Crafting Critical Heritage Discourses into Interactive Exhibition Design

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Crafting Critical Heritage Discourses into Interactive Exhibition Design

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ABSTRACT
This paper argues how a more reflective design practice that embraces critical discourses can transform interactive exhibition design and therefore the museum visiting experience. Four framing arguments underpin our exhibition design making: the value of materiality, visiting as an aesthetic experience, challenging the authorized voice, and heritage as a process. These arguments were embodied through design, art and craft practice into one interactive exhibition at a house museum. We draw from our design process discussing the implications that adopting an approach informed by critical heritage debates has on exhibition design and suggest three sensitizing concepts (polyvocal narratives, dialogical interaction, interweaving time and space) bridging the practice of interactive exhibition design and critical heritage theory.

Author Keywords
Critical Heritage; Tangible Interaction; Craft Practice; Exhibition Design; Reflective Practice.

CSS Concepts
• **Human-centered computing~Human computer interaction (HCI)**; *HCI design and evaluation methods*; Field studies

INTRODUCTION
Theoretical research in Human Computer Interaction (HCI) has been found to have little impact on practitioners' ways of working as it is often seen as over prescriptive or too abstract [54][44]. More than new theories, designers often seek resources to support their decision-making processes and reflective practice [48]. They seek inspiration, the prompting of their creative response, and the expansion of their interpretative design thinking [54]. Interactive exhibition design and HCI-heritage work suffer from this theory-practice divide, with little reflection and discussion bridging heritage-based theory and practice-based work [47]. Much is known in museum studies about what makes a heritage visit memorable; the impact of technology; and the critical significance that cultural heritage holds in contemporary society. Still, Interaction (IX) Designers [53] see museums as willing to embrace new technological trends in ways that constrain design briefs in space and time thus limiting experimentation and reflection. More work is needed to bridge these two areas of study and practice.

In this paper, we draw from our Research-through-Design (RtD) process that places particular focus on the articulation of knowledge gained through the act of designing [52] and the creation of design exemplars that become the means for communicating insights to the HCI research and practice communities [63]. We explore theoretical potential and new ways of thinking about technology [19] in museum exhibitions; using design practice to frame conceptual arguments developed in heritage studies (particularly, critical heritage) that question and disrupt some acknowledged models of heritage display and interpretation. Our starting point was a broad analysis of contemporary heritage discourses, through which we identified four framing arguments that we find pivotal for IX Designers working across HCI-heritage: the value of materiality, visiting as an aesthetic experience, challenging the authorized voice, and heritage as a process. In our process of RtD centered on artistic and craft-based methods, these arguments around the meaning of heritage were translated into a multi-sensory interactive visiting experience for a house museum, the Bishops' House in Sheffield (UK). We articulate our theoretical and contextual understandings, and discuss implications for designing interactive exhibitions in house museums, a particular kind of lived historical heritage where past daily life is recreated. We then describe the interactive exhibition and share insights from its evaluation with visitors and volunteers, to show how such heritage framing arguments played out in the final design. Finally, we

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reflect on our research experience and propose three sensitizing concepts [46][5][6][41] to inspire other design researchers and practitioners in HCI and beyond.

THEORETICAL AND CONTEXTUAL FRAMINGS

We argue for the value of considering critical and disruptive discourses from heritage studies to develop a critical, situated and craft-based approach to interactive exhibition design. Four framing arguments from heritage studies can inspire the design of digitally-augmented experiences of heritage. In the following sections, we show how these four arguments resonate with our research context: house museums. This particular type of heritage site is ideal to explore these arguments through practice and to generate new opportunities for exhibition designers. We previously showed that whilst digital technology offers new opportunities to bring heritage to life [7], designers should arguably consider the immersive and atmospheric nature of particular house museums, and consider bespoke designs for the seamless and situated experience of technology [11]. We introduce the four arguments before describing how they were crafted into our design process. We do not claim to provide an exhaustive review of heritage study research; instead, as designers, we focus on points that helped us frame our critical understanding.

The Value of Materiality

Traditionally, museums are concerned with material cultures as their chief role is collecting and preserving artifacts for future generations, and to communicate what is known about those objects. The early museums were places where touching, holding and smelling were an integral part of the visit, a courtesy paid by the curator or the collection owner to their visitors or guests [13]. By the mid 19th century, however, the personal, physical relation with the objects was gone, mostly because of the widening of the audience and therefore the changing mission of museums as public institutions [13]. In the 20th century the object-information package that favors a visual, text-based approach, where you see the object and read about it, became the norm of museum displays [15]. This has widely produced information-led exhibitions where 'objects [are] seen as means to illustrate themes, ideas or stories rather than functioning as the primary carriers of information or creators of meaning within displays.' [60], p.144. However, visitors enjoy looking, touching, smelling and listening more than reading [17], and many scholars in museum studies today acknowledge the crucial role of materiality and embodiment to complement cognition with emotion, which is essential for our understanding, appreciation, imagination and creativity [25][15][60][33] [61].

House museums offer interesting settings to explore the value of materiality in a context where a visually-driven 'cabinets and labels' approach exhibition design is not deemed appropriate [59]. Visiting a house museum is different from visiting a traditional museum. House museums are 'sensory spaces' that are experienced 'through sensing first and through thinking about it second' [33], p.6: walking through Bishops' House (our design case, see Methodology section for details), visitors feel the steep stairs, uneven floors and irregular walls; they hear the creaking of old floorboards and smell the oak paneling; they see rooms arranged as in the 17th century and their original features. This type of house museums is described as 'living history museums' [33], combining cultural and historical narratives with material settings that preserve a version of a communal past. The domestic settings recreate a historic time period and show what a home could have been like back then [37]. Exhibition design in house museums goes beyond the curation and display of artifacts: the whole house is a historic object [33], meaning that content and container are one [62].

Technology has a role to play in sensory engagement, and tangible and multisensory interaction is entering the exhibition designers' toolbox. Examples are bespoke and standalone interactive pieces within an exhibition that engage visitors through audio-visual and tactile means: a homely-looking room with unusual objects to explore [18], a magic cauldron and a magic mirror to engage children [55], and manipulable replicas to trigger multimedia content [32]. Expanding on the sensorial experience, a 3D printed replica of a religious artifact augmented with smell and audio-visual content engaged participants in embodied meaning making although its lab evaluation is limited [22]. Such examples show the potential for tangible interaction [24] in support of a material-based, sensory engagement. Embedded technologies add to the designer's toolbox new ways for bringing content and objects together; as intertwined instead of juxtaposed (e.g. a museum panel next to objects [15]). In our case, designing for house museums challenged us to think of materiality beyond the traditional engagement with objects displayed in vitrines. Our work was site-specific: it responded to the sensory properties and evocative qualities of a particular space (a house, that house), and we used technology to augment the place and its content through a craft-based approach.

