Blend In or Pop Out? Designing an Embedded Interface for A Historical Cemetery

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Abstract. Historical cemeteries are under-explored design spaces within Human-Computer Interaction (HCI), even though they are visited for many reasons nowadays. We present our strategy to embed interfaces into this sensitive environment and report on interim results and the potential of such interfaces to support these places' preservation. We followed an iterative design approach by (1) brainstorming various ideas and (2) creating four low-fidelity prototypes to (3) discuss them in two expert interviews. This led to a final prototype resembling a birdhouse, a reoccurring and tolerated object in the cemetery. We (4) tested our prototype in a field study, asking passers-by about their interaction and perception. Our results show that our design approach is suitable and unobtrusive for the culturally-sensitive target environment. Further, embedded interfaces seem to facilitate and are more inviting to visitors to inform themselves about the place's characteristics and historical meaning, supporting its preservation.

Keywords: Historic Cemetery, Design Opportunities, Embedded Interfaces, Community Space.

1 Introduction

Historical cemeteries, such as Xoxocotlan in Mexico or Père-Lachaise in France[1] are popular tourism locations for their architecture, the graves of famous people, and their representation of culture and history. Nowadays, such cemeteries are often used as park-like areas for personal recreation, sports, or other activities [3, 4] besides paying your respect for the deceased. Despite the visitors' feedback that more details about the location and the deceased would be appreciated [1, 8], municipalities are still reluctant to offer interactive content at those sites, mostly fearing to destroy the solemn atmosphere.

Current, non-embedded solutions use virtual reality (VR), Augmented Reality (AR), or simple mobile applications. Yet, only a few HCI researchers looked at tangible, embedded interfaces due to these places' cultural-sensitivity. Häkkilä et al. [3], for example, turned a tombstone into an interactive display, inspired

[1] www.pandotrip.com/top-10-impressive-cemeteries-around-the-world-18694/, accessed Dec. 29th 2020

by commercially available displays[2] or QR codes[3] on gravestones. However, their study also revealed that participants perceived a digital display as rather obtrusive and unsuitable for the environment. In comparison, due to being culturally-sensitive places, cemeteries require interfaces to be physically and culturally unobtrusive [3]. We approach the research gap to identify design opportunities and requirements for embedded interfaces at historical cemeteries by looking at one historical cemetery in particular.

In our work, we focused on embedded, physical interfaces integrated into the environment for three main reasons: (1) Mobile applications offer easy and ubiquitous use, but do not allow an embodied, multi-sensory experience, nor is their handling fully culturally-accepted yet [9–11]. (2) Embedded interfaces facilitate an embodied experience of a place [12] and allow users to focus on their surroundings, instead of on the technology [13]. (3) There is little research about embedded interfaces at historical cemeteries, which we aim to enrich with our study results.

We approached the topic by first conducting a brainstorming to gather various ideas and requirements for an installation considering the target environment. Then, we created a set of four low-fidelity prototypes to discuss them in two expert interviews and built one interactive, birdhouse-inspired prototype to be tested in an in situ survey and guerrilla test. Our results show the need to preserve such places' meanings by making them relevant and accessible to their visitors and the potential of embedded interfaces to support this process.

2 Related Work

We build on existing work on technology in historical landmarks and cemeteries and consider general work about unobtrusive design briefly introducing it below.

2.1 Historical Landmarks and Technology

The preservation of historical landmarks serves as the living memory of a society supporting local identities [14, 15]. Previous work often focused on the digitization of information [16–18] or enhanced cultural heritage sites via mobile applications [19–21]. The digitization process includes the creation of virtual 3D models of cultural heritage objects [16, 17], digital storytelling [25], and web-based documentation [17]. Augmented Reality (AR) is a well-established technology for enhancing heritage sites [23, 24]. However, mobile applications are still challenged by imprecise position tracking, varying daylight conditions [19] and require the user to preinstall the application. They also make the user focus mainly on the device display instead of the environment [22]. Krösche et al. [20] emphasized the difficulty in raising awareness toward cultural heritage: The "lacking interest and perception" of the public is also caused by a lack of information directly provided at the monuments themselves. Hence, we see potential in exploring embedded interfaces that can capture and guide the user's attention.

