of sound were created and dynamically controlled: the background sound of the natural environment of the animals such as the sound of the rainforest (low-level birds and insect vocalisations) while the foreground sound was the specific animal vocalisation. The foreground sounds were overlaid on the background sound in a random way controlled by sensors that detected the presence of visitors; the volume was increased in the presence of a crowd. A comparative evaluation with sound and without sound was conducted with 150 participants finding that sound increased the awareness and learning of the natural environment, but this effect was somewhat diminished in crowded areas. As in this experiment we too create a multisensory environment for the visitors to experience although our approach is simpler and more direct the expectation is a similar effect of increased appreciation occurs.

3 CHALLENGES AND OPPORTUNITIES OF OUTDOOR HERITAGE

The meSch project[1], of which the research reported here is part, aims at creating new experiences for cultural heritage visitors by bridging the gap between the material collection and the digital content via tangible and embodied interaction (Petrelli et al. 2013). While part of the research done in meSch is for traditional museums and indoor sites (such as historical buildings) (Petrelli et al. 2014), here we focus on the design of an outdoor experience. The outdoors poses a set of specific challenges and offers a number of unique opportunities. To start with, the visit is a full-body experience, much more so than within a

[1] Material Encounters with Digital Cultural Heritage: http://mesch-project.eu

museum: spaces to cover are larger than when moving from exhibit to exhibit and from room to room; visitors need to walk, there may be a sense of anticipation and when the destination is reached, there is a feeling of immersion, of *being there*. While engagement in a museum tends to be via prolonged observation, in an outdoor setting multiple senses are stimulated: there is the physical, full-body experience of being there, the sight and the sound of the surroundings, possibly the smell too. The multisensory setting palces the visitor in direct connection with the heritage and enables engagement at an emotional, affective level rather than at a pure informative level (Dudley 2010, Davidson et al. 1991). This is not to say that for the outdoors one should avoid the delivery of information, but instead that forms of content delivery that, by design, aim at inducing an emotional response can be more effective outdoors than indoors because of this multisensory context. Indeed the natural surroundings, the beauty, and the peace some heritage offers have a restorative function when visitors are in need of recharging (Packer 2010, Kaplan et al. 1993).

From a technical point of view the outdoors can be really challenging: power supply may be limited or non-existent, Wi-Fi is very unlikely to be available and even mobile phone signal may be limited if the heritage is located in a remote place. This brings also the issue of installation, maintenance and sustainable deploy of system components in an open-air, unsupervised natural environment where particular technological requirements need to be satisfied, e.g. water, heat and wind proofing; low cost, easy recharging and replacement. As a result the preferred device for such environments has so far been mobile technology, most recently apps for smart phones. While the use of a mobile device can solve the technical issues, it can also become a pitfall. Empirical work on the use of mobile devices in museums has clearly shown that attention is diverted from the heritage onto the device, even to the point in some cases of ignoring the original (vom Lehn & Heath 2003); or choosing what to look at on the basis of what is on the screen (Szymanski et al. 2007) rather than what is of interest; or to spend time with the device in order to understand how it works (Heath et al. 2005). The design has therefore to strive to keep the attention on the heritage and complement the experience of the visit with technology; the device should work as an enabler or an amplifier of the experience of being there, not to compete with or substitute it.

It has been acknowledged that different visitors have different motivations for visiting (Falk 2009) and personalisation has been proposed as the solution to the issue of accommodating different needs. By means of personalisation, digital technology can match a visitor's profile to specific content (Ardissono et al. 2012) thus providing different experiences to different people. Systems developed so far are not directly controllable by users: the system takes the decision on what the visitor should be offered and dynamically alters its response by continuous monitoring of visitors' behaviour and, if needed, readjusting the content delivered (Ardissono et al. 2012). All of this is opaque and visitor never become aware that alternative content is available: they are never in the position to explicitly choose their own visiting experience. Other means of accommodating different needs are worth exploring.

A further point to keep in mind is that the vast majority of visitors come in groups; although they may split and re-join, they pay attention to each other (Tolmie et al 2014) and they enjoy the visit more if they can share it (Lanir et al. 2008). As mobile technology is often for a single user, attention needs to be paid to avoid the technology becoming an impediment to the social dynamic. Indeed, interactions that involve multiple visitors, possibly belonging to different groups, can be designed to surprise, engage and amuse (Heath et al. 2005, vom Lehn et al. 2007). Positive examples of the use of mobile technology outdoor do exist, e.g. the work of Ciolfi end McLoughlin (2012); in these cases the social aspect is designed within the interaction itself.

Reflecting on the existing research, a set of principles could be defined to drive the design of our system:

- *To engage at multiple levels, not just cognitive*: the design should take into account that the visitors have a multisensory experience, and that the content is delivered in specific places and in the context of a natural environment. The design should then attempt to amplify the experience by engaging all the senses;
- *To focus the visitors' attention on the heritage, not the technology*: whatever technological solution is implemented, it should be at the service of experiencing the heritage while there, in a form that cannot be repeated online. The direct reference to the physical space the visitors are in and the surrounding scene are essential to the design of the experience;
- *To deal with group dynamics sensibly*: the fact that visitors are often in a group should be at the centre of the design, as walking the site together is a fundamental aspect of exploring an outdoor space;
- *To be provocative and surprise visitors, but design simple and straightforward interactions*: visiting heritage is considered a leisure activity; in the outdoors there is also the pleasurable diversion of the excursion. Some unexpected elements can be included to make the experience more memorable;

- *To personalize content on the basis of clear conditions*: personalisation allows accommodating different needs in different ways, but visitors should be able to explicitly influence and change the experience they have. Design should then combine visitors' choices with autonomous decisions of the system, where system decisions are possibly focussed on the movement of the visitors in the outdoor setting.

We have used these principles in the design and implementation of the "Voices from the trenches" experience. We used them to drive the design of the interaction and of the content, to carefully combine content, places and interaction is such a way that each component contributes to the whole evocative experience. Our work on the design is discussed below.

