Design Recommendations for Historical Cemeteries Using Speculative Design

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(a)　　　　　　　　　　　(b)　　　　　　　　　　　(c)

Fig. 1. The three diegetic artifacts supporting our speculative design process: a) Step into My Shoes, b) Walk Together and c) Voices of a Cemetery.

Historical cemeteries are interesting design spaces within Human-Computer Interaction (HCI), due to their cultural and personal significance, and that they also serve multi-purposes within an urban community. However, contemporary usage of such places and technological developments partly interfere with preserving such places' significance. To evaluate how to counteract this challenge, we conducted an iterative design approach including a) five expert interviews, b) a design workshop using speculative design artifacts (n=4), followed by c) semi-structured interviews that evaluated the derived design concepts (n=6). We made an exemplary study of a European historical cemetery, and consolidate ten design recommendations for interactive historical cemeteries. Eight align with prior work, two are new. Furthermore, we identified design opportunities for supportive technology to maintain such places' atmosphere and regulate users' behavior to comply with the local code of conduct. Our work supports other HCI researchers, aiming to preserve cultural heritage sites such as historical cemeteries.

CCS Concepts: • **Human-centered computing** → *User centered design*.

Additional Key Words and Phrases: historical cemetery, design space, speculative design, embedded interfaces, historical significance

1 INTRODUCTION

"A cemetery is a living place that reflects the conditions and social realities of the surrounding community both past and present" [56]. Preserving and communicating the significance of cultural heritage sites such as historical cemeteries is a permanent challenge, increasingly so with the rapid development of smart, interactive environments [4, 66]. Historical cemeteries are provocative edge cases that are also increasingly researched for their multi-purpose functionality of serving as social community places, tourism points of interest, and a community's living memory of the past [28, 41, 70]. However, the contemporary needs and developments partly conflict with preserving such cemeteries and their role in preserving memories and remembering historical persons and events of the past. The communication of such places' roles and importance to visitors and making the information more accessible onsite are two approaches supporting their preservation [48, 49] but are still under-explored [62].

Tangible and physically embedded interfaces have been shown to increase awareness and enable direct interaction with such places [17]. They provide enriching information through the digital content while their physical design and materiality can support the place's atmosphere, a characteristic that digital interfaces are still challenged to convey [62]. Active and historical cemeteries are sensitive design contexts [37, 41] that require culturally and physically unobtrusive interfaces [31]. Mobile phone usage, for example, risks being perceived as disrespectful, particularly because others cannot comprehend whether users are looking up information related to the cemetery or indulging in independent activities [32, 58]. Interfaces for historical cemeteries need to be adapted to the place's sensitivity and meaning. However, none of the prior work has approached this design space by targeting interaction scenarios considering future societal or technological changes and developments. Yet the gap between technological advances and historical site preservation is constantly growing, challenging the preservation of such places' significance.

Speculative design supports envisioning future contexts and provoking reflections on current practices [5, 6]. In our work, we integrated speculative design methods [57] to provoke novel ideas and envision future interaction scenarios at historical cemeteries. Considering the advantages of embedded, physical interfaces for such contexts, the work is guided by the research questions:

RQ1 How can we design for historical cemeteries to turn them into interactive design spaces complying with contemporary and place preservation needs?

RQ2 How can speculative design methods support narrowing the current gap between contemporary user needs and historical cemetery preservation?

We approached the questions with an iterative design approach conducted online using the example of a particular historical cemetery in Munich, Germany. This cemetery is officially classified as a cultural heritage site. We included expert interviews (n=5), in which we identified the problem space, design requirements, and the role of historical cemeteries in the future. Deriving three speculative design concepts from the interviews (see Figure 1), we conducted an online workshop (n=4) for evaluation. Lastly, we iterated on the concepts followed by semi-structured interviews with cemetery users (n=6).

Our work contributes ten design recommendations when designing for embedded interfaces at historical cemeteries. Eight align with findings from prior work, two are new. Further, our work is the first to our knowledge that applies speculative design methods for the design of historical cemeteries. As such, our work extends current research into the historical cemetery design space. Furthermore, it reflects upon the challenges and possibilities for sustaining historical cemeteries under the ongoing technological advancements as inspiration for related work on interactive cultural heritage sites.

Table 1. Experts and their area of expertise in relation to our target environment.

ID	Area of Expertise	Expertise in Years	Gender
ExP1	Researcher in Urban Development.	7 years	Male
ExP2	Researcher in Architecture History.	8 years	Female
ExP3	Researcher in Urban Development.	1.5 years	Male
ExP4	Researcher in Urban Architecture.	10 years	Female
ExP5	Tour Guide and Cemetery Administrator	16 years	Male

2 RELATED WORK

Embedding the work thematically, we introduce a) ongoing work to preserve cultural heritage sites with a particular focus on onsite interactions, b) human-computer interaction (HCI) research relating to active and historical cemeteries, and c) speculative design for the design of interactive built environments.