Visiting as an Aesthetic Experience

The physical engagement with museum objects provides visitors with powerful experiences as they understand and empathize in ways that textual interpretations might not support [15]. Far from being perceived as boring and tiring, museums are, for many visitors, 'restorative environments' that, with their unique aesthetics, capture imagination and facilitate recovery from mental fatigue [26] [35]. Such aesthetic experiences are chiefly about *being there*. The aesthetic experience is not the experience of beauty – for it can be pleasant or unpleasant; it is characterized by intense attention, extended cognitive engagement, and affective responses [31]. Empirical studies on visual [31], auditory [42] and haptic aesthetic experiences [57] [8] all converge in intertwining perception with embodied cognition. In the heritage context, the aesthetic experience is multisensorial and can provoke a visceral response (i.e. to paintings [25]

[57] or to living history [33]) that results in a feeling of connection at a deep, personal level [31][33]. It is in creating such connection that exhibition design has a role to play. The process of making an exhibition can be reformulated in terms of creating an aesthetic experience [4] where design facilitates the experiential by using the language of the arts with 'objects rich in meaning; stories that evoke emotions such as empathy; metaphorical play to forge new connections; design that melds space, light, image in one integrated experience' [4], p. 16. Discourses in heritage have encouraged a shift from object-centered to experience-centered [36] and more recently, embraced an immersive turn [27].

Houses are immersive and evocative spaces [2]. However, once turned into museums, they often shift 'from being woolly, sloppy and impressionistic, to being places that are systematic, objective, and professional' [59] p.35, thus losing some of their poetics. To bring their space to life, house museums have adopted alternative approaches from the arts: for example, commissioning artworks responding to their space and collection as a way to present visitors with new interpretations [30] [7]. While our work at Bishops' House was carefully designed to be sensitive to the place, it gently provoked visitors and stirred their imagination. Designing for house museums also challenged us to think of aesthetic experiences in terms of the whole visit instead of an engagement with an individual piece of work. Such a holistic and experiential approach to exhibition design has yet to reach HCI.

Challenging the Authorized Voice

Critical Heritage has emerged as a field of enquiry that challenges the 'authorized heritage discourse' approach – a long-established orientation to heritage as understood and interpreted via the expert's perspective, and tending to privilege the prestigious, universal and grand narratives [50]. Alternative discourses on the same heritage do exist, clustered around different communities (defined by geography, ethnicity, culture, belief, etc.) that call into question the concept of consensual heritage underpinning the authorized heritage discourse [50]. Besides new views on contested heritage, the seeking of alternative interpretations brought about greater visitors' participation including hands-on approaches in galleries to encourage a two-way dialogue between a museum and their visitors [49]. More recently, social media has been used to widen participation beyond those visiting in person, to include communities that may be excluded or marginalized [20]. Alternative approaches to exhibition design are moving away from a single authorized voice towards the presentation of multiple and contrasting voices, with technology used to facilitate more polyvocal experiences [1]. Practice-based examples of digitally-enhanced polyvocality include a locative media bespoke device that tells 'history from below': the stories of common people enjoying a pleasure garden in Victorian times, pickpockets included [40]. Another example is the interactive soundscape created for the remains of WWI trenches that used autobiographical material from soldiers and civilians to contrast the official voice of army officials [38]. A final example are smart replicas used to unlock the differing narratives of soldiers, civilians and officers around the occupation of The Hague during WWII [32].

In our work at the Bishops' House, we designed for more polyvocal experiences – something not yet explored in the context of house museums. Apart from interventions relying on screen-based devices [9][29][43], digital technology remains largely absent from house museums, which miss out on the potential benefits of interactive design to overlap multiple stories on the same space. This type of heritage site is indeed criticized for following an authorized heritage approach that limits interpretation to a single perspective or time, and presenting heritage in a linear manner often focused on one leading character [50] [59], rather than the many people who lived there over time, often across centuries [62][59]. The Tenement Museum in New York challenged this single perspective: visitors choose among multiple guided tours to step back into a specific time period and 'meet' the residents of that time. Digital technology can give voice to the many inhabitants of the house across the centuries, and enable visitors to explore them all.

Heritage as a Process

In its challenge of the status quo in heritage interpretation, critical heritage questions what constitutes cultural heritage and how it comes to be so. Nowadays cultural heritage is understood as going beyond the material to include intangible aspects of human culture such as craft knowledge, performance, and traditions. Museum collections now include oral histories and personal memories alongside official and institutionalized material. These changes impact the way a museum is conceptualized: from 'guardian of collections' to 'ambassador of cultural values and significance' via an endless reframing of the past in contemporary culture [58]. Plurality of values is important if heritage has to become an expression of social inclusion rather than a means to assimilate and dissimulate different, potentially dissenting voices [50]. By moving away from a single authorized discourse and opening up to multiple interpretations, cultural heritage thus becomes an active process where multiple stories are actively used, remade and negotiated by each visitor [50]. Visiting experiences are then personal constructs that are remade and recombined over time [16]. In such an open-ended context, visiting becomes a process of personal meaning-making, a form of negotiation with the past where objects help make stories more tangible [50]. The concept of heritage as a process that is actively constructed and recombined over time is particularly significant in the context of house museums where animators often dress up and enact characters to visitors: 'It is this sensory experience of an embodied performance of a lifestyle that constitutes the process, through which heritage is both encountered and constructed.' [33], p.6. Exhibition design in a house museum can find inspiration from such an embodied storytelling that weaves the narratives with

physical objects and social history, a game of performance and fiction within a specific physical space [33]. The visit as an embodied encounter with the past resonates with the critical view that heritage is not limited to the physical building but encompasses people's experiences and memories that are shared with others across time [50]. Staff and volunteers play an important role here, as they weave stories and place by sharing with visitors a mixture of facts, speculation and anecdotes about the lives of previous residents [11] [12]. The meaning of the surrounding heritage emerges from the visitor-docent interaction process: visitors are expected to take part in the dialogue, to question and deepen their interests. In comparison, digital technology is easily seen as dry, a distraction from the actual place and curators of house museums are reluctant to introduce it [11]. However, digital technology has the potential to encourage a more dialogical model of engagement when combined with participatory approaches to heritage making that can support such dialogue [1]. An example is the *Digital Natives* exhibition where the design team worked in collaboration with teenagers in a process of dialogic curation of digital technologies [51]. In our work, we focused our attention on museum volunteers – underestimated actors in heritage settings, who are vital to the survival of small museums like Bishops' House [23].

In summary, house museums are places that encompass both tangible and intangible heritage. They offer unique embodied experiences with objects and spaces and a dialogical yet tangible representation of past lifestyles. To interactive exhibition design, house museums offer an opportunity to combine objects with stories in a playful way centered on fictionalized realities and performance. We argue that these opportunities can be realized by bringing the four framing arguments holistically into design practice: recognizing the value of materiality, seeing visiting as an aesthetic experience, challenging the authorized voice through co-creation and understanding heritage as process. We now describe our craft-based approach embodying these sensitivities and the interactive exhibition resulting from it in order to show how we addressed such challenge in practice.

METHODOLOGY

We used RtD with a co-creation mind-set [45] that aligns with [3] to explore new ways of designing interactive exhibitions that were fueled by the aspiration and desires of museum volunteers. Our design process was focused on nurturing collective forms of creativity by bringing together the richness of our participants' contribution through design as discussed more in details in [10]. Next, we show how our theoretical and contextual understandings (outlined previously) were *translated* through the making of an interactive exhibition: 'Curious House: meet the characters who bring Bishops' House to life'. This exhibition featured a series of interactive tableaux, which were the outputs of our RtD process. Because of their aesthetic qualities and ability to support richer investigations in design research they are research products, not prototypes [34]: the aesthetic qualities and the skilled craft make the installations professional interventions, ideal to study tangible and embodied interaction in the field [28]. We provide a description of our site and design process to illustrate our critical, situated and craft-based approach to exhibition design.