4 VOICES FROM THE TRENCHES, A DESIGN CASE

In this section we describe "Voices from the Trenches", a bespoke system designed to provide an interactive, evocative audio experience for visitors to the archaeological remains of a set of trenches and the associated camp built during World War I in the mountains of Trento, northern Italy. Three elements were key in our design: the physical, full-body interaction that triggered the system; the design of an evocative sound experience based on historical content; and aspects of personalisation as to make the experience of the trenches unique to every visitor. We first discuss the design concept of 'narrative in place' and how personalisation complements it to create individual experiences. We then provide details on the creation of the specific system used in the trenches and the choices made in terms of the physical manifestation of the system, the content used and its presentation.

4.1 Personalisation of Narratives in Place

The starting point for the design was the observation that to move attention back to the heritage the story must come directly from the place; we deliberately avoided screens so as to free the visual channel and selected sound as an evocative and group-friendly media. During a small experiment in a local outdoor heritage site, we observed that audio creates a wider *attraction zone* where passers-by become aware of the sound source, and a closer *engagement zone* around the emitting point where one has to stop and listen in order to understand what the voice says. The radius from the emitting point captures different degrees of interaction, and different sounds are more suitable when the visitor is at different positions, e.g. voices are unintelligible when far away.

The scenario we envisaged was that of a small group of visitors walking the grounds of a heritage site and hearing a sound that catches their attention; the group then moves toward the sound source, approaching the narrative point and listens to the story which is told in place. The distinction between the attraction sound (e.g. music or sound effect) and the narrative (voices) captured the different function the audio medium had at different points in the interaction: the music to attract, to invite movement towards the source and create a sense of anticipation, the narrative to hold in place, to create intimacy and emotional connection.

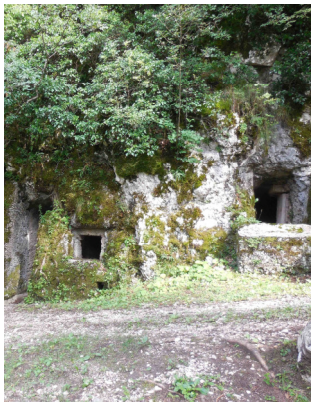
Literature in the area of museum studies acknowledges that different visitors have different interests and different needs (Falk 2009); at the same time curators acknowledge that the same heritage can be read in different ways and therefore that alternative interpretations can be offered to visitors. We capture this multiplicity of interpretations and visitors' interests through an open design that enables every interaction to evolve into different paths. For every point of interest selected in the heritage, a set of alternative narratives tells, simultaneously, different stories; each narrative has a distinct theme (e.g. the official history vs. personal accounts) and a matching tone of voice (e.g. the commanding voice for the official vs. the intimate and reflective voice for the personal theme). Themes can be strongly contrasting: in an early experiment in an historical cemetery (Ciolfi et al. 2013) we implemented themes as contrasting as the sombre stories of the deceased and a trail of anecdotes and curiosities about the cemetery and the people within. By offering a variety of interpretations we enable visitors to select the content that more closely matches their mood and feelings: some people may be at ease with sombre stories while others would prefer a lighter entertainment; our open design accommodated both attitudes.

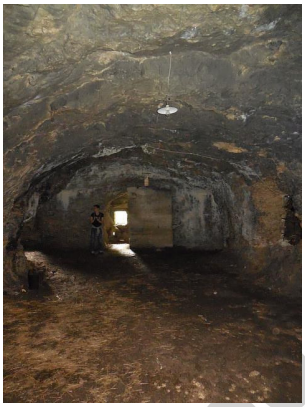
The personalised experience of narrative in place is completed by the automatic response of the system to visitors' behaviour. A rule-based system tracks the visitors' path and plays the right sound for the current position taking into account the path followed so far, the content already heard and the visitors' current choice. So, visitors approaching a point of interest will first hear the attraction sound for the theme they have currently selected. When closer to the point, the narrative specific to that point of interest and the selected theme is then played. The visitors can then listen to the content for another theme by simply selecting it or can decide to continue onwards in their visit to the next point of interest. The visitors can change theme at any point in time, thus we support those who want to listen to multiple stories at each point as well as those that prefer to follow a single theme consistently from beginning to end.

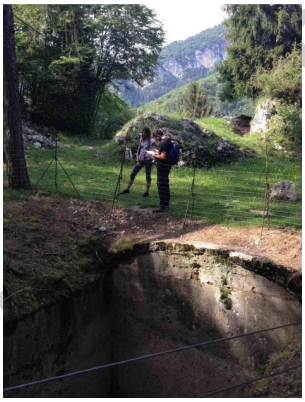
When selecting the sound file to be played next, the rule-based system considers: where the visitors are (at which point of interest and at what distance from it); what theme is currently selected; whether the visitors had just arrived or was at the same point of interest in the previous interaction. A further rule controls the narrative selection so as not to play the same content twice. The rule-based system allows us to add more sophisticated conditions, although these were not used in the evaluation experiments reported here; complex rules include playing certain content only if some other content has been played (or not played) before, a condition needed to create a linear narrative that develops across multiple points of interest. For this particular deployment we allowed visitors to independently decide the path of their visit, but restricted them to listening to each piece of content just once, thus for example playing the same poem twice was impossible.

4.2 Content Selection and Composition

Choosing the points where the story would be told, the themes to develop across those points and the specific narrative for each point and each theme was a substantial part of the system design. Some experiments with an early prototype of the narrative in place concept had been carried out in a local heritage site (Ciolfi et al. 2013); the experience gained has been used to design the aspects related to the content and content delivery, specifically: to select points of interest located far enough apart to avoid interferences; to position the audio source above the ground (ideally above the visitors' head) for better listening; to select a variety of themes; to keep the content short (about a minute for each narrative) and to select distinct attraction sounds for each theme as reminder and cue of the theme itself.

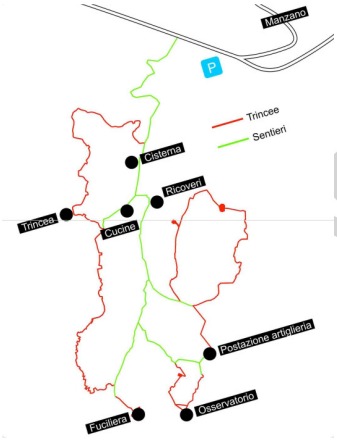

refuge outside (rifugi esterno)


refuge inside (rifugi interno)


water cistern (cisterna)


shooting point (fuciliera)


kitchen (cucine)




artillery (postaz. artiglieria)


trench (trincea)


observation point (osservatorio)

Figure 1: The narrative points and the site map. Photos taken during the trial (images of participants used with permission).