2.1 Preserving Cultural Heritage Sites Through Interactive Technology

The preservation of cultural heritage is often linked to creating digital representations of the architecture [55, 60] or documenting (in-)tangible information [2, 3, 46]. In contrast, immediate, onsite interaction has been shown to support contextualization - the process of understanding and making sense of the experienced [40] - due to their embeddedness in the physical, spatial and social construct of a place [39, 42, 63]. Understanding these characteristics in connection is essential to understanding a place's significance [7, 45, 49, 65], and presents the challenges of conveying historical significance in the face of a visitor's possible lack of interest or awareness [48], or a lack of information adaptation for different visitor profiles [69].

Attempts include providing onsite tangible interfaces such as small 3D printed replicas of the architecture [59], camouflaged information displays, e.g., in the form of birdhouses [17, 37], interactive storytelling using Virtual Reality (VR) [64] or Augmented Reality (AR) [15, 39, 50]. Enabling users to directly interact with historical artifacts or environments [53] increases user engagement and further facilitates the understanding of a place's significance [11]. However, public places are complex design spaces because of their multi-functional purposes and meanings. Cemeteries also belong to public places due to their open accessibility for everyone and their role as community places. Historical cemeteries, in particular, serve as contemporary and past community places while also communicating their history to community-outsiders [19, 41]. Accordingly, there is not just one meaning to a place. This challenges the preservation of such places' historical significance.

2.2 The HCI Cemetery Design Space

Prior work has already explored active [31, 32] and historical cemeteries [16, 17, 36, 41], defining them as sensitive design spaces that embody high socio-cultural meaning [34]. As some cemeteries cannot be accessed physically, Eichert [22], as well as May et al. [54], developed digitization tools to document geographical information and personal information about the deceased. Similarly, Häkkilä et al. [33] implemented a VR replica of an inaccessible historical cemetery. The VR replica enabled visitors to experience the cultural heritage site, which they would not have been able to visit otherwise. While being just a virtual replica, the authors still identified the need for sensitive design and to treat the space with dignity toward the dead. In the physical reality onsite, prior work has explored interactive tombstones [31] or navigation applications [20, 32]. Newton et al. [58] developed a mobile AR application to overlay information on

tombstones to provide information about worn-off engravings. However, in Häkkilä et al. [32], mobile phone usage at a cemetery was also perceived as rather disrespectful. Based on similar reasons, prior work also identified the need to design embedded interfaces unobtrusively by, e.g., using context-specific natural materials and objects [17, 31, 37]. Each of these examples approached the cemetery design space with the sensitivity, respect, and caution it requires but with little consideration about future societal or technological developments. Considering the increasing gap between cultural heritage preservation and technological developments, we see the potential in exploring speculative design methods to identify future interaction scenarios and developments influencing the design space.

2.3 Speculative Design

Speculative design provokes out-of-the-box thinking through fostering ambiguity in the design process while still grounding ideas in contemporary, real-life conditions [13, 21, 29]. It is often applied to envision future interaction scenarios and their effects at the emotional, social and political levels [6, 27, 51]. In contrast to other design approaches, it aims to question common beliefs and values to reshape future developments [47, 67]. Kozubaev [47], for example, created a speculative design artifact (also called diegetic artifact [9]) and explored how participants of an art community would shape the future's narrative. They stated that the location for which interfaces are designed essentially influences the narrative. In another work, Eriksson and Hansen [24] presented a speculative concept of supporting the bereavement by simulating the heartbeat of a deceased loved one through a tangible interface. Their goal was to challenge the as-is status and open up the bereavement design space. In the context of interactive built environments, prior work by Stals et al. [68] and Mitchell Finnigan and Clear [57] applied speculative design to gather a deeper understanding of the user-building/ user-environment relationship and how to design interfaces fostering these relationships. Both projects conducted the studies using a participative approach to design future smart cities in collaboration with end-users. Speculative design is a conventional approach when aiming to challenge the as-is status and envision future interaction scenarios that extend current design spaces. It considers the complex connections and interdependencies beyond the direct interaction scope but also reflects on potential consequences at social and political levels [71].

In Short. Prior work has defined the sensitive design space of cemeteries but lacks envisioning future developments and changes that are not only technology-driven but also concern societal and political changes. In our work, we integrate speculative design methods in our approach to potentially narrow the increasing gap between preserving the place's significance and contemporary needs.