The Bishops' House: A Community Heritage

Built c. 1500, Bishops' House is a surviving example of Tudor timber frame building. A two-story building, the House was inhabited for over 500 years until 1974, and then turned into a museum and restored back to its 17th century structure. In 2010, it was saved from closure through the efforts of a group of local volunteers that nowadays still manage and keep the place open at weekends. Today, visitors find some period room displays (e.g. a dining room, a bedroom), some display cases with objects connected to the house (e.g. pottery, shoes), and a few hands-on activities about Tudor history. The volunteers act as gatekeepers and storytellers of the many stories, anecdotes and broader narratives of the House. Visitors are mostly schools, Sheffield residents and tourists. The House is now a reference point for the local community who is emotionally attached to the place. Despite the volunteers' wish to communicate more about the house, the visiting experience suffered from a 'museumization' approach: past life displayed as if frozen in time and with interpretation limited to a single and linear perspective [50] [59].

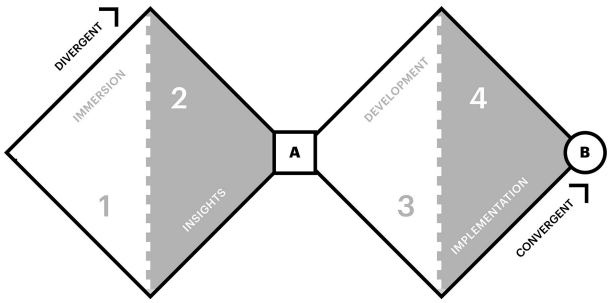

Figure 1. The four phases of our RtD process. Phases 1 & 2 build knowledge in and out of the field. Phases 3 & 4 use that knowledge to design the final exhibition featuring the Interactive Tableaux (B). 'A' marks a physical representation of 'intermediate knowledge' with Containers of Stories [12]

Taking critical discourses into an interactive exhibition

Our RtD process was organized into four phases (Figure 1), which we briefly summarize to ground the final exhibition within the wider research process. A more detailed description of the Interactive Tableaux is then provided to show how the four framing arguments were translated in the interactive exhibition.

(1) Immersion Phase - The first author, an exhibition designer, conducted ethnographic research and co-creation activities with the volunteers as a means of discovering and getting inspired - an approach used in previous HCI research such as [12]. This phase was about opening up the design space by gaining first-hand experience and by inviting the volunteers to share their personal interpretation through

creative and hands-on engagement. Through completing a set of design probes, ten volunteers reflected on their experience of being at the House and voiced their multiple and contrasting interests and feelings about the place: e.g. what type of exhibitions they wished to have, the artifacts and stories they liked the best [12]. Making the probes was also a reflexive and sensitizing exercise for the designer, a way to synthesize some of the material and experiential features observed during fieldwork whilst gathering others' experience in a form that provided inspirational insights for exhibition design. From the start, we included multiple perspectives, and how to bring these together through co-creating the interactive exhibition with the volunteers became an important focus.

(2) Insights Phase - We were motivated by the need to test our theoretical and contextual understandings (outlined previously) into practice. Inspired by the way house museums commission site-specific work from artists to present visitors with new interpretations of their sites, we organized a two-week exhibition at Bishops' House [12]. We invited three artists to response to the place by creating work that explored the more recent history of the house: a series of large hand-drawn 1960s wallpaper panels that were overlapped onto the centuries-old timber frame walls [39]; a sound installation playing childhood memories of a woman who lived in the house in the 1970s before it was turned into a museum [56], and new interpretation boards that temporary replaced the museum panels with a dialogue between imagined residents from different eras.

Figure 2. Insights Phase: Containers of Stories (2016).

Alongside these, we exhibited Containers of Stories: four interactive cabinets (Figure 2), each containing one volunteer's miniature exhibition in a drawer. The cabinets were the result of a co-creation workshop with four volunteers who recorded their own story about previous inhabitants at the house (e.g. a woman living in Tudor times and the difficulties of keeping the house tidy back then, a young girl who tells about her memories of celebrating Mayday at the house). Volunteers selected or created bespoke objects to place inside their drawers, which were then augmented with the stories (via NFC tags): audio recordings played when visitors placed an object on top of each cabinet. This first exhibition served as a means of synthesis (Figure 1, A) where we tested insights through practice. The cabinets were evaluated with 15 groups of visitors and findings [12] showed the impact of designing for tangible interaction [24] to promote emotional and personal engagement with the House. The exhibition also served as a method of exploration: it brought to the fore the importance of communicating the stories of the many people who lived in the House, how their lives might have resonated with the local history, and how the House might have felt like as a home back then.

(3) Development Phase - Informed and inspired by the two previous phases, the first author designed a number of bespoke creative tools to engage a larger group of volunteers in the making of a final exhibition that was more extended and refined. The co-creation process took place over six months and included 20 volunteers who took part in four co-creation workshops and three focus groups. The aim was to enable the volunteers to appropriate and re-think the interpretation of the House [10]. The creative methods allowed the group to explore multiple forms of engagement and to generate provocative content designed to question visitors and make them look at the place with new eyes. The first author had a pivotal role: by volunteering weekly herself at the museum she was constantly immersed in the context of the research (the House and the volunteers) and its ethos. The interactive exhibition design process took place in the university design studio where the collaboration with the volunteers was digested and documented via design synthesis [10]: design-based methods (e.g. architectural scale models, mood boards) were used to bring the richness of volunteers' aspirations and contributions together. In other words, the fieldwork was taken into the studio to feed new concepts that were then critiqued, abandoned, fused, refined and consolidated to formulate new questions for the volunteers to respond back at the next session. The design synthesis materialized the understanding and sense making of the creative activities for the next workshop. Through this iterative process of inspiration (in the workshops) and reflection (in the studio), the concept of the Interactive Tableaux (detailed in the next section) emerged as a dialogue between the past of the House across five centuries, represented by five imaginary characters, and the present, represented by the visitors and the volunteers.

4) Implementation phase – The five Interactive Tableaux were presented as part of a two-month exhibition (Figure 1, B). During the evaluation, we worked closely with the volunteers who collected 120 post-visit questionnaires. We also conducted observations and recorded 577 interactive sessions logs. In this paper, we use findings from the questionnaires to show the impact of the tableaux on the visitor experience. Next, we describe the tableaux and how the conceptual arguments were translated into their design.

THE INTERACTIVE TABLEAUX

The interactive installation featured five free-standing tableaux that were placed in different rooms on the two floors

of Bishops' House. Each tableau was designed as a miniature theatre set of a domestic scene, a possible view of the House in that century, as if the character lived in it (Figure 3, top). For example, Anne's tableau portrayed a family room from the 1970s with a TV set, while Tom's featured a bedroom shared with domestic animals (a mechanical cockerel) as it was common in the 17th century (Figure 3, middle). Mistress Mary's 16th century tableau included some of the original features in the House from that period. The characters were not represented inside the tableaux, although their name and period were engraved in the frame. They had just stepped out, but came back as if brought to life with their stories when an NFC-augmented object was presented to them.