Two curators at the Museo Storico Italiano della Guerra were involved in this stage of the design process. From a number of possible locations they selected the camp and trenches that are generally used for educational purposes: school groups are guided through an area of about 3.5 hectares (8.5 acres) stopping at specific points. This is a place familiar to the curators and relatively easy to access for the public; the visit takes between 1 and 1.5 hours overall. The design of the content was very

much holistic and iterative: the curators took into account physical aspects such as the specificity of the visit for non-guided tours (self-directed trail, small groups) and the logistics (easily recognisable stations with comfortable stopping points), but also aspects of content such as which stories could be told at each spot and which themes would work across the whole site.

The sound of an evocative immersive experience of wartime is commonly associated with a soundscape of explosions and gunfire. The curators excluded this option from the very beginning: while these sounds would match the history of the location, the emotional response engendered would be strongly negative in the audience, as previously observed at a sound-and-light artistic intervention were the sound of bombing created physical discomfort for many people present and required warning signs to be put in place stating that the experience was not suitable for the very young or the elderly. Despite fighting having taken place in precisely the area selected, curators felt that reviving it via the sound of battle would seem extremely out of place today when one is standing amongst the beautiful, quiet mountains. In their design of the content, curators were looking for an inclusive and emotive trigger to empathise with who lived during wartime and the feeling of being under attack could taint the overall experience of the visit. Rather than producing an impression of how it would have felt to be in this place during the war, curators felt that the result would almost seem a caricature of what the soldiers had felt and heard and lacking in the desired feeling of respect. An interaction based on soundscape would also provide a very limited set of information; narrative, instead, could work simultaneously at the informative and affective level.

Similarly, a descriptive, dry-facts tourist-guide style was discarded too as the purpose was to create an emotive and evocative experience. Other non-historical themes such a botanical trail were considered at first but discarded later as requiring expertise beyond the competences of the curators.

The curatorial team then oriented themselves toward a style of narrative that was personal, at times even intimate, as opposed to more factual, formal, detached and authoritative descriptions. Factual information was then presented in novel ways, to provide a more evocative experience. An example of one such presentation, for a water cistern, is provided below. As shown in Fig. 1, the water cistern is a hole in the ground with cement walls; a traditional way to describe it would have been: "this are the remains of the water cistern; by collecting rain it was possible to provide drinkable water for the soldiers and animals in the camp." Instead the curators designed narratives that leave visitors free to make their own connections and interpretations from the different points of view that were presented, such as the commander talking about the regulations regarding the building of the cistern; the soldier talking about being thirsty and the hope the new cistern will relieve them; the peasant talking about the digging and building construction in the familiar landscape (some text abridged):

- *Order of the day*: "War service, part I: servicing water to the camps. It is essential that a camp is not short in drinkable water for both men and horses. Excellent is rainwater held in cisterns, if these are properly built and with filters. Spring water is generally safe too, but may not be drinkable if the percentage of minerals is very high. As rule each soldier needs 6 litres of water a day and 25 for a horse or a mule."
- *My dear wife*: "[…] Here we suffer hunger and cold, we hardly have water to drink and if I had just a glass I would pay it 50cents, even for a dirty one. It is a relief to know that the situation should improve shortly because we have been ordered to build a cistern for water collection."
- *Women in the war*: "Since January 1915 there has been government work going on our Nagiá. Every man in the village, from 14 to 60 year old, must work there and when they come home they say one cannot recognise the place anymore: trees have been cut; pits, trenches and caves dug up. […]"
- *Poems from WWI*: Brothers, by G. Ungaretti.

Although each narrative is independent, their juxtaposition was expected to generate reflection due to the complementary or contrasting voices represented. The commander, for example, presents the regulations about how much water is needed for every soldier in the camp, but then the reality of the soldier is to still be thirsty. Content for each of these four themes was made available at each point of interest. In general, the 'Order of the day' was closer to a traditional descriptive content, rich with factual information, but it was structured to read as a military order. We expected that in this way the same content was made more emotional and engaging. The poetry theme was sometimes difficult to align with the specific topic, such as in this case as the poem "Brothers" does not make any reference to the water. However a poem was needed to complete the set of narratives for every single point of interest. It should be noted that most of the time a poem relevant to the place was available for the curators to use, such as shown in Table 1 below for the kitchen point of interest.

The text used in the composition of the narratives comes from the museum extensive collection of archival material from both official sources (military plans and journals, orders, regulations) as well as personal sources (diaries, letters). This

guaranteed the authenticity of the historical information and also the emotional load of the words that are used. Research in the archives provided initial material that needed, in some cases, some editing to create the intended effect - that of personal narratives connected to the place. For example in "My dear wife" above the reference to the construction of the cistern was added to make the reference more explicit within a diary excerpt that already talks about being thirsty.

The curators also had the specific intention of evoking how the place was used during the War. Historical content that was specific to the place was then selected and all the references to villages, valleys and mountains surrounding the camp were left in the text (see Table 1 for some examples). References to commanders acknowledged in plaques in the trenches were also included to make the personal connection even more vivid.

In summary, much effort was put into the preparation of the narrative content in its final form as it explicitly aimed at sparking empathy in the listener and making connection between the stories and the territory. This process resulted in the selection of 7 narrative points (Fig. 1) and 4 themes (Table 1) that captured complementary or contrasting voices of the War. The selection of the attraction sounds and the final rendering of the narratives, which is discussed below, complemented this work.