3   ITERATIVE APPROACH

We conducted an iterative design approach comprising five structured expert interviews, a design workshop, and six semi-structured interviews. We decided on these methods because expert interviews are most efficient in initial and exploratory research phases [10]. Additionally, we carried out the workshop and semi-structured interviews with cemetery visitors to directly adapt the concept to their needs and activities. Each phase was analyzed using thematic analysis. The second author transcribed and coded all interviews and discussed and iterated on the coding scheme together with the first author using the collaborative platform Figma [25]. All iterations were run online using Zoom [43] and Figma [25] due to local quarantine and social distancing regulations at the time of data collection[1]. In each iteration,

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[1]The study took place during the global pandemic COVID-19. Zoom [43] is an online meeting tool including video and audio recording and breakout rooms for smaller, separated group tasks. Figma [25] is an online collaboration tool supporting, e.g., brainstorming processes. The researchers' university holds licenses for both tools that allow for safe data recording and storage. We conducted all steps online to reduce the risk for participants and researchers and comply with the local distancing rules.
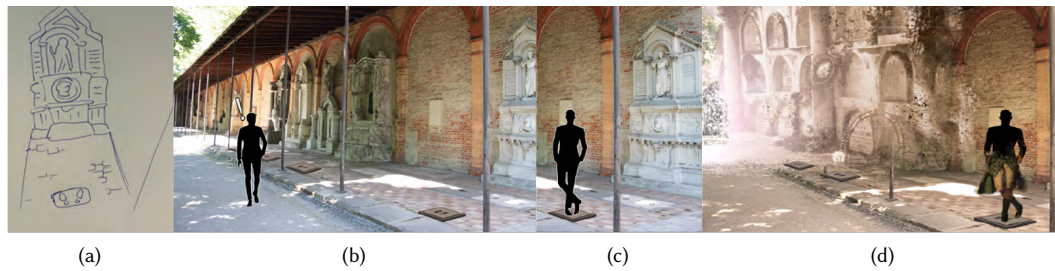
Fig. 2. Exemplary concept development of Step into my Shoes: a) First sketch, b) First scene of the storyboard, a visitor approaching the artifact c) Second scene, the visitor turning into a user by stepping onto the interface and d) third scene, the environment transforms into a scene from past times.

participants were informed about the study purpose and agreed to the data collection and processing according to the European General Data Protection Regulation [1]. We conducted a reflexive thematic analysis in each iteration according to Braun et al. [12] and Byrne [14]. This includes 1) familiarizing with the data, 2) the initial code generation, 3) the clustering into broader themes, 4) the revision of the themes, 5) the definition of the themes, and 6) the consolidation and reporting of the findings. One author conducted the steps 1 and 2. Two authors collaborated on the steps 3-6 each time.

3.1 Iteration I: Expert Interviews

We searched for experts working with urban development and architecture or directly with our target environment online (see further details in Table 1). In total, we interviewed five experts with an average of M=8.5 years of working experience (SD=5.24); three self-identified as male, and two as female.

3.1.1 Approach and Questions for the Expert Interviews. We developed an interview questionnaire with 14 questions, including three about their demographics (current occupation, tasks, and years of experience). We asked a mix of seven questions about the current and near-future role of historical cemeteries, including the meaning of our example cemetery for society: 1. How do you view the role of the cemetery for Munich's society? 2. As a cultural good, what values, knowledge, or experiences should a historical cemetery, like this particular cemetery in Munich, provide people with? 3. How has the role of the cemetery shifted over the past ten years? 4. Where do you think the role and meaning, for the public, of the cemetery, will shift in the next ten years? 5. What role do the architectural elements at the cemetery play from a socio-cultural perspective? 6. How is a younger audience attracted and encouraged to explore and learn more about the history of such places?, 7) How do you view the broad usage of historical cemeteries in today's society contrary to the initial reason for building a cemetery?

Additionally, we added three questions about the technology usage onsite: 1. What do you see as important considerations when designing for historical cemeteries? 2. What is your view on the usage of modern technologies in the scenery of historical public environments? 3. Do you see media and digital information as an appropriate design material for historical cemeteries?

We decided on near-future developments (ten years from today; May 2021) so that participants could personally relate potential changes to their experiences onsite. The interviews took about 30 minutes on average.

3.1.2 Results from Expert Interviews. Overall, this included three themes: *Technology*, *Role and Activities*, and *Atmosphere*.

Technology. Technology was seen as a potential design material with many opportunities, especially considering the possibility of communicating information to engage with visitors through embedded and interactive interfaces. However, experts also saw a certain contradiction in the technology's ephemeral character in comparison to the cemetery's timelessness; *"Technologies interfere with the everlasting rest that such places communicate due to the short lifespan of such"*; ExP2. Additionally, embedded technology could easily become intrusive when integrating, e.g., blinking elements. Experts agreed and emphasized designing unobtrusive technology that serves the main purpose of conveying information about the place to make it more accessible.

Role and Activities. The theme comprises the cemetery's public and cultural role, including its development in relation to its urban surroundings. Experts reported it as a place to reflect and relax as well as for jogging, as a tourist site, or for socializing with friends and families. They also criticized the diverse usage, i.e., *"Nevertheless it still is a cemetery, so you should not necessarily do picnics or let your dog loose"*; ExP4. On the contrary, they emphasized the cemetery's historical significance, which should be kept as its most prominent characteristic; *"I think that the old south cemetery is a treasure, so to say the memory of Munich"*; ExP5. Nonetheless, they admitted the more hectic urban surroundings greatly impact the purpose of visiting the cemetery nowadays, mainly for being a green oasis used for free-time activities. Another issue deriving from these concerns is visitors' little interest in and increasing ignorance of the place's historical significance and value for society and the neighborhood.