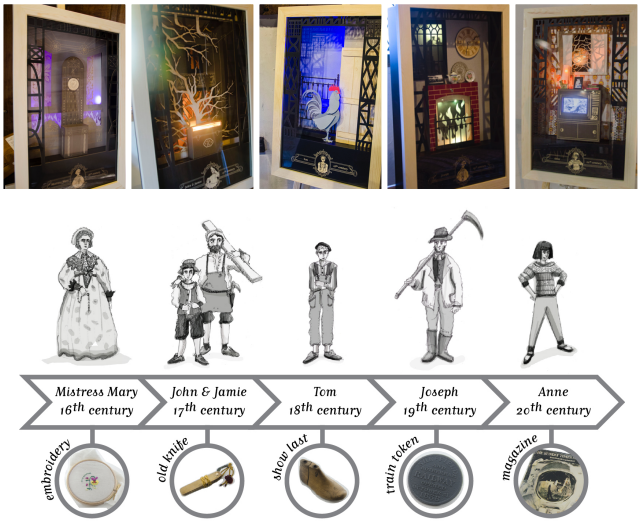

Figure 3. The tableaux and their corresponding characters, their associated century and their object.

We used embedded technology to provide visitors with interaction via tangible manipulation [24], where objects functioned as tangible keys to unlock content from the tableaux. The five NFC-augmented objects were displayed at the reception desk where the volunteers introduced visitors to the tableaux and invited them to choose an object for their visit (Figure 4, top). The objects were associated with their owners (e.g. 'Mary's embroidery', 'Anne's Magazine', Figure 3, bottom): five imaginary characters inspired by history represented a century of the House, from when it was built in the 16th century to when it was last inhabited in 1970s (Figure 3, middle). In essence, each object signified a century: the embroidery represented Mary's narrative from the 16th century, while the 20th century was captured by The Times magazine, which was associated with Anne's memory of living in the house during the 1970s and watching the Moon landing on TV.

The particularity of the installation is that visitors would choose an object that belonged to a period (e.g. Anne's 1960s magazine), but use that object at all stations to provoke different responses from the characters. Depending on which tableaux they went to see, they heard different perspectives on the object: Mary from the 16th century would be scared by Anne's magazine and the astronaut on its cover, while Anne would recall her memory of watching the Moon landing on TV in the living room with her family. Visitors kept their object whilst walking through the house and this allowed us to explore the value of material encounters to encourage meaning making and emotional responses during the visit.

Figure 4. (Top) A visitor choosing the embroidery for her visit. The NFC is in the tag that has minimal instruction of use. (Left) Joseph's tableau and its NFC reading stand. (Right) A family visiting Mistress Mary with 2 different objects: the father holds the knife, the daughter holds the embroidery.

The tableaux were fully handmade, and their visual design was grounded in artistic and craft-based methods. Techniques from theatre design were used to give visual depth by working each scene in layers: the façade of the House, the interior view and the background-outside scene. We used mood boards and archive images to inspire the miniature interiors. Interesting features described by the volunteers during co-creation workshops were magnified (e.g. scaled up, engraved) and featured in each set. The tableaux were made to be bespoke for Bishops' House and to draw visitors to meaningful details around the place. We thought of the tableaux in terms of aesthetic experience that explored the multisensory qualities of the place; the changes of light throughout the day and the crackling fire, which would have been significant for lighting the rooms in the past whilst keeping people warm; the floral smells of lavender bags displayed all around the place, and the various noises from both inside (e.g. creaking floorboards) and outside (e.g. a train in the distant valley). All of these features were crafted in the experience of the tableaux. The light became an important element with colors and behaviors changing (i.e. pulsating or still): depending on characters' reactions to being presented with an object, the light was used to intensify the ambiance and feeling portrayed by the characters. We used sounds such as crackling fire, snoring, or clicking of cutlery on plates that were evocative of a lived-in home. Each

tableau had also a specific feature activated when the visitors interacted with it: flickering a light, playing a video, activating a mechanical movement (e.g. a moving cockerel, see Figure 3, middle tableau), releasing smell as Mary's tableaux featured a scented oil digital diffuser (controlled via a Raspberry pi) to release a floral scent when particular snippets of content were triggered.

During the Development Phase (Figure 1, phase 3), the characters, their personalities and their narratives were developed over several workshops with the volunteers. The characters were very unique to the house and embodied volunteers' knowledge, aspirations, interests and personal memories of a particular era (e.g. moon landing). For instance, they wanted visitors to be challenged and curious about the place. This translated in each tableau/character reacting in a different way when it was presented with an object. We used technology to enable the coexistence of the characters' multiple perspectives and their contrasting voices. By 'showing' the objects to the tableaux (by scanning the object's tag on the stand, see Figure 4), visitors triggered different reactions from characters who were at times talkative (i.e. when shown objects from their own time), or annoyed (i.e. sending visitors away to check something for them), and even confused (i.e. with objects from other times). What a character would say and how they would behave was an integral part of the creative interaction design process. For example, Joseph was cheeky and he would make fun of visitors by going to sleep and snoring loudly when he had enough of them (the snoring sound would play from each subsequent interaction), whilst Mary would send visitors to Anne to seek more information about the magazine. We put our effort in crafting a coherent yet surprising experience where the characters were not thought of in isolation but in relation to each other and to the place. In fact, the tableaux, the objects and the voices of the characters were designed as an ensemble and emplaced experience.

Finally, we thought of heritage as an active process: as something actively constructed rather than viewed as static. We developed the interactive experience to encourage an active exploration of the place. With their chosen object, visitors could come back to see the characters a second, third and even a fourth time for additional stories and reactions. Visitors who followed characters' suggestions were rewarded by carefully prepared acknowledgments of their actions (e.g. Anne played her favorite song, and the cockerel started to move only the second time people visited its tableau).

EVALUATION INSIGHTS

We now turn to the insights from evaluating the visitors' interaction with the Tableaux and discuss the findings in relation to our four framing arguments. Questionnaires were distributed at the end of the visit by volunteers and filled in anonymously by visitors who were prompted to give feedback on: their favorite character(s) (if any) and why they liked them; if the objects reminded them of anything; to rate and describe their experience, and to say if they would consider coming back to the house to meet more characters and hear new stories. The 120 visitors who took part were a mix of 'locals' who regularly stop by on their way to the adjacent park and 'one-off' visitors including tourists visiting Sheffield for the day. We use quotes from the questionnaires (indicating visitors' number, e.g. v1) to support our arguments. Only the findings relevant to this paper are reported; a thorough discussion is in [11].

The Value of Materiality

The installation was multisensorial: the tableaux were visually very rich and played stories and noises activated by the digitally-augmented objects. The objects were very tactile: the embroidery and the knife were handmade by two volunteers whilst the train token was 3D scanned, scaled up and printed for people to hold it and feel the enlarged embossed text (see object in Figure 3, bottom). The tangible qualities of each object were carefully thought through: their size to fit one's hand (i.e. the token was scaled up while the magazine was scaled down); their weight (i.e. light enough to be easily carried around but heavy enough to convey a sense of substance and reality); their shapes and texture (i.e. the smoothness of the shoe last). Considering these material features as part of the design enhanced people's experience as one visitor described when holding Tom's shoe last: '*I really enjoyed holding it and the feel of the smoothness as I walked around*' (v34).