[2] www.funeralguide.co.uk/blog/digital-gravestones, accessed Jan. 1st 2021
[3] www.bbc.com/news/uk-england-somerset-31525144/, accessed Jan. 1st 2021

2.2 Interactivity at Cemeteries

The primary purpose of a cemetery is to serve as a community place [27]. While research shows changes in the intention of visiting cemeteries, technology use and opportunities are still limited [4]. Ciolfi and Petrelli [26] researched design opportunities for the cultural heritage of a historical cemetery. The authors covered a range of ideas regarding information richness, (peripheral) interaction, and the level of obtrusiveness. However, they did not include any solutions embedded in the context. Other HCI projects concentrated on mobile applications [2, 29, 30] or used a tombstone as an interface [3, 28]. The latter, however, was considered disrespectful and unacceptable by study participants as it would be too directly connected to the physical remains. The authors [3] emphasized the need for a physically and culturally unobtrusive design for embedded interfaces.

2.3 Unobtrusive Design

Unobtrusive interfaces are defined as non-disruptive and quickly moving from the periphery of attention to the focus and back as needed [5, 31–34]. They also aim for a "natural interaction" that can be easily understood, executed, and ignored by others, and hence, are culturally unobtrusive. This includes the consideration of more implicit interaction modalities [36] as well as a context-dependent natural look of the interface [35], considering the requirements for physical unobtrusiveness. In this study, we want to contribute to this still limited research status by exploring the design space for embedded interfaces by considering the requirements for an unobtrusive interface.

3 Iterative Approach and Results

We applied an iterative, user-centered design approach using qualitative user research methods. As a first step, we brainstormed design opportunities and requirements among four Media Informatics and Human-Computer Interaction students, all female. Based on the results, we created four low-fidelity prototypes considering a natural design approach [35]. We evaluated these with two experts in independent semi-structured interviews who confirmed the birdhouse-inspired prototype's suitability for the target environment. Finally, we developed a first interactive prototype according to the gathered requirements and tested it at the target location. Each participant was informed about their data privacy rights according to the GDPR and gave their consent to being audio-recorded and photographed. Below, we report on our methods and key results which influenced our further design decisions.

3.1 Brainstorming and Low-Fidelity Prototypes

Method We conducted a brainstorming using the Lotus Flower method by Michalko [37] which supports the creative thinking process through an iterative,

structured approach. Moderators start with eight core categories for their overall design goal, and brainstorming participant gather another eight ideas for each of these categories. We prepared the following eight categories that we considered essential to define interaction and interface concepts for the historical cemetery: (1) available information about the deceased, (2) interesting stories from a user perspective, (3) information presentation, (4) embedding interfaces at the target location, (5) guiding the user attention to the interface, (6) contextual limitations and considerations, (7) preferred interaction modalities and (8) the potential influence of the user's cultural background. We presented pictures of our target environment so that participants could better relate to it.

Results Overall, participants agreed on an unobtrusive design and to avoid big displays or signs as "[...] it has something touristy about it. I wouldn't want this.", participant 2. Instead, the interface should *blend in* by using natural materials or objects similar to those already existing in the target environment, such as wood or stone, and objects, such as grave lanterns or birdhouses. They further suggested avoiding sound as an interaction modality as it could be disruptive and perceived as disrespectful. Instead, the focus should be on touch interaction with mainly visual output. To make the unobtrusive interfaces obvious enough, participants suggested using *pop-out* effects as in web design, using color, shape, or size differences [6]. This also includes the interfaces' positioning. Information about a particular person should be close to the grave. Hence, the lantern or the birdhouse could be suitable interface objects[4]. The birdhouse interaction (Figure 1, left picture) might be more comfortable as it would hang at eye-height and the lantern would require to kneel(Figure 1, right picture). Participants also discussed "[...] us[ing] stones to trigger an information display" with low salience like an e-ink display (Figure 1, second picture from the left). Depending on the size and the information, this could either be placed in the cemetery's central areas or embedded into a grave's decoration. In comparison, information about the cemetery should be placed in distance to individual graves. Here, participants suggested redesigning the information boards at the cemetery's entrance attached to the outer walls or introducing smaller walls as paths' divisions within the cemetery. The idea targeted attentive visitors who could discover hidden notes and information by moving stones as in a mosaic (Figure 1, second picture from the right). Lastly, participants emphasized the relevance of sharing information about the persons' roles and works and how those influenced the city's development.