Meaningful Atmosphere. Lastly, the theme *Meaningful Atmosphere* contains the cemetery's architecture and its effect on visitors. The architectural history embodies the cemetery's values and atmosphere, which *"[...] makes it a unique place with a unique character"*; ExP5. All agreed that architecture is an important cultural good worth persevering and of high socio-cultural meaning for the individual and the society. Furthermore, they saw the benefit of its atmosphere to provide an access point for visitors to actively experience the history and envision past times and scenarios.

In Short. Experts saw the benefit in using embedded technologies as a design material to turn the cemetery into an accessible and informative place communicating its history and significance. However, challenges concern getting and directing visitors' attention and triggering their interest in learning about the place, particularly as it is mainly used for free time activities nowadays. Moreover, while it is a place to actively experience history, many activities interrupt its atmosphere and calmness and thus also distract from its meaning. Considering these findings, we prepared three diegetic artifacts for a follow-up design workshop to provoke change in the status quo and lead to novel interaction ideas.

3.2 Diegetic artifacts

We conceptualized three speculative design concepts in the form of diegetic artifacts. The artifacts were based on the expert interview findings, and we presented them in the form of sketches to participants as shown in Figure 2(a). Diegetic artifacts serve as discussion impulses [21], realized through, e.g., descriptive stories or visual renderings [57]. However, their technical feasibility is less important than leaving room for speculation through ambiguity [5, 13].

Step into my Shoes. This concept relates to the saying "to step into someone's shoes" and shows users information about past times related to the deceased person. It consists of a plate with imprinted footprints positioned in front of a grave that triggers a mixed reality experience on stepping (see Figure 1(a)). Users see themselves dressed in the clothes

Table 2. Workshop and semi-structured interview participants.

ID	Gender	Latest Cemetery Visit	Participated In
W1	Male	2 years ago	Workshop
W2	Female	<0.5 years ago	Workshop
W3	Female	1 year ago	Workshop
W4	Male	1 year ago	Workshop
Si1	Male	2 years ago	Semi-structured interviews
Si2	Female	<0.5 years ago	Semi-structured interviews
Si3	Female	<0.5 years ago	Semi-structured interviews
Si4	Female	1 year ago	Semi-structured interviews
Si5	Male	<0.5 years ago	Semi-structured interviews
Si6	Male	1 year ago	Semi-structured interviews

of the deceased. The concepts derive from the challenge to generate interest for the place's historicity and using the atmosphere for raising awareness. It, thus, aims at creating a direct connection between the user and the deceased to increase their awareness, interests, and respect toward the dead. Furthermore, by seeing themselves in the dead person's clothing, we aim for a certain level of discomfort to provoke stronger emotional reactions.

Walk together. This is a concept to regulate visitor behavior by tracking each person's movement speed and calculating the average speed across all visitors. As long as the average indicates a moderate behavior, the interface projects slowly moving leaves on the ground, supporting the place's atmosphere. Crossing a pre-defined threshold, the leaves start to move faster, communicating and encouraging users to lower their speed (see Figure 1(b)). This concept links to the critique of diverse, and partly non-respectful place usage. The interface passively and implicitly connects users by revealing the responsibility for and interdependence of each others' behavior and experience onsite. At the same time, it aims at provoking the social dynamics and individual behavior because it tracks and highlights non-compliant people.

Voices of a Cemetery. This conceptualizes the idea of interactive historical architecture in the form of memorizing walls and statues that share the cemetery's and the individual's history. It relates to the challenge of embedding technology into the place and raising awareness and interest for the history. As shown in Figure 1(c), we propose text output revealed through moving bricks or an Augmented Reality (AR) overlay. Additionally, a smart voice user interface embedded into the walls and statues talks to the users, responding to their questions and reading their stories aloud. As such, the cemetery turns into a living entity with a mind and personality of its own. It questions, among other aspects, what type of personality and how much autonomy such a place should be enabled for. Besides, by offering direct human interaction with the architecture, the architectural history receives more attention, which further increases the contextualization of the place's historical significance.

3.3   Iteration II: Online Design Workshops

The workshop aimed at discussing the concepts from a non-expert cemetery visitor's perspective to inspire new ideas. We recruited workshop and semi-structured interview participants via the university mailing list under the condition of having prior onsite experiences (see further details in Table 2).

3.3.1   Procedure and Tasks. We first introduced the participants to the topic and each other. Then, we showed them a 5 min. video recording from our target environment to facilitate remembering the place, its meaning on a personal level, and the activities conducted onsite. Afterwards, participants individually took notes on their personal experiences and

place relationship using Figma [25] before sharing them with the rest of the group. This followed a brainstorming activity in pairs. Participants received quotes from the expert interviews related to each identified theme (i.e., *"Architecture is tightly connected to the meaning and narrative of a cemetery."*; ExP4 or *"The first impression should not be connected to the daily life but should highlight the historical meaning and value of the place and enhance reflection without distraction."*; ExP5). The quotes served as inspiration for brainstorming own speculative ideas to turn the cemetery into a smart, interactive environment. The participants presented their ideas to each other. Lastly, we presented our speculative design artifacts in the form of pictures and a short written description, and discussed the concepts with the participants. The workshop took about 2.5 hours.