The multisensory interaction included smell, light, audio-visual and movement. With certain content, Mary's tableau released lavender scent into the air. The evocative qualities of smell were appreciated by visitors who described how '*the smell made the rooms seem more lived in*' (v33). Noises were used as a means to indicate that the character had left or was busy, and subtly invited visitors to move on when the content was exhausted. Beyond sound, we used other features such as changing lights, moving parts and playing videos on a TV set (Figure 3, right), which contributed to engage visitors with stories. This approach brought heritage to life and engaged visitors with stories in ways that text-based interpretations would not: '*Very engaging! I liked it a lot. Much better than reading static text and just looking at the objects'* (v28).

The theatrical quality of the tableaux with their visual richness added a lot of '*texture'* and '*3D impressions*', which captured attention: '*so much delightful details that drew me in'* (v47). In fact, the tableaux were considered as '*exquisitely crafted'* (v96) and '*works of art in their own right'* (v71), with the design bringing everything together in one integrated experience: '*the smells, movements and sounds coming together from the interactive – Super'* (v32).

Visiting as an Aesthetic Experience

Tangible interaction allowed us to design for a seamless experience of technology that was aesthetically engaging and bespoke to the particular setting of Bishops' House. It was

surprising for visitors: '*the technology is invisible, creating the feeling of history using technology'* (v108). Using embedded technology enabled us to focus the visitor experience on 'being there' rather than on the infrastructure used to augment the visit i.e. '*it makes you feel like you are really there'* (v11). Because of the high level of finish with detailed and intricate designs, visitors felt immersed in the tableaux '*like a look into the past'* (v82), which were '*very life-like'* (v69), giving a '*great, authentic atmosphere to the house'* (v42). Here we want to emphasize craftsmanship as an integral part of designing for an aesthetic experience in house museums. All our design choices made the experience unique and bespoke to the place. Visitors talked about the tableaux using the language of the arts to describe an aesthetic experience: '*Not sure of what I learnt but certainly had an enjoyable + emotional experience'* (v93).

Each tableau was displayed in a specific room that was represented within the tableau itself; the stories a character tells were designed to bring the visitors' attention to the place: 'Did you see the floral ornaments? Look up in the Parlor of Bishops' House! Two beautiful flowers are part of the decorative plaster…' (Mary, character). The design of the tableaux invited visitors' engagement with the room by featuring architectural details in each set (e.g. engraved). One instance is the 'witches' marks' on the door: volunteers often point to these hand-carved marks that are difficult to see, and use a drawing of the back door to show where to look for the witches' marks. The door became a key feature of Tom's tableaux as he lived in a time when witches' marks used to scare the evil spirits away was common. Such details were subtle but magnified elements in the House that volunteers discovered or considered significant and worth talking about.

The installation was designed holistically as the characters and their objects, their mood and stories as well as the rooms in which the tableaux would be displayed were all considered at the same time. This created a visiting experience that engaged visitors with all their senses (appreciating the intricate details of the tableaux, the stories and humorous noises, the tactile objects), that make them use their bodies (following the suggestions of the characters and visit other tableaux, looking at the room), and their imagination (responding to the question characters would pose, thinking about life in the past). In essence, we orchestrated the digital augmentation of the House to take visitors simultaneously back to the many pasts of the house and to provide them with different perspectives. This expanded visitors' understanding: *'this gave me a better understanding of its history than just reading text panels'* (v6). We used visual, auditory and material means to stir visitors' imagination: '*I was able to imagine the rooms with other people living in'* (v33), '*Interesting, made you really imagine what life was like'* (v46). Designing for an aesthetic experience contributed to make the visit more engaging: '*I think this type of interaction is necessary for viewers to be interested and drawn into the museum objects'* (v59).

Challenging the Authorized Voice

We used digital augmentation for providing a polyvocal discourse that was representative of the House history: '*nice to have history experiences alive through the voices of other rather than a dry written description'* (v7). Furthermore, stories were told from the perspectives of ordinary people. Visitors said they '*could see the house through the eyes of the characters'* (v6), from the perspective of people who represented different status (middle class, working class, young and older, see Figure 3). The experience was '*very life-like'* (v69) and '*more human'* (v74). Indeed, visitors also enjoyed the characters for their human qualities and temperament: '*Mary had a dry sense of humor!'* (v84); '*Tom seemed like a nice Sheffield lad'* (v27). Characters were also described as '*inquisitive and cheeky'* (v109); '*interesting and accessible'* (v92); '*thought-provoking'* (v80), with '*a range of voices and accents'* (v68), which gave visitors '*a real sense of all the different people who [might] have lived here'* (v82). In this way, visitors '*gained a broader perspective of life across various centuries'* (v61). Indeed, using characters from different times simultaneously '*demonstrated the total age and use of the house'* (v102). Visitors were able to '*sense generations of people living within these walls'* (v71). The human traits embodied by the characters spread to the place: '[the characters] *made the house come alive, added personality to the objects on display as well as the spaces within the house'* (v60).

Telling stories about, for and by common people encouraged an emotional and personal experience of heritage*: 'They [the characters] definitely triggered memories and ideas. Really personal interaction'* (v93). Visitors liked some characters more than others because they could identify with them: '*I liked Anne best because she had a history so close I can relate to it as if it were one of my parents talking'* (v74). Overall, the visiting experience was appreciated by both one-off and returning visitors, showing the potential for repeated visits: '*although I have visited often, I was encouraged to look with new eyes and if I come again I hope to find out more'* (v52).

Heritage as a Process

Through co-creation with the volunteers, the social history of the house was collectively re-imagined. The narratives and characters were partly invented, partly inspired by the volunteers' knowledge on and experience of being at the House. Visitors described how the Interactive Tableaux brought the house to life: '*The exhibition gives life to the house through the voices of characters who might have lived there in different times'* (v6). The installation challenged the linear visiting experience. The characters invited visitors to move around, up and down stairs, and to come back later to listen to more content and visitors followed the characters' suggestions: '*I love how you needed to keep re-visiting them to build up the story'* (v24); '*having to look around the rooms and then go back to the installation once you'd found what they* [the characters] *were speaking about for more info'* (v90). Visitors described their experience as '*exploring and*

discovering the stories' (v31). This was facilitated by technology giving the illusion of an ongoing conversation, as if the characters were talking to visitors and to each other. Critical to this was how we 'crafted content' to resemble a real conversation (see details in [11]): '*I really liked the way they had conversations together. Felt like you were part of the conversation'* (v93). Our attention to the interaction challenged people's expectation of technology: *'it did not say the same thing again and again like you usually expect with computer-programmed objects'* (v92). Content was progressive from general to more specific, increasing visitors' curiosity and motivation to come back to hear more from the characters: '*it was somehow addictive – we wanted to make them talk again and again, and we went around a second time with a second object'* (v84).

Visiting, then, became an active and continuous process of meaning making through time and space, which was not limited to Bishops' House: '*I enjoyed the linkages with other things going on in Sheffield at the time'* (v60). Evocative and thought-provoking content encouraged the visitors' sense making and challenged it by not giving fixed 'answers' but prompts for further understandings. Characters pointed towards details in the tableaux that were significant features of the house. For instance, visitors were prompted to look through both windows: one in Joseph's tableau where one could see the smoke of the factories as it was in Joseph's time, and one in the House from which visitors could see the city today: '[I learned] *that you could see the smoke from the iron works from the window. I even tried to see it before realizing it was no longer there'* (v32). This comment captures how the tableaux created an embodied experience of the heritage across time. The embodied experience of the place was designed within the conversation that the different characters had with each other, the visitors and the volunteers, illustrating the idea that heritage is a continuous and dialogical process of understanding and reflection. For example, when presented with objects of another time a character would send the visitor to talk to the 'people of the 21th century' or to the character of the 'right' century. Past and present became intertwined through juxtaposition and gentle provocation.