Combining the different suggestions, we implemented four low-fidelity prototypes as presented in Figure 1, further considering the natural design approach according to Schlacht [35]. This approach finds mimicries of nature, such as organic shapes and biological structures, and local artifacts that are typical for the target environment to achieve a natural design.

[4] The target environment included many trees and natural vegetation between the tombs and information boards at the entrances.

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

Fig. 1: Each prototype was inspired by reoccurring objects on European cemeteries: (a) birdhouse, (b) pebble stones, (c) brick wall, and (d) grave lantern.

3.2 Expert Interviews

Method We discussed the prototypes in semi-structured interviews with a manager from the municipal cemetery administration (MCA) and a cemetery guide (CG) in independent sessions. The interviews focused on the meaning and usage of the historical cemetery and their opinions of the prototypes. The MCA manager had over 36 years of working experience in his job, the CG about 14 years. Both were male and consented to provide their data according to GDPR. We transcribed the interview recordings afterward and translated citations from the mother tongue into English.

Results Both experts saw issues with the grave lantern idea (a) as there would not be any in current use at our target location. Hence, it would "change the cemetery's appearance massively"(MCA). Birdhouses (b), however, were already part of the current cemetery and hence, could be acceptable. However, neither saw a benefit in (c) the brick wall prototype, as "there is sufficient, textual information along the outer walls. Elderly people wouldn't understand that [how to interact]" (CG). Lastly, (d) the scanning sign idea of engraving pictures or symbols on stones reminded the MCA of a ritual for children's graves: Relatives and friends say good-bye to the departed child by coloring and writing messages on rocks, placing them on the grave. The ritual would support families in their grief. However, as there would be no burials at the historical cemetery, the screens would face the same issue as the grave lanterns. But that "depends on where exactly it would be positioned" (MCA). Both experts emphasized the need to guard historical cemeteries due to their cultural and historical value. They would need to be made more accessible and understandable for visitors to preserve their original purpose of mourning and visiting the deceased. But they would also have to be developed to adapt to current community needs, such as tourism and recreational and sportive activities.

From our expert interviews, we derived the following main insights: (1) Historical cemeteries' relevance has to be made more accessible and understandable to visitors. (2) The place's original purpose should be retained and supported. (3) The birdhouse-inspired prototype seemed to be the most promising to iterate.

Fig. 2: Left: The birdhouse-inspired mid-fidelity prototype can display text via an LED matrix connected to an Arduino UNO triggered by four touch buttons. A portrait of the person is carved into the wood from the backside. When somebody approaches the object, an ultrasonic distance sensor triggers its illumination from behind and makes the portrait appear on the translucent wood. Right: The prototype in context.

3.3 In Situ Survey and Guerrilla Test

Birdhouses are reoccurring, accepted objects in the cemetery and allow certain mobility: They can be placed at different heights, positions, and distances to a grave while all electronics can be hidden inside. We developed an interactive prototype using the materials as presented in Figure 2. It included translucent wood displaying a picture of the person whose grave we chose as a testing environment and textual information. We decided on four information themes, the person's importance for the city, works, relationships, and place of residence.

Method First, we conducted a survey and a semi-structured interview with 19 passers-by (11 female, eight male) who were spontaneously recruited. We asked them to rate the prototype's appropriateness for the context, how natural it looked, and how well it caught their attention using a 5-point Likert scale (1=totally disagree to 5=totally agree) and open interview questions. The prototype was attached to a tree trunk next to a grave. We analyzed the results of the survey questions using descriptive statistics. Nine participants (three female, six male) agreed to participate in a follow-up guerrilla test. Guerrilla testing is used as a practical, rapid method to test the usability of a system with few users only [40, 43]. During this optional part of the interview, we asked all participants to use the Think-Aloud method [39] while interacting with the prototype. Afterward, we asked them for qualitative feedback about the prototype's usability.