3.3.2   Results of the Workshop. We derived five themes from the thematic analysis: *Cemetery Atmosphere*, *Respectfulness*, *Technology to Communicate Information*, *Non-permanent Technology* and *Speculative Concepts*. The latter comprised the participants' and our speculative design ideas. We identified each theme in all four participants' statements.

Cemetery Atmosphere. The theme *Cemetery Atmosphere* aligns with the expert interviews' results regarding the importance of keeping the cemetery's historical and natural atmosphere. Furthermore, participants use the cemetery as a place for reflection, connection to nature and the dead, and escape from the hectic urban environment. Thus, the personal-emotional connection to the place and its socio-cultural role should be fostered and preserved in future scenarios.

Respectfulness. In this theme, death was seen as a continuing part of life independent of the age that needs to be respected and preserved. Interfaces *"[...] should remind the visitors that they are at a cemetery, even if you don't know anyone [...] that has a personal meaning to you."*; W1. Mobile phone usage, for example, would distract and interrupt participants in their moments of mindful reflection. Accordingly, the need for a place to honor, respect, and mourn the deceased will also remain in the near-future. Interfaces should, thus, support respectful visitor behavior.

Technology to Communicate Information. This theme identifies the information that should be embedded into the environment. Participants emphasized the need for valuable information that would extend already provided information and guide attention to, e.g., *"the surroundings and atmosphere of the place."*; W2. It reveals the need for spatial navigation and understanding of the connections between the different areas within the historical cemetery.

Non-permanent Technology. This theme summarizes the discussion around the transience of fast-moving technologies. Participants had two main concerns against installing permanent interfaces into the environment: 1) they, in comparison to its timeless surrounding, will out-date quickly, and 2) their decay might reduce the place's natural beauty (*"[...] they just out date and start to look bad."*; W2). Accordingly, interfaces should either be embedded only temporarily or in a way that their decay also adapts to the cemetery's beautiful atmosphere and nature.

Speculative Concepts. The concepts introduced by participants comprised a shape-shifting environment that rebuilds the surroundings to different epochs by, e.g., using holograms that show the decay of graves and the deceased or ghosts that act as cemetery guides. An additional suggestion was to *"strengthen the seasons, summer and winter at the cemetery since those strongly influence the perception and experience of the place."*; W3. For example, winter would be a more silent season, which an interface could enhance.

In comparison, participants appreciated our speculative concepts, overall. For *Walk together*, they found it a good strategy to separate place visitors by intention while fostering respectful behavior. As it could slow down cemetery visitors according to the local code of conduct, it might enhance reflections and increase awareness of one's surroundings.

They also did not think the idea too harsh but suggested to provoke even extremer effects. This could be achieved by leading people outside the cemetery to places according to their behavior, e.g., more suitable places for socializing than the cemetery. Another suggestion was to emphasize rule breakers by projecting circles around them, or adding, e.g., thunder noise for extreme rule breakers and to make use of public shaming.

Voices of a Cemetery received more critical feedback because it would require a careful balance of not turning it into a free-time attraction. However, W3 also assumed that it might become *"just normal in the future when humans have chips and lenses and all of that in their body, [...]. I wouldn't worry too much if this is really accepted or not in the future"*. Also, they saw potential in its entertaining character to extend the cemetery visitor groups and to communicate its historical significance in relation to contemporary situations. While W4 could imagine adding holograms of the deceased telling their stories, all other participants thought such digital representation of buried persons unethical and too extreme because they would lack consent by the dead.

Lastly, *Step into my Shoes* received positive responses from all participants. They appreciated the unobtrusive interaction possibility in combination with the additional information onsite. The only worry concerned potential misuse, e.g., children jumping up and down on the grave for fun because of the interface. They suggested adding a timer activating the interaction only after a couple of seconds to slow down the response time. Additionally, they could imagine making the user experience more immersive by adding contextualized noises or spatially distributed visualizations. In contrast, they did not have any concerns about "wearing" the clothing, mainly because it would only be a non-materialistic projection without the actual sensation of wearing or smelling the clothes.

In Short. Altogether, the workshop showed the expectations that the role and atmosphere of historical cemeteries would not change but sustain, similarly to death being a continuous part of life. Furthermore, participants used our target environment as a place contrasting to its urban surroundings due to its naturalness and calmness. They appreciated the potential behavior control and denunciation by a system like *Walk together* in cases when visitor behaviors interrupt this atmosphere. For the next step, we iterated on our concepts, considering their suggestions for improvement.