DISCUSSION

By articulating our RtD approach in relation to four framing arguments from heritage-based theory, we contribute to current work linking heritage-based theory and HCI practice-based work [47]. The process we followed showed how our four arguments 'trickled-down' [21] into our design. The responses of visitors collected in the evaluation of the Tableaux showed the value of considering a more critical and questioning approach to exhibition design. Stepping back and reflecting on our experience, we see that practice and heritage-based theory can mutually inform and challenge each other. After theory has 'trickled-down' to practice, it is now the turn for practice to 'bubble-up' empirical insights and challenge theoretical assumptions [21]. We outline three sensitizing concepts to synthesize our research and provide designers in HCI and beyond with directions along which to look [6]. Each concept is underpinned by our four arguments and raised further consideration for designing digitally-augmented exhibition in museums.

Polyvocal Narratives

House museums have more than one story to tell [62] [59]: by designing for polyvocal narratives, exhibition designers can create experiences of heritage that are more inclusive and representative of the site and its community. In our work, technology played an important role in facilitating the telling of multiple interpretations through multiple voices. But we found it critical to place our efforts on how the different voices coexisted in a place and resonated with each other. We addressed this through design practice by carefully creating the tableaux as an ensemble, their physical appearances as well as the narratives. The crafting of the narratives was key to create a sense of a place inhabited by multiple voices and histories: the characters were not thought of in isolation but in relation to the many different people that inhabited the same place (the characters, volunteers and visitors). They referred to each other and offered multiple perspectives on the house, which were at times complementary and in some cases contradictory offering contrasting viewpoints that pushed visitors to make their own critical judgement. In our work, we combined polyvocality with co-creation to include under-represented actors in heritage making such as minority communities or museum volunteers [23]. We built upon volunteers-visitors interaction that is so particular to house museums. This concept played out through the characters' personalities, moods and beliefs *which reflected what the individual members of our group were interested in* (Peter, volunteer). Volunteers' voices were included in our design, and magnified through the co-creation of the interactive exhibition in which individuals' aspirations and contributions were valorized. They described this process as *a joint effort*, which in turn strengthened the resilience of the community.

Here we propose two implications when designing for polyvocal narratives of heritage: first, for IX Designers to focus on the orchestration of the different voices and to envision them as an ensemble rather than isolated entities. Secondly, our work demonstrated the value of including volunteers in the exhibition design process to present an alternative interpretation of the place. Bringing volunteers and heritage communities into the design process presents practitioners with the challenge to bring multiple voices together and we suggest to place efforts on nurturing such process to be truly inclusive and representative.

Dialogical Interaction

Interaction in house museums takes place mainly on a human level e.g. via talking with volunteers or guides who share insights about the place. This is critical when designing digitally-augmented exhibition as technology should not distract visitors by taking them away from the actual place

(looking down at a screen). In our case, we designed for tangible interaction where technology was embedded in objects. However, it was not enough to design for a seamless experience of technology. The five characters in the Tableaux (Figure 3) were to act as facilitators of dialogic interactions. Visitors described their experience as having a conversation with previous residents who pushed them to explore the place more. We used material and sensory means to scaffold this conversation in evocative and embodied ways that promoted extended interactions focused on the sensorial experience of *being there*. Holding an object in their hand, throughout their visit, and using it to prompt characters to speak gave visitors agency to initiate a dialogue; the character then may have referred to the object in the visitor's hand or to decorations in the room or the world outside pushing the visitors to become more curious of what was around them. Speculation and ambiguity were used as a resource for encouraging inquisitive use [14]: things were not delivered all at once but revealed progressively to arouse curiosity and extend engagement with this dialogue. If visitors came back to the same character they were rewarded by carefully prepared acknowledgments of this action. This interaction strategy required us to create a large amount of content with many narrative strands designed for the many possible interactions, e.g. a character being presented with the same object many times, this for every one of the 5 objects (a total of 80 snippets of content). As such the system was ready for visitors who made the most of their visit by coming back to characters to listen to all remaining content and a lot of them did as we showed in [11]. However, visitors feedback shows that they did not have to listen to everything to feel fulfilled. Our design encouraged open-ended, dialogical interaction that satisfied both repeated and one-off visits.

We encourage IX Designers to consider dialogical interactions for developing more interactive, open-ended and extended engagement with heritage. Efforts should be placed on designing a system that fulfil both long and short-term engagement, and invite visitors in a process of personal exploration and discovery, which has the potential to foster an active process where stories are actively used, remade and negotiated by people [50].

The Interweaving of Time and Space.

Particular to house museums is their temporality, but spatial constraints and curatorial choice tend to limit the visiting experience to one particular era [59]. This was illustrated with the Bishops' House, where the building was restored back to how it was in 1500s with interpretation focused on Tudor history. Revealing the temporal dimension of the House became a focus for the final exhibition where digital augmentation was used as an overlapping tool to simultaneously provide visitors with different perspectives on the place, taking them back in multiple times, from Tudor to modern. The exhibition presented the House beyond an individual era for visitors to become aware of both its depth (how old it was) and breadth (the many connections of the House with the City). Insights from evaluation showed that visitors became aware of 'the total age' of the House and of its complexity. Throughout our critical, situated and craft-based approach, we thought about temporality in relation to place. Thinking and acting in place were useful methods to encourage our exploration. Spending time on site was also helpful to develop our sensitivity to the site and its particular atmosphere.

There is a real potential for designing interactive exhibitions that consider time and space together to create emplaced experiences of heritage. Exhibition designers should not only consider one aspect (e.g. time) of experience but instead, think about temporalities in relation to the place. Then, they should also think beyond the actual museum for the experience to be situated within a broader context. Here we highlight an opportunity for exploring both the depth (temporal layers) and breadth of the site (the space within it sits e.g. land, city) and suggest to weave both dimensions into the experience through designing digitally-augmented exhibitions. Finally, there is a potential to challenge linearity and mono-logic narratives by considering the performativity and spatiality of the experience as demonstrated with the Interactive Tableaux.

CONCLUSION

By articulating herein our RtD process in relation to heritage-based theory, we make an original contribution to a discourse in HCI that has been arguably under-explored to date from a practice-based perspective [47]. We have presented four arguments from heritage discourses that we found relevant for designing and reflecting on digitally-augmented exhibitions. We discussed *the value of materiality*, *visiting as an aesthetic experience*, *challenging the authorized voice* and *heritage as a process* and showed how these informed the design of a multisensory visiting experience at the Bishops' House. Insights from the visitor evaluation demonstrated the value of translating these critical discourses into our design. By taking a critical, situated and craft-based approach to designing an interactive exhibition, we turned spatial and aesthetic constraints into opportunities for creating polyvocal, dialogical and spatio-temporal experiences of heritage. We contributed by sharing three sensitizing concepts to provide more design-oriented resources for exhibition designers and other practitioners working across HCI-heritage fields. The concepts synthesize our reflection, which was empirically evidenced. We believe that while technology provides us with the means to design interactive experiences, it is critical for practitioners to place their attention on how IX is crafted and orchestrated in relation to the place and how the experience created resonates with the community and its broader context.