4.3 Sound Selection and Recording

The selection of the attraction sounds was the result of much deliberation. The sounds used (Table 1) all represent a strong connection with the corresponding theme and a reference to the past and are designed to produce a respectful, contemplative atmosphere. The aim here is to augment the physical surroundings with sounds that will induce both an emotional response and also contemplation on the history of the area and the people that lived, fought and died there. The attraction sounds are all evocative of different aspects of this history, while having (sometimes quite subtle) links to the war that was fought here. The trumpet used for the 'Order of the day' is the Italian military wake up call, while the male choir for 'My dear wife' is that of the Italian Alpine army singing the beginning of a World War I song with a geographical reference to the area; both are well-known and highly evocative sounds. The whistle of a departing train intended to represent the taking of civilian refugees away from their land in the sound for "Women in the War", and a requiem in memory of those that have died is the sound associated with the poetry theme.

Two professional actors (one male and one female) were hired to record the content that was delivered by the system. This resulted in high-quality recordings that were voiced clearly and with a tone that matched the emotions of the specific pieces of content. This ranged from quite formal pieces for the 'Order of the Day', through a selection of diaries and letters that varied in tone, to the often sad or angry tones of some of the poems written by soldiers at the time.

Theme (Attraction Sound)	**Sources**	**Content Sample (abridged) (Point of interest in Fig. 3)**
Order of the day (Trumpet calling soldiers to assembly)	Official documents, laws, bulletins, regulations on the military organisation of the camp.	"Notes on the visit to the Nagiá Grom stronghold, sector 4a - peak Biaena, Rovereto command centre, done on the 18th September 1917 by myself, General Arthur Arz von Straussenburg. The stronghold is in good conditions and properly positioned. […]" (shooting point, Fig. 3)
My dear wife… (Male choir singing a war song)	Diaries of the soldiers; letters sent home.	"[…] You can easily imagine our relief when we moved from the tents into the welcoming wood barracks, with camp stoves always burning, built inside caves dug into the mountain rock." (covered refuge, Fig. 3)
Women in the war (Steam train whistle)	Diaries and letters from the family; stories of building work in the camp; stories of refugees moved from the area of war onto camps in Austria.	"It was the 27th May 1915, as miserable pilgrims we all left our homes and our dear village were we lived many happy years. From Mori we went to Rovereto station - we were loaded like cattle. The train travelled for a few days. Then they left a few of us among German people that could not understand a single word of what we were saying. […]" (observation point, Fig. 3)
Poems from WWI (Fragment of the introduction of the War Requiem by Benjamin Britten)	Edited collections from both Italian and Austro-Hungarian soldier-poets.	"The smell of war means the smell of rotten leather. That of sweat. The smell of dry excrement. That of fresh blood under the sun, thick, sweet, slightly nauseating. The smell of putrefaction. The smell of anise in the water bottle. The smell of cigarettes "Sport" found in the abandoned Austrian trench, in round packs of brown paper. […]"(kitchen, Fig. 3)

Table 1: The four themes, the sound used to attract to the points of interest, the type of sources used and excerpts of the final scripts.

4.4 Implementation

For "Voices from the Trenches" we created a bespoke wearable device to allow visitors to freely explore the trenches. This device made offered visitors a form of tangible interaction to control their experience (Hornecker and Buur, 2006) . With their presence and their movements visitors would activate sounds played via loudspeakers positioned at points of interest, with an instantiation of ubiquitous computing in a natural environment (Hodges et al. 2012). The wearable device took the form of a belt inspired by World War I army clothing (Fig. 2b); visitors wear the belt as they explore the site. The selection of the theme is via Near Field Communication (NFC) enabled cards (Fig. 2d), each of which corresponds to one of the four themes discussed before. The visitor changes theme by placing a card within a specific pocket of the belt (Fig. 2a).

Each card was printed with: a brief description of the associated theme; a professional drawing (made by an artist that regularly collaborates with the museum) that represents the theme; an historical photograph from the museum collection relevant for the theme. The feeling of the interaction was then markedly different from what is generally perceived as interaction with technology. Intentionally, no screen was used and the selection of the theme to listen to is via these beautifully illustrated cards. In this way we included a tactile and visual component that complements the physical experience.

(a) (b) (c) (d) (e)

Figure 2. (a) The belt-like device worn by visitors and (b) the historical dress that inspired it; (c and d) the cards used to select the themes, (e) the sound lanterns used at the points of interest.

Each point of interest is marked by a sound lantern (Fig. 2e) that conceals a loudspeaker, together with the electronics needed to control it and communicate with the belt. When visitors approach a point of interest, the belt recognises the loudspeaker, connects to it using Bluetooth and uses the strength of the Bluetooth signal to infer the visitors' proximity to the point of interest. As discussed above, each narrative theme has a different attraction sound that represents the corresponding content; when approaching a point of interest the attraction sound of the currently selected theme plays. As the visitors move closer, the belt selects the narrative for that point of interest and the selected theme. When the narrative is played, the visitor can then choose another theme, by simply switching to another card, and thus play another narrative, or move away from the point of interest to continue the visit. If a different theme is selected when already in place, the attraction sound for the new theme is skipped and the narrative content played immediately; so when in place multiple narratives are played in sequence every time a new theme is selected.

Finally, attention was paid to the playback of the sounds. The sound sources were placed at the points of interest around the site, generally at a level above average head height. The sounds were recorded and played back in uncompressed form with a 44.1kHz sampling rate and a resolution of 24 bits. Playback volume was higher for the attraction sounds, to enable them to be heard from further away and thus attract attention. Lower volumes were used for the playback of the content, although we noticed that this should be varied somewhat from one location to the next depending on factors such as how enclosed the space is, if there are competing noise sources and also the nature and tone of the content itself.

In summary, throughout the interaction design we tried to exploit the combination of the tangible and embodied interaction with the listening experience: different sounds are played depending on the physical position and the visitor's choice; music or sound effects invite them to get closer, voices invite them to listen. Our design extended to the content too. Care was taken in creating the audio snippets in order to make the experience more evocative and emotional; as discussed above this

included careful selection of sounds, editing of narrative content and the use of professional actors to record the final narratives.