3.4 Iteration III: Semi-Structured Interviews

As the last step, we evaluated the iterated concepts that we turned from sketches into storyboards (see Figure 2) and strengthened the provocative interaction features. For this we added a red circle around rule breakers and noise to *Walk together*, visualized the conversation between user and wall in *Voices of a Cemetery* by reducing the entertainment character, and visualized a 360° immersive projection of former times for *Step into my Shoes*. We were interested in how participants could imagine embedding the concepts in their cemetery visits and how this would change their experiences. Each session took between 30-40 minutes.

3.4.1 Approach and Questions. We invited participants to a Zoom session in which they envisioned walking through the cemetery with the different concepts implemented. To facilitate their imagination, we prepared storyboards of each concept situated in context (exemplary shown in Figure 2, b-d). Additionally, we asked participants about features of the concepts and interaction consequences for the cemetery atmosphere and visual appearance, particularly considering the code of conduct at cemeteries. It includes: 1. In general, what do you think about the concept that was just presented to you? 2. What use does this concept have for cemetery visitors, in your opinion? 3. How would you expect the interaction to work? How would you imagine starting and ending the experience? 4. Do you think this concept is appropriate for a cemetery? Furthermore, we asked questions more specific for each concept.

Additionally, for *Walk Together*, we asked participants about 1. What would you do if you were the only one that noticed a "disturbing" person, and that person would not change their behavior? 2. Do you think that the technology itself suits a historical cemetery? 3. At cemeteries, there is usually a code of conduct. How do you see this concept influencing it? 4. What do you think about the red circle surrounding a fast-moving person?

For *Voices of a Cemetery*, we additionally asked: 1. Imagine a future where we can add an extra layer of reality to our field of view. Where would you say that this extra layer would fit in a cemetery? How would you design the hints, so they fit the appearance of a cemetery? 2. Which elements that are part of a cemetery would be suitable to use for the interactive storytelling as illustrated in the storyboard? 3. Which way would you like to interact with the diverse objects to explore the story of a cemetery? 4. Could you imagine that this technology can have other use cases than a cemetery?

Lastly, for *Step into my Shoes*, we aimed to know: 1. Are there any positive or negative opinions about this concept from your side? 2. How would you prevent a too playful usage of the installation? 3. Would you assume that you had to stay on the plate to stay within the experience? If not, how would you imagine leaving the experience? 4. Imagine that other passers-by could also see you wearing the outfit as viewers. What is your opinion regarding this?

3.4.2   Results. Focusing on the three concepts, we present the results structured by themes per artifact resulting in eight themes using the inductive approach presented above.

Step into my Shoes. This concept resulted in three themes: *Humor versus Appropriateness*, *History Experience* and *Interaction in Space*. The first theme picks up on the challenge of balancing user entertainment and avoiding creating a free-time attraction distracting from the cemetery or disrespecting the dead. Making the experience fun could attract new user groups and provide additional reasons to stay at the cemetery. At the same time, the interaction and the information need to pay respect to the code of conduct and the deceased. It includes how an interaction might appear for passers-by; *"[...] it might look weird to bystanders if they cannot see what you are seeing."*; Si5. The second theme, *History Experience*, comprises comments about the information conveyed through the artifact. Participants agreed that it would provide *"[...] a great way to experience the past and maybe connect to people buried in a new way."*; Si2. Lastly, the *Interaction in Space* theme describes how participants imagined their interactions and movements in space. Two participants would feel encouraged to continue walking, which requires a certain radius of free space around the installation. Another topic concerned the transition phase when stepping down, where participants suggested, e.g., a fading effect of the visualization (*"when you go out of it, the stuff you see fades away."*; Si1).

Walk together. This comprised three themes: *Dis-/regarding the Code of Conduct*, *Projection* and *Natural Materials*. The first theme concerned human behavior control and its consequences for violating the code of conduct. Contrary to the workshop participants, interviewees thought the newly added highlighting circle was effective yet too embarrassing: *"people don't really want to catch attention in public, especially not at a graveyard. I would say it is extreme but effective."*; Si2. Nonetheless, all participants saw the value in such an interface to passively regulate the visitor behavior and increase users' awareness of their surroundings. Another effect deriving from such a concept might be an increase in social encounters, either among passers-by talking about a highlighted user or between passers-by and highlighted users to stop them from running. The *Projection* theme clustered participants' critiques about using projections visible to all. Three participants were concerned that it would be too obtrusive and interruptive. The other three thought it was rather enriching for the environment and contributing to the atmosphere. In the *Natural Materials* theme, we grouped

suggestions and statements to adapt the interface's appearance to the natural surroundings by either using similar materials or camouflaging the outer surfaces.