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REFERENCES

[1] Gabi Arrigoni and Areti Galani. 2019. Digitally enhanced polyvocality and reflective spaces: challenges in sustaining dialogue in museums through digital technologies. In Areti Galani, Rhiannon Mason, and Gabi Arrigoni (Eds.) *European Heritage, Dialogue and Digital Practices*, 37-61. Routledge.

[2] Gaston Bachelard. *The Poetics of Space*. Penguin Classics, 2014.

[3] Shaowen Bardzell, and Jeffrey Bardzell. 2011. Towards a feminist HCI methodology: social science, feminism, and HCI. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, New York, NY, USA, 675-684. DOI: https://doi.org/10.1145/1978942.1979041

[4] Leslie Bedford. 2014. *The Art of Museum Exhibitions-How Story and Imagination Create Aesthetic Experiences*. Routledge.

[5] Steve Benford, Gabriella Giannachi, Boriana Koleva, and Tom Rodden. 2009. From interaction to trajectories: designing coherent journeys through user experiences. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '09)*. ACM, New York, NY, USA, 709-718. DOI: https://doi.org/10.1145/1518701.1518812

[6] Glenn A. Bowen. 2006. Grounded theory and sensitizing concepts. *International journal of qualitative methods,* 5, 3. 12-23. https://doi.org/10.1177/160940690600500304

[7] Caroline Bugler. 2015. Making History: Caroline Bugler investigates the historic houses making moves to reinvent themselves and attract new visitors (October 2015). *Museum Association Journal*, 115, 11, 21–25.

[8] Claus-Christian Carbon and Martina Jakesch. 2013. A Model for Haptic Aesthetic Processing and Its Implications for Design. In *Proceedings of the IEEE*. 101, 9. 2123-2133. https://doi.org/10.1109/JPROC.2012.2219831

[9] Luigina Ciolfi. 2015. Embodiment and place experience in heritage technology design. In *The International Handbooks of Museum Studies*, 419-446. Wiley-Blackwell, London.

[10] Caroline Claisse, Daniela Petrelli, and Nick Dulake. 2019. Design synthesis: an act of Research through Design. In *Proceedings of the 2019 Research through Design Conference*. Figshare. Journal contribution. https://doi.org/10.6084/m9.figshare.7855826.v2

[11] Caroline Claisse, Daniela Petrelli, Nick Dulake, Mark Marshall, and Luigina Ciolfi. 2018. Multisensory interactive storytelling to augment the visit of a historical house museum. In *Proceedings of the 2018 Digital Heritage International Congress. IEEE*.

[12] Caroline Claisse, Daniela Petrelli, and Luigina Ciolfi. 2017. Containers of Stories: using co-design and digital augmentation to empower the museum community and create novel experiences of heritage at a house museum. In *The Design Journal, Volume 20, 2017 – Issue sup1: Design for Next: Proceedings of the 12th European Academy of Design Conference*, Sapienza University of Rome, Italy, S2906-S2918. DOI: https://doi.org/10.1080/14606925.2017.1352801

[13] Constance Classen 2007. Museum Manners: The Sensory Life of the Early Museum. *Journal of Social History*, 40, 4. 895-914.

[14] Peter Dalsgaard. 2008. Designing for inquisitive use. In *Proceedings of the 7th ACM conference on Designing interactive systems (DIS '08)*. ACM, New York, NY, USA, 21-30. DOI: http://dx.doi.org/10.1145/1394445.1394448

[15] Sandra Dudley. 2010 Museum materialities: objects, sense and feeling. In Sandra Dudley (Ed.) M*useum Materialities: Objects, Engagement, Interpretations*, 1-17. Routledge.

[16] John H. Falk. 2009. *Identity and the museum visitor experience*. Left Coast Press.

[17] John H. Falk, and Lynn Diane Dierking. 2012. *The museum experience revisited*. Left Coast Press.

[18] Kieran Ferris, Liam Bannon, Luigina Ciolfi, Paul Gallagher, Tony Hall, and Marilyn Lennon. 2004. Shaping experiences in the hunt museum: a design case study. In *Proceedings of the 5th conference on Designing interactive systems: processes, practices, methods, and techniques (DIS '04)*. ACM, New York, NY, USA, 205-214. DOI: https://doi.org/10.1145/1013115.1013144

[19] William Gaver. 2012. What should we expect from research through design?. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '12)*. ACM, New York, NY, USA, 937-946. DOI: https://doi.org/10.1145/2207676.2208538

[20] Elisa Giaccardi (Ed.). 2012. *Heritage and social media: Understanding heritage in a participatory culture*. Routledge.

[21] Colin M. Gray, Erik Stolterman, and Martin A. Siegel. 2014. Reprioritizing the relationship between HCI research and practice: bubble-up and trickle-down effects. In *Proceedings of the 2014 conference on Designing interactive systems (DIS '14)*. ACM, New York, NY, USA, 725-734. DOI: https://doi.org/10.1145/2598510.2598595

[22] Jean Ho Chu, Daniel Harley, Jamie Kwan, Melanie McBride, and Ali Mazalek. 2016. Sensing History: Contextualizing Artifacts with Sensory Interactions and Narrative Design. In *Proceedings of the 2016 ACM Conference on Designing Interactive Systems (DIS*

'16). ACM, New York, NY, USA, 1294-1302. DOI: https://doi.org/10.1145/2901790.2901829

[23] Kirsten Holmes, & Deborah Edwards. (2008). Volunteers as hosts and guests in museums. In Kevin D. Lyons and Stephen Wearing (Eds.) *Journeys of Discovery in Volunteer Tourism: International Case Study Perspectives*, 155–165. Cabi.

[24] Eva Hornecker and Jacob Buur. 2006. Getting a grip on tangible interaction: a framework on physical space and social interaction. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '06)*. ACM, New York, NY, USA, 437-446. DOI: http://dx.doi.org/10.1145/1124772.1124838

[25] Annamma Joy and John F. Sherry. 2003. Speaking of Art as Embodied Imagination: A Multisensory Approach to Understanding Aesthetic Experience. *Journal of Consumer Research*, 30, 2, 259-282. https://doi.org/10.1086/376802

[26] Stephen Kaplan, Lisa V. Bardwell, and Deborah B. Slakter. 1993. The museum as a restorative environment. *Environment and Behavior*, 25, 6, 725-742. https://doi.org/10.1177/0013916593256004

[27] Jenny Kidd. 2018. "Immersive" heritage encounters. *The Museum Review,* 3, 1. https://doi.org/10.33139/tmr.v3i1.16

[28] Ilpo Koskinen, John Zimmerman, Thomas Binder, Johan Redstrom, and Stephan Wensveen. 2012. *Design research through practice: From the lab, field, and showroom*. Elsevier. Harvard.