5 FIELD TRIAL

In the summer of 2014 we conducted a field trial to evaluate the concept of narrative in place in the trenches. The research method was qualitative: we observed how people reacted and behaved at the narrative points, and how and when visitors chose the themes. We were particularly interested in the group dynamics and to see if an interaction that was intentionally open would generate discussion among the members of the group. We also aimed to gather feedback on the experience we had designed and to discuss with participants how to improve it. Questions we wanted to address included:

- *Embodied experience with sound*: Is a sound-body interaction type of experience of heritage engaging? Did our design invite visitors to relate to the environment in a different way?
- *Narratives and places:* Did the chosen attraction sounds and narrative materials create an emotional response in the visitors? How did this affect their response to the place itself? Was the combination of narrative and place more engaging?
- *Personalisation and choices*: If visitors have the opportunity to choose, do they do it? Would they follow one theme or multiple? Would they follow a similar path of visit?

Designers, technologists and curators took active part in the trial in a cooperative evaluation.

5.1 Trial Set-up and Data Collection

The evaluation set-up had 28 stories uploaded for a total of about 23 minutes of content, complemented by the 4 attraction sounds played when the visitors are at a distance. The length of the narratives varied with some of the shortest poems lasting 30 seconds. Keeping the content short was intentional, with all the narratives kept between 30 and 120 seconds to avoid either overwhelming the visitors with content or giving them too little (Hornecker 2008, Serrel & Raphling 1992).

The 7 narrative points where distributed across the whole site and were connected by several footpaths (see Fig. 1). No preferred order of visit was suggested and the multiple paths allowed participants to choose their own. The sound lanterns were positioned as high as possible to allow a better diffusion of sound and to facilitate listening. The lantern case was made of laser-cut plywood for minimal impact on the landscape (Fig. 2d).

Participants invited to take part in the study were in the network of the Museo della Guerra: three guides that lead school groups, two history enthusiasts, and the architect involved in the restoration of the archaeological site. Apart from the guides who came as a group, participants were invited to come with a friend as we intended to replicate a normal visit as much as possible. Of the three companions invited to join, one had a personal interest in history; the other two were not experts on the subject. Overall 9 people took part in the trial: the 3 guides and 3 groups of 2 people. Each group spent about 1 hour visiting and was then interviewed for about 45 minutes. The demographic was varied: 3 women and 6 men aged between early 30s and mid 60s. All were local residents; some were also familiar with the place as they have previously come with students or participated in its restoration. The visit was recorded in video, the interview in audio. Observation notebooks were used to inform the follow-up interview with specific elements from the visit itself.

Multiple sources of data were collected: the video and the observer notes were complemented by the interaction logs automatically recorded by the belt. The logs captured the full interaction with the cards and enabled us to see if participants followed a single theme for the full visit, or listened to many themes and if there was any pattern. The log also recorded the time of arrival at each narrative point and when they left it, so we could compare the time of staying with the time of listening.

Upon arrival in the woods that was our base, each group was briefed on the activity of the day and asked to sign the consent form; they were then shown how to use the device, given a map of the place, invited to start from whatever path they preferred and to go for a normal visit. Researchers recording followed at some distance. After the visit, participants sat with us at the base camp for the semi-structured interview, which was conducted in Italian (the participants and interviewers were all native Italian speakers).

All sources of data were used in the analysis. Recorded videos of the visits were looked at during the data analysis, observed behaviours were noted and relevant comments transcribed. The interviews were transcribed verbatim. The field notes and the logs complemented this material. The analysis was iterative and repeated across each of the different sources; for example the thematic analysis conducted on the interview transcriptions was compared and complemented by the field notes; comments in the interviews were integrated by video observations. The findings, discussed next, integrate these different sources and analysis.

5.2 Findings

The 'Voices from the Trenches' experience was designed around three key elements: the immersion in the place through the seamless activation of the audio triggered by visitors' movements; the evocative content designed to bring multiple voices from the past of the specific place; and the creation of a personalised experience by combining visitors' choices and system pro-activeness. This section discusses how the experimental findings answer the research questions captured by our design choices.

5.2.1 Embodied Experience with Sound

Key to the experience was the seamless interaction: the system automatically reacts to the presence of the visitors (by means of the belt they are wearing) and their movement. As we wanted to bring to the fore the experience of being there, interaction with devices was deliberately reduced to the minimal action of wearing the belt and, as discussed below, to changing or choosing another narrative. Visitors interact with the system by just walking the site of the heritage, a form of weak embodiment, making use only of proximity of the visitor, rather than some form of continuous expressive interaction that would interfere with the normal behaviour and group formation in a natural landscape with prominent physical affordances. The automatic start of the attraction sound first and the narrative after was appreciated by everyone: "*the automatic start is brilliant*"; "*the music first when you are still far: really beautiful. Then you approach it and the story starts. It's like it acknowledges you have arrived*".

A number of visitors commented on the emotional aspects of the sounds; their presentation matching the place and themes; and the professional quality of the delivery of content by the actors, stating that this recitation enhanced the emotional impact of the pieces: "*the audios are really well made, I liked the fact that text was declaimed*". There was also a theatrical effect of sound being played in some of the locations used, particularly inside the dark caverns where the sound lanterns were not visible, and audio resonated all around: "*it resounds all around you*"; "*I liked the caverns best because you enter but cannot see - then the music starts, it is of great effect*". When the recorded narrative finished playing, the echo effect gracefully faded into silence. Visitors noted that at open air spots, instead, the ending of the narration was more abrupt, suggesting the possible use of a background music that fades in and out: "*Maybe for those [lanterns] outside create an introduction and a final. The audio finishes and you... whereas it would be nice to be accompanied. Inside, in the cavern, there is the reverberation that supports that, outside there isn't… there's the need for something more*".

Often the sound lanterns (loudspeakers) could not be seen by the visitors before the sound started; observed reactions included stopping and turning toward the sound source, touching the partner and pointing, markedly deviating from the walking trajectory to approach the point of interest. This is due to the fact that it was an archaeological site with very little left to look at (Fig. 1) therefore the visitors were not driven toward the point as there was not much to see: the sound captured their attention and they deviated from their path in a natural way. Opinions on the fact that the listening points (the lanterns) were intentionally designed to blend with the surround and not always clearly visible differ. Some would have liked for the sound points to be prominent so as not to miss a point of interest, others instead liked the sense of surprise that comes with hearing a sudden sound, as made it explicit in this comment: "*if you do not see the lantern [the sound] takes you by surprise, it's nice*".