Voices of a Cemetery. It comprised two themes: *Virtual Interaction Elements* and its *Suitability for Historical Cemeteries.* The first includes preferred interaction modalities and the representation of interactive content. For example, voice interfaces were considered weird in public but appreciated when being alone: *"If I am alone, I would like to talk to Alexa and Siri, but that is complicated when there are many people.";* Si4. They suggested a visual trail on the ground that participants could follow or allow for gesture or tangible interaction. Visual information should adapt to the user's proximity and emphasize interactivity while underlining the cemetery's atmosphere. In contrast, tangible interfaces could be *"any physical element that is not directly connected with a personality";* Si1. Nonetheless, four participants confirmed the concept to be engaging and interesting even for young users. In contrast, the *Suitability for Historical Cemeteries* theme reflects participants' opinions about mixed reality applications at historical cemeteries in the future. They expected such technologies to become ubiquitous and, thus, socially accepted across different urban environments. Further, participants thought it up to the individual person to decide whether they wanted to become an active user or stay a place visitor.

In Short. The interviewees were more cautious about publicly singling out visitors disregarding the code of conduct. Further, the concepts, particularly *Step into my shoes* and *Voices of a cemetery*, were well-imaginable to be turned into embedded interfaces at the target environment in the near-future. Based on our findings, we derived ten design recommendations presented in Table 3.

4 DISCUSSION

Below, we discuss the derived design recommendations (see Table 3) and how they support complying to contemporary and place preservation needs (**RQ1**) when designing for historical cemeteries. Furthermore, we reflect on our methodological approach with a particular focus on the speculative design methods and the concepts (**RQ2**) and complete the discussion with a short reflection on the meaning of our findings for cultural heritage sites in general.

4.1 Designing an Interactive Historical Cemetery

Interactive and embedded interfaces can increase the user awareness of a place [17]. Nonetheless, one of the challenges identified in prior work was that modern technologies might not be perceived as appropriate for the sensitive context [32]. However, thinking about near-future scenarios, our results showed that participants expected modern technologies to become ubiquitous and thus also accepted means for places such as historical cemeteries in the future. Our work resulted in ten design recommendations, two novel, eight in line with prior work within the HCI community on interactive cemeteries. We group the recommendations according to the common effect that should be achieved when applying them:

4.1.1 Apply Modern Technologies to Facilitate **Contextualization***.* Modern technologies allow adapting content to the surroundings or different (non-) user groups through applying unobtrusive design [38]. Furthermore, we see advantages in balancing proactive and passive triggers (R2) to guide users' attention toward particular places of interest, (R1) reveal hidden or inaccessible information [58], and (R3) increase users awareness toward their surroundings. In turn, increased awareness fosters contextualization of a place's historical significance and, thus, supports the place's preservation [39, 40].

Table 3. Design Recommendations for Interactive Historical Cemeteries: Eight align with findings in prior work, two are new. We group the recommendation according to the design goal that they would foster when applied.

Group		Design Recommendations	Description	Reference
Contextualization	R1	**Preserve through Modern Technology**	Modern technologies such as, e.g. VR and AR support revealing and communicating hidden information non-invasively and facilitate the learning about the place's significance.	e.g., [20]
	R2	**Embed Interfaces for User Engagement**	Embedded interfaces enable the place to proactively and spontaneously trigger onsite interactions independently from the user or any brought devices (such as, e.g. Step into my Shoes).	e.g., [16]
	R3	**Foster User Awareness**	Interfaces should engage people with the surroundings by slowing them down and guiding their attention towards certain cemetery characteristics to increase their awareness.	e.g.,[41]
Timelessness	R4	**Respect the Deceased**	Showing content from past ages related to the deceased was appreciated but should not personify any of the characters, e.g., by simulating interaction with the ghost of a deceased.	e.g., [31]
	R5	**Enhance the Place's Atmosphere**	Historical cemeteries represent timelessness and are appreciated for their peaceful and natural atmosphere, which should be enhanced and supported.	e.g., [37]
	R6	**Design for the Temporal Course**	Transience and decay are relevant themes in the context of historical cemeteries. Interfaces should adapt to this aging process or serve as temporary installations only.	new
Code of Conduct	R7	**Support Local Code of Conduct**	Historical cemeteries are sensitive design spaces where the user behavior should comply with the local code of conduct to achieve a more homogeneous experience among place users.	e.g., [8]
	R8	**Consider Passers-by Perspectives**	When deciding on the interaction modalities, the outside perspective of passers-by should be considered. For example, voice user interfaces, e.g., might be perceived strangely and give users an uncomfortable experience.	e.g.,[32]
	R9	**Balance the Entertainment Character**	Balance the level of entertainment to avoid turning cemeteries into amusement parks. Interfaces should support their role as a community place and a place to mourn and remember the deceased.	e.g., [26]
	R10	**Avoid Public Humiliation**	Acting against the local code of conduct disturbs other place users and should be regulated. However, the regulation should avoid public humiliation.	new

*4.1.2 Preserve The Place's **Timelessness**.* Our results show that historical cemeteries are, and will continue to be, valued and visited for their timelessness, tranquility and naturalness. Due to their timelessness and continuity, cemeteries reflect not only the past and present (as discussed, i.e., in [56]) but also open the door to future social realities. Embedded interfaces should (R6) adapt to the place's temporal course by accounting for potential decay already in the design

process and material choices. In line with prior work, they should (R5) maintain such place characteristics [16, 37]. This further includes (R4) keeping the connection to the deceased alive, and enabling their remembrance in a respectful manner and the rituals to honor them.