[29] Vincenzo Lombardo, and Rossana Damian. 2012. Storytelling on mobile devices for cultural heritage. *New Review of Hypermedia and Multimedia*, 18, 1-2, 11-35. https://doi.org/10.1080/13614568.2012.617846

[30] Hedvig Mårdh. 2012. Re-entering the house. Scenographic and artistic interventions and interactions in the historic house museum. *Nordisk Museologi*, 1, 25-39. http://dx.doi.org/10.5617/nm.2998

[31] Slobodan Markovic. 2012. Components of Aesthetic Experience: Aesthetic Fascination, Aesthetic Appraisal, and Aesthetic Emotion. *i-Perception*. 3, 1, 1-17. https://doi.org/10.1068/i0450aap

[32] Mark T. Marshall, Nick Dulake, Luigina Ciolfi, Daniele Duranti, Hub Kockelkorn, and Daniela Petrelli. 2016. Using Tangible Smart Replicas as Controls for an Interactive Museum Exhibition. In *Proceedings of the TEI '16: Tenth International Conference on Tangible, Embedded, and Embodied Interaction (TEI '16)*. ACM, New York, NY, USA, 159-167. DOI: https://doi.org/10.1145/2839462.2839493

[33] Alevtina Naumova. 2015. "Touching" the Past: Investigating Lived Experiences of Heritage in Living History Museums. *The International Journal of the Inclusive Museum*, 7, 1-8.

[34] William Odom, Ron Wakkary, Youn-kyung Lim, Audrey Desjardins, Bart Hengeveld, and Richard Banks. 2016. From Research Prototype to Research Product. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16)*. ACM, New York, NY, USA, 2549-2561. DOI: https://doi.org/10.1145/2858036.2858447

[35] Jan Packer and Nigel Bond. 2010. Museums as Restorative Environments. *Curator: The Museum Journal*, 53, 4, 421- 436. https://doi.org/10.1111/j.2151-6952.2010.00044.x

[36] Ross Parry. 2007. *Recoding the museum: Digital heritage and the technologies of change*. Routledge.

[37] Rosanna Pavoni. 2001. Towards a definition and typology of historic house museums. *Museum International*, 53, 2, 16–21. https://doi.org/10.1111/1468-0033.00308

[38] Daniela Petrelli, Nick Dulake, Mark T. Marshall, Anna Pisetti, and Elena Not. 2016. Voices from the War: Design as a Means of Understanding the Experience of Visiting Heritage. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16)*. ACM, New York, NY, USA, 1033-1044. DOI: https://doi.org/10.1145/2858036.2858287

[39] Lyndall Phelps. 2016. Remnants of Domesticity. Art installation Retrieved August 01, 2019 from lyndallphelps.com/project/remnants-of-domesticity/

[40] Steve Poole. 2017. Ghosts in the Garden: Locative Gameplay and Historical Interpretation from Below. *International Journal of Heritage Studies*. 24, 3, 300-314. https://doi.org/10.1080/13527258.2017.1347887

[41] Shriti Raj, Kelsey Toporski, Ashley Garrity, Joyce M. Lee, and Mark W. Newman. 2019. "My blood sugar is higher on the weekends": Finding a Role for Context and Context-Awareness in the Design of Health Self-Management Technology. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19)*. ACM, New York, NY, USA, Paper 119, 13 pages. DOI: https://doi.org/10.1145/3290605.3300349

[42] Stephen Roddy and Dermot Furlong 2014. Embodied Aesthetics in auditory Display. *Organised Sound*, 19, 1, 70-77.

[43] Margaret H., Szymanski, Paul M. Aoki, Rebecca E. Grinter, Amy Hurst, James D. Thornton, and Allison Woodruff. 2008. Sotto voce: Facilitating social learning in a historic house. *Computer Supported Cooperative Work (CSCW),* 17, 1, 5-34. https://doi.org/10.1007/s10606-007-9067-y

[44] Yvonne Rogers. 2004. New theoretical approaches for HCI. *Annual Review of Information Science and Technology*, 38, 1. 87-143. https://doi.org/10.1002/aris.1440380103

[45] Elizabeth B-N. Sanders, and Pieter Jan Stappers. 2018. Co-creation and the new landscapes of design. *Co-design* 4, 1, 5-18. https://doi.org/10.1080/15710880701875068

[46] Corina Sas, Steve Whittaker, Steven Dow, Jodi Forlizzi, and John Zimmerman. 2014. Generating implications for design through design research. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '14)*. ACM, New York, NY, USA, 1971-1980. DOI: https://doi.org/10.1145/2556288.2557357

[47] Tom Schofield, Daniel Foster Smith, Gönül Bozoglu, and Christopher Whitehead. 2019. Design and Plural Heritages: Composing Critical Futures. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19)*. ACM, New York, NY, USA, Paper 6, 15 pages. DOI: https://doi.org/10.1145/3290605.3300236

[48] Donald Schön. 1983. *The Reflective Practitioner: How Professionals Think in Action*. Basic Books, New York.

[49] Nina Simon, Nina. 2010. *The participatory museum.* Museum 2.0.

[50] Laurajane Smith. 2006. *Uses of heritage*. Routledge.

[51] Rachel Charlotte Smith, and Ole Sejer Iversen. 2014. Participatory heritage innovation: designing dialogic sites of engagement. *Digital Creativity,* 25, 3, 255-268. https://doi.org/10.1080/14626268.2014.904796

[52] Pieter Stappers, and Elisa Giaccardi. 2017. Research through design. In *The encyclopedia of human-computer interaction, 2nd edition*. Retrieved November 2, 2019 from https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/research-through-design

[53] Jamie Steane, and Joyce Yee. 2018. *Interaction Design From Concept to Completion*. Bloomsbury Visual Arts.

[54] Erik Stolterman. 2008. The nature of design practice and implications for interaction design research. *International Journal of Design*, 2, 1. 55-65.

[55] Robyn Taylor, John Bowers, Bettina Nissen, Gavin Wood, Qasim Chaudhry, Peter Wright, Lindsey Bruce, Sarah Glynn, Helen Mallinson, and Roy Bearpark. 2015. Making Magic: Designing for Open Interactions in Museum Settings. In *Proceedings of the 2015 ACM SIGCHI Conference on Creativity and Cognition (C&C '15)*. ACM, New York, NY, USA, 313-322. DOI: https://doi.org/10.1145/2757226.2757241

[56] Rachel Emily Taylor. 2016. The Girl Who Lived in Bishops' House. Art installation Retrieved August 01, 2019 from https://www.rachelemilytaylor.co.uk/Bishops-House-Museum

[57] Chi Thanh Vi, Damien Ablart, Elia Gatti, Carlos Velasco, and Marianna Obrist. 2017. Not just seeing, but also feeling art: Mid-air haptic experiences integrated in a multisensory art exhibition. *International Journal of Human-Computer Studies*, 108, 1-14. https://doi.org/10.1016/j.ijhcs.2017.06.004

[58] Nicholas Thomas. 2016. *The Return of Curiosity: What Museums are Good For in the 21st Century*. Reaktion Books.

[59] Franklin D. Vagnone, and Deborah E. Ryan. 2016. *Anarchist's Guide to Historic House Museums*. Routledge.

[60] Kirsten Wehner and Martha Sear. 2010. Engaging the material world: object knowledge and Australian Journeys. In Dudley, S. (Ed.) *Museum Materialities: Objects, Engagements, Interpretations*. Routledge.

[61] Paul F. Wilson, Jane Stott, Jason M. Warnett, Alex Attridge, M. Paul Smith, Mark A Williams. 2017. Evaluation of Touchable 3D-Printed Replicas in Museums. *Curator, The Museum Journal*, 60, 4, 445-