The reaction to the different attraction sounds was interesting to observe too: the trumpet of the 'Order of the day' always got a little smile; the choir prompt a murmured singing by some; while the 'War Requiem' used for the poems was too quiet to be heard in the open unless one was already very close to the lantern. When the lantern was reached visitors tended to linger around it to be able to listen to the story being told. While listening, visitors' visual attention was devoted to the surrounding environment providing them with a sense of place, a behaviour discussed below. Attitudes and standing position varied with the narratives: poems and soldiers' diaries engendered a more still and reflective pose with visitors staring at a single point, while with the 'Order of the day' visitors tended to move and look around more. Our analysis suggests that listening in place facilitates visitors to concentrate on the experience of being there; as their visual channel was not absorbed by looking at a

screen, the listening was complemented by the looking around and observing the place; this in turn triggered comments to their partners that seem to reinforce the experience and the sense of place.

The voices had a strong evocative effect. Not seeing the sound lanterns produces the effect of a disembodied voice speaking: "*the voice of a person who is not physically there … it is like someone is imprisoned in the place*". This combination of a "magical" voice, together with the high quality delivery and the fact that visitors hear rather than read the content was felt to generate a very different (and much more engaging) experience than just following a guidebook. Indeed one of the guides themselves who uses very similar content in their work commented on the value of sound in place with a proper emotional tone: "*a third person reading it out loud is much more effective than reading it yourself*". This underlines that the mode of delivery of narratives in place is key to making the same content more evocative even for those people who already know both the place and the content. Along the same line, the mode of delivery, via loudspeakers hidden in the sound-lanterns instead of headphones, affected the experience of listening and engendered positive comments: "*sound in the headphone isolates, it becomes your own thoughts. Sound in place - like here - it is a narrative that comes directly from this place, that past*". In the words of this participant, the sound in place acquires a physical dimension that the sound via a personal device does not have. It captures a bodily experience with the past. The social dimension of sound in place is equally important. When compared with a traditional audio guide, which uses headphones or a small speaker held close to the head, the sound lanterns produce sound that is shared among the visitors. The visit becomes a more social experience. Rather than being isolated by headphones you are sharing the visit with those people that are with you: wearing headphones *"isolates you from the context"*, *"makes you a little island"*. Indeed groups were observed commenting to each other in between pieces of content, as discussed below.

5.2.2 Narratives and Places

The design aimed at creating an evocative experience by intertwining the sense of being in place, the narratives and the bodily interaction with sound. We were therefore particularly interested in the responses of the visitors with regard to the relationship between narratives and place. The importance of narratives to the appreciation of the heritage should not be underestimated: only the remains of basic structural work of the camp and trenches are left to be seen (Fig. 1): the pit in the ground that was the cistern, some cement blocks for the kitchen, the cave where the barracks for the soldiers was built. As for the other points of interest, all needed some description for their original function in the soldiers' life to be understood. The substantial research for the content, the careful writing of personal accounts and the professional acting were instrumental with this respect: *"It struck me that a place that was abandoned after the war resumed life through these reconstructions"*. The value of the recordings is somehow amplified by the fact that they are listened to in the place where those facts occurred: *"diaries acquire a special meaning when listened to in a place like this"*. Listening to the same recordings in a different place such as a museum would not have had the same emotional effect. The power of narrative in place was amplified by the performance of the actors in reciting the scripts: "*some of the personal accounts were poignant. We stayed silent as a form of respect*." The connection made by the narratives with the locations was much appreciated by those who knew the area, such as the references to villages and peaks. Some participants knew the geography of the area very well and pointed out the different places, some also added information they possessed themselves, such as where the enemy line was and how the trenches developed all along the valley. The discussion in place made the experience more vivid but made some visitors wonder if strangers would then have a diminished experience and how one could help them appreciate how much the stories are about the territory. In the interview participants noted that complementary information could be provided in paper as part of the package, for example a map of the two fighting lines on the side of the two facing mountains: "*people who come here want to spend time looking around at the landscape. It is not like in a museum where one looks at an object then moves to the next. So explaining that a cannon shot reached the mountain in front makes you look at the place in a different way* ". This is an interesting observation that brings to the fore how personal motivations and identity shape the visit (Falk 2009) and the value of designing the narratives to complement and explain the landscape.

The analysis of the logs showed participants stayed in the engagement area of the points of interest 3 times longer (on average) than the listening time. This is confirmed by our observations of groups talking in between and after listening. By design, the narratives were not direct explanations of what each point was, but the function of the place could be inferred from the narrative. It was then not unusual for groups to exchange very short comments when it dawned on them what that place was, such as touching their partner and pointing at the cistern when the meaning of the pit in front of them became clear to them through the narrative. By leaving interpretation open we enabled participants to feel and interpret the place in their own individual way: the story of where I live; my life vs. theirs; to experience the place as a visitor, not a guide; the lived history. This was captured in some humorous comments, for example in the kitchen the 'Women in the war' theme is a letter from a mother to a soldier son that ends with the words "…We are always anxiously waiting a letter from you, all in vain. Write soon." to which a visitor commented to the partner: "*the requests from the mothers are still the same…*"

Not everyone picked on the reference in the narratives to places and people; those who did, however, appreciated it very much: "*it was really something that the narrative talked about Lewandosky and there is a plaque commemorating him just outside the artillery point. I've heard about him but did not know he was actually here*". Visitors were aware that the narratives might have been slightly rewritten to better fit with the intended design of the experience. This, however, was not considered a limitation and the rigor and authoritativeness of the Museum was appreciated and acknowledged: "*even if they are not precise excerpts from diaries, they are the outcome of a research and are a faithful representation of what was happening at the time*". This comment is important as it validates our intentional design of narratives to support the appreciation of the place and the importance of the rendering of the content as personal accounts (rather than the more traditional guide-like format) in order to turn the visit into an evocative and memorable experience. This observation is in contrast with the comments collected in the interview in reply to the question about whether there were other types of narratives they would have liked; indeed some participants suggested a more traditional guide-style, factual theme, one that would explain what the place as a whole was, why a trench was built the way it was, how did they cook, how the artillery was positioned and so on. We interpret this as a desire to have more details than the need to change the format as the 'Order of the day', the theme with the more factual content, was the most liked and listened to, as discussed below. Another suggestion on additional themes was to talk about special occasions such as Christmas, or how life was at extreme temperature such as in Winter under the snow for weeks or in Summer with scarce water under a scorching sun. Interestingly all the themes suggested point toward themes of the everyday, at times even the mundane, indicating that the opportunity of establishing a personal connection with the heritage is important.