Results Overall, our prototype was perceived as *blending in* by being unobtrusive (75% agreed or strongly agreed) as well as seamlessly integrated (75% agreed or strongly agreed) and rather culturally fitting (50% agreed or strongly agreed, 30% were neutral) for the environment. The reasons mentioned were its

small size, its close position relative to the grave, and the plain design. However, three participants also stated that they would not have noticed it as an interface they could interact with (e.g."It looks like a donation box. I would have just ignored it." p.13). All participants considered it essential to maintain the natural image and atmosphere of the cemetery. Twelve out of 19 participants preferred our prototype to digital displays or phone applications because it provided information in the environment and appeared as a part of the cemetery. This also offered users to receive information without them originally intending to do so, which was positively acknowledged. However, four participants would have preferred no changes to the location at all. In comparison, the remaining 15 participants appreciated the opportunity to interact with their environment instead of just visiting it. However, the sunny conditions limited the translucent picture display's visibility, and the meaning of the icons remained partly unclear. Nonetheless, eight of nine guerrilla study participants agreed or strongly agreed to the prototype's usability. The remaining person ranked it neutral. They further appreciated the prepared information of the buried person that was displayed on the button push.

4 Discussion and Limitations

4.1 Limitations

There are several limitations showing our initial status. We tested the interface in context with individuals but not its effect on third persons, limiting our findings regarding the prototype's unobtrusiveness. Also, our prototype hangs in trees, which not every cemetery has. Yet, we could imagine it suitable for cemeteries with similar vegetation. Lastly, the prototype is still on a primary status requiring further iteration toward a high-fidelity version.

4.2 Suitability of the Birdhouse-inspired Prototype

Our prototype's goal was to provide individuals with more information if desired by using an interface that can easily be ignored and preserves the place's natural and historical conditions. Participants found the birdhouse prototype to be rather attention-inviting, but not demanding [41], and adapted to the context [38]. We also placed it at the periphery of perception [5, 42]. Furthermore, the material (wood) and object (birdhouse) choices supported the unobtrusive design [31] that we were aiming for by redesigning a naturally appearing object [35]. Participants rated the interface as non-interrupting and unobtrusive for the cemetery's atmosphere, making it compliant to the required physical and culturally-sensitive unobtrusiveness [3]. In comparison, it was partly perceived as being too unobtrusive, showing the need to let it *pop out* more. Nonetheless, the birdhouse-inspired interface proved to be unobtrusive, embedded, and natural for our target environment. It further shows the effectiveness of the natural design approach to achieve an unobtrusive design. This can be adapted according to the context, taking other reoccurring, natural objects as interface inspiration.

4.3 Untouched Preservation versus Encouraged Engagement

In some historical cemeteries, it is prohibited to introduce any changes, as was the case in Ciolfi and Petrelli's work [26]. Yet, we see significant benefit in an embedded, physical interface as it makes information available at the spot. This further supports directing visitors' attention and awareness, which is one of the main difficulties for historic landmarks [20]. In our study, we also had visitors with initially no intention of informing themselves about the place but still appreciated the possibility of doing so. It raises a question about preservation approaches considering whether it is more important to leave a place physically untouched or extend it unobtrusively, offering immediate information. Considering our experts' feedback, there is a clear need to make the historical meaning of such places accessible and understandable to a broader audience. Our study also identified the need to preserve historical cemeteries in their role as community place [27]. We see further research potential in these topics to support the communication of historical cemeteries' meanings and their roles as community spaces to their visitors.

5 Summary, Conclusion and Next Steps

Our work used an iterative approach to explore the design space for embedded interfaces at a historical cemetery. Considering the limitations of preserved, historical landmarks, our prototype confirmed to blend in well while even requiring to pop out a bit more for future design iterations.

We used a natural design approach to adapt the interface's shape and appearance to a reoccurring object (a birdhouse) from the target environment [35], which caused our prototype to be considered unobtrusive, barely distracting, and well-adapted to its natural and historical surrounding. Our results further show that even participants who did not intend to inform themselves about the location appreciated prepared information available at the spot. We also identified the need and, hence, design opportunities for HCI to support historical cemeteries preservation in conjunction with its original role as community space.

In the following steps, we want to iterate on our prototype and deepen our understanding of the adequate level of embeddedness by exploring different strategies and designs. Additionally, we want to research more solutions to bridge their historical, social and cultural roles. With our current work status, we hope to spark a discussion about the role of embedded interfaces at historical cemeteries, including the design opportunities to emphasize such places' historical value and their communal character.

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