*4.1.3   Foster The **Code of Conduct**.* A historical cemetery's atmosphere and meaning are influenced by visitors' activities and behaviors [61]. This leads to the need to (R9) balance the entertainment character of interfaces to avoid turning the place into an amusement park. Similarly, as discussed in *Walk together*, misbehavior can be monitored by a system to (R7) make people comply with the local code of conduct. However, system reactions should (R10) avoid public humiliation by (R8) considering the passers-by perspective in the design process. This requires also a change to the level of how the place is monitored and by whom. We see potential in applying slow design, which promotes mindful and meaningful user interactions by providing more time to users in their interaction, fostering reflection and mental rest [30, 35].

4.2   Speculative Design Method and Concepts

The applied speculative design method generated new insights and discussion points around the historical cemetery design space. Our overall approach confirmed the design space's sensitivity and its important socio-cultural role within a community [16, 34]. By integrating the speculative design methods [5], our participants were enabled to reflect on the social dynamics and the cemetery's future role for their individual lives and the community. Each concept triggered critical reflections about either: the social dynamics and its control (Walk Together), balancing the entertainment level and consent from the dead about telling their stories (Step into My Shoes) or the autonomy and character of a historical place as a communication partner (Voices of a Cemetery). Integrating the speculative artifacts allowed us to trigger reflection concerning beyond the interaction or the cemetery. Accordingly, the diegetic artifacts supported our goals, enabling participants to envision future developments and interaction scenarios not only on an interaction but also on a societal level.

Regarding our approach, Mitchell Finnigan and Clear [57] and Stals et al. [68] conducted their studies onsite for the embodied experience of the built environment. We substituted the lack of onsite experience with videos and pictures from our target environment. We see differences in the onsite versus remote studies regarding participants' limited imagination of the place and of their interaction behavior. Onsite, it seems easier to speculate about future interaction scenarios and needs that are directly linked to certain environmental characteristics or realistic place usage procedures. In comparison, the remote workshop and interviews stimulated more abstract imaginations and insights resulting from the exclusion of the physical environment. This is a possibility for further methodological exploration in future studies.

4.3   Outlook For Smart Historical Cemeteries: Impact on Societal Level

Our results show that the preservation of historical cemeteries' significance can benefit from the rapid developments of smart, ubiquitous environments as long as interfaces comply with their code of conduct and are adapted to the places' atmosphere [4, 66]. The variety of contemporary place usage, for example for sport and socialization [37, 61], proves that we have already moved away from the sole purpose of mourning the deceased and remembering past times. Accordingly, there is a clear need to develop solutions now to preserve such places' historical significance in the future.

It requires the consideration of ethical limitations and socio-cultural changes by questioning what will be perceived as respectful behavior and what values are worth preserving. In our study, we identified a need for behavior regulation on site. This leads to the assumption that a certain level of supervision would be appreciated revealing the relevance to

reflect on our findings on a political level. This also questions to what extent, how, by whom and with what consequence the supervision could be implemented. For example, current research studies the effect of autonomous agents to support police work [52], also showing that users are less inclined to comply with punishments induced by robotic agents than by humans [44]. Other related issues link to data evaluation and processing to identify misbehavior, which are known challenges in the development of smart cities in general [18, 23]. However, within the scope of our work, we only want to raise awareness of these interlinked challenges between interaction design and societal and political inter-dependencies for follow-up work that aims to design smart historical cemeteries. Thus, designing to preserve historical cemeteries while complying with contemporary needs requires caution for the place's sensitivity and a thorough consideration of short- and long-term consequences on societal level.

4.4 Limitations

Our study focused on a single European historical cemetery, which does not represent all types of cemeteries or historical burial places. However, European historical cemeteries are also the ones mostly explored within the HCI community and challenged by the multi-purpose use. Another limitation derives from the participant sample, which did not represent all user types (e.g., joggers), and thus limits the findings to a certain user group perspective. Lastly, due to the pandemic, we conducted our study online only. Yet, considering our findings, we see advantages in the more abstract place integration instead of the embodied cognition approach in prior work.

5 CONCLUSION

We extend the design space of historical cemeteries with our work by integrating speculative design methods in an iterative approach. Envisioning near-future interaction scenarios, our results showed consistently throughout iteration the permanent, timeless character of historical cemeteries and the relevance of preserving this also in future urban developments. We identify ten design recommendations to support others in their design process, i.e., to embed solutions that support place users complying with the local code of conduct. Our discussion further outlines challenges and opportunities when turning a historical cemetery into a smart, interactive environment. In short, we see great potential for embedded interfaces to support their preservation and contextualization as long as they adapt to the place's sensitivity and code of conduct, and independent of the technological advances, the cemeteries' character should also be maintained in the future. However, integrating supportive technology to guard the character raises new challenges for future projects.

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