In the interviews we explored the possibility for visitors to take away something of the experience. While we left all options open and mentioned being able to listen to the narratives again, there was an overall consensus that sound was meaningful in place and the appropriate medium to take away would have been visual: "*I would take home the cards – they are spectacular - you take them away and you have a memento*", "*no I would not be interested in the sounds, but on photos of the place, to remember how it was*", "*maybe of the poems I have listened to, one of the cards*". The enthusiasm about the content was clear: "*what I would really like to have is a list of references so I would be able to get to the sources*", "*I'd like to know where the content comes from, see more diaries*". Curators were very pleased by this comments showing their effort was appreciated and indeed that such an experience could establish a longer-term interest.

5.2.3 Personalisation and Choices

The last pillar in our design was to offer a personalised visit. We were therefore not prescriptive in the order of the visit and offered visitors the choice of what to listen to; on this basis the system then personalised the playback of the audio files taking into account the position (both point of interest and distance), the current thematic choice and if a narrative has been played last. Variety was the norm in the sequence of visit: no two groups followed the same path, nor did they listen to the same themes or in the same order. All groups listened to at least 2 themes for every station, but no one listened to all the stories available even if a couple always played at least 3 themes and often all 4 ("*if I were alone I would have listened to all of them all the time*"). The log and the interviews both show that the 'Order of the day' was the most popular theme played by almost every group at every stop: "*I liked the 'Order of the day' best – I'm not one for poems, I'm afraid. Poetry is a leap of imagination, the 'Order of the day' is real life, how things really happened and you can make connections to your life today, like when we were in the kitchen to hear how little food they had and now people go on a diet [bitter laugh]*", "*My favourite was the 'Order of the day' – it made me experience how real life was here. I considered the other themes as 'enrichment', an addition* ". Apart from the 'Poems' which one of the groups never listened to, the other themes seem to complement the main 'Order of the day' in no particular order although there was a preference for new content such as 'Women in the war' ("*it is a topic very rarely talked about*", "*one knows about the soldiers fighting, but the women had to hold the families, look after the injured and witness as terrifying a scenes as the man – I liked this theme very much*") or the least known poems ("*poems are always an emotion, but those we studied … they spoil the feeling of the place with memories of school. But I loved the one I didn't know, in the kitchen, the association poem–daily life is fantastic.*").

The exploratory behaviour of listening to multiple themes seems to be triggered by the short length of the audio clips: "*this length is great - it allows you to listen to everything without spending 8 hours here*"; "*the length is just right – we see it everyday with groups: people have lost the ability to pause and listen* [comment by one of the 3 guides]"; "*I liked it to be 'spots' – quite the opposite of a museum audio-guide where each audio is 10 minutes and you cannot follow it all and if you listen to everything you stay in 6 hours and after a while you just get fed up and stop.*" To accommodate specific interests ("*I would have liked to hear more of the 'Order of the day'* "), participants suggested adding more clips for the same theme instead of extending the length. When probing how further clips should be played participants discarded any automatic start on the basis of a prolonged stay and preferred a mechanism for explicit request. Our own observations support the choice of short clips (as well as additional play) to be on request: groups were observed talking and pointing at the landscape in

between listening sessions at the same stop, possibly making explicit to other members of the group the location of places mentioned in the narratives just played.

Important to the overall experience was the possibility for visitors to choose what to listen to via the NFC-enhanced cards, a deliberate choice that does not expose the technology, as the material used (paper) does not feel digital or technological in any way. While this mechanism gave visitors the possibility of choosing and interacting, it did not distract from the listening experience and complemented the bodily interaction with tangible aspects. The choice of the theme via card was also designed to be social, the decision to be shared by the group of visitors. We observed group members looking at the cards, discussing the themes and negotiating what to play next (Fig. 3). Only one group stated in the interview that they decided on a theme to follow at the beginning and kept it all along their visit listening to additional narratives "*as enrichment"*. The use of cards invited collaboration and there was always a consultation of some form, an attention to what the party wanted and a balance between different wishes: "*let's listen to the 'Order of the day' first, I've seen it is the one you like best, isn't it?*"

We discussed with participants the option of having many different themes, an easy scenario for the belt – simply by printing more cards. What emerged is that variety is good but a large number of cards to choose from may induce people to pick just the few they are already familiar with, while by holding only a few unfamiliar themes one may be pushed to listen to them, maybe just out of curiosity, and this could trigger unexpected reactions: "*one could think 'poems? who cares?' but then when here, in the trench, looking down at the lake and listening to a poem… one starts to think… it is different, a poem in here*".

6 DISCUSSION AND CONCLUSIONS

At the beginning of this work we set out to explore the possibilities of using audio to deliver an interactive narrative in place as a novel experience for visitors to outdoor heritage. The driver for this research was a strong need expressed by curators to improve the visiting experience of the remains of the trenches and camp of World War I with a significant historical meaning. The requirements were to facilitate a connection between the visitors and the history of the place and those who were affected by the war. The aim was to create an embodied interaction that takes visitors beyond the traditional view of heritage as a source of information toward a sensorial experience of feeling the past. Narratives, interaction and place were integrated by design to create evocative encounters for visitors that would provoke empathy and allow the visitors to build their own personal interpretation of the history of the place.

Over the course of this project we expended much effort in the careful design, creation and reproduction of the audio content that the system presents to the visitors. Content themes were chosen to represent the less information-intense and more thought provoking experience that we were aiming for. Essential was the expertise of the curatorial team, as well as the close collaboration with the development team: interaction design alone would not necessarily have generated such an intense connection with the place as resulted from this process. Comments from the visitors regarding the narrative content, the quality of the delivery and the added meaning that resulted from the use of the audio in place speak to the quality of the result.

The use of multiple themes also enabled us to present multiple points of view to the visitors and for the visitors to personalise the experience based on simple, clear conditions. Visitors could change theme easily, by simple inserting a new card into the pocket of the belt. They were also free to move around in whichever way they saw fit. This allowed them to both follow a single theme across the whole site or to listen to multiple themes at each point of interest. The simplicity of the theme change mechanism also meant that visitors could move between these modes of visit at any time. The use of tangible interaction, through the belt that the visitors wear and the paper cards used to select theme also enable us to hide the technology from visitors. The visitors interact with seemingly non-technological artefacts: a belt and some cards. The loudspeakers that deliver the content are also not particularly conspicuous, allowing the impression that the narrative is being delivered by the heritage site itself.

This leads to another aim of this work, which was to examine the use of audio to present information to visitors as a group, rather than individually. Existing audio guides for heritage, along with a large number of smartphone-based systems that have been developed, isolate visitors from each other. Visitors must use headphones, or hold a small speaker to their ear, in order to listen to the content. This not only separates them from each other, but also acts as a barrier between them and the heritage that they are visiting, an effect that is even more pronounced when the screen of a smartphone is also used as part of the interactive guide. By situating the sound within the environment we create a social, immersive, multi-sensory experience that extends far beyond that offered by a traditional audio guide.

This project also allowed us to examine the emotional effect of such a system, and the potential for an emotional connection between the visitors and the heritage site. There is a strong link between sound and emotion, a link that is used to great effect in sound design for film and television; there has not been much investigation of the use of this in cultural heritage. Yet many heritage sites have the potential for a strong emotional connection between the visitors and the place, but the use of sound in traditional audio guides does not work at an affective level. We have seen from the comments of the visitors that used our system that the sounds we chose in many cases helped create this connection. Visitors mentioned staying silent as a mark of respect, the beauty of some of the audio in the place, and even how the location added more meaning and emotion to the content. We find these results extremely interesting and worthy of further study. While there have been studies of the emotional response to music and sound effects, the link between emotions, sound and environment seems less thoroughly investigated. In particular the role of personal narratives and the sound of human voices can be a very powerful instrument to bring historical facts and events closer to the visitors.

The system described in this paper was not without its problems. The use of audio in an outdoor environment can be tricky. There is a need for loudspeakers situated in the space, with the attendant problems of power and connectivity. There are also issues with audio quality and volume: sounds must be loud enough to be heard when needed, but not so loud as to cause discomfort, or reduce audio quality. Fine-tuning this aspect proved to be one of the trickiest parts of this study. This required regular testing and adjustment of the volume of each of the individual sound recordings. In particular, the attraction sounds needed to be played at a significantly higher volume than the content, so that they would attract visitors from a distance. This issue is also affected by the content itself, as some content should be delivered in a quieter, more respectful way than others. Repeated testing of the content in place was required to ensure that these criteria were all met, without compromising the experience.

A further issue is that of scalability: how well would such a system work in a busy environment with many groups interacting? From our investigations we have found that the audio lanterns produce sounds and voices that are well localized. By placing the lanterns a sufficient distance from one another groups of visitors are not disturbed by the audio that other groups are listening. This works particularly well in larger outdoor spaces, such as the one used in this study. We have also found that as there is no fixed path or itinerary for visitors to follow individuals and groups are free to move around in the space, so that groups can easily wait for a certain spot to be free before going there, if they wish a more private experience.

During interviews with the group that was made up of professional guides all of the guides agreed that they would like to use the system when accompanying large groups, especially school groups, as the emotional nature of the content would complement the more factual material that they themselves provide. They also specified that in this case they would like to be able to manually control the start of the audio content. The volume of the audio can however become an issue with such larger groups. The natural social interactions between members of the group can cause a certain amount of noise that requires higher volume levels to overcome.

The design of the sounds used to attract attention, to drive visitors closer to the point and deliver content is also worthy of some further research. For this work we attempted to balance the relevance of the sounds to the themes, the recognisability of the sounds, and the mood that we were aiming to create. We also aimed at connecting the sound with the territory and used the narratives to explicitly refer to close by villages and mountains, an element particularly appreciated by our participants some of which knew the area well. From the positive comments received from the visitors we believe we were relatively successful in this task. However, we feel that there are a number of further question that could be investigated with regards to these sounds. For example, does the effectiveness of the narratives remain for people who are not familiar with the place? Do the sounds reflect the themes in isolation, or is it a result of the context of the project and the location? As with the issues of audio volume just discussed, there is also an issue of scalability here: can we design sounds that can be identified and differentiated by visitors in a busier environment? Within the audio display domain there has been significant work on creating sounds that stand out from other sounds, methods of attracting attention, but how can we combine this with the desire for relevant, emotionally rich sounds that help to portray a desired theme?

However, even bearing these questions in mind, we feel that this work has produced a useful contribution. We have examined the use of situated audio in an outdoor heritage site, developed a series of attraction sounds and narrative audio content and successfully deployed this system in a real-world site. The feedback from curators and visitors alike has been very positive, noting the emotional nature of the resulting experience and the value that the audio and the location added to each other. We feel there is real potential here for further examination of this area in order to create immersive, evocative situated audio experiences for outdoor heritage and open environments more in general.

ACKNOWLEDGMENTS

The research described here is part of a shared effort carried out in meSch, Material Encounters with Digital Cultural Heritage. meSch (2013-2017) receives funding from the European Community's Seventh Framework Programme, "ICT for access to cultural resources" (ICT Call 9: FP7-ICT-2011-9) under the Grant Agreement 600851.

We are grateful to the MUSE FabLab in Trento for their support in the fabrication of the lanterns. We thank the Gruppo Alpini di Mori, Mr. Spartaco and Mr. Bruno, for their assistance in setting up and run the trial.

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- We show co-design, setup, test of a digital interaction for an archaeological site
- The prototype is a visitor-aware personalised multi-point auditory narrative system
- Visitors interact with sound by walking and using NFC cards in a belt-like device
- Narratives had explicit reference to the territory and aimed at generate emotion
- The mix of sound, voices, personal stories, immersive experience was very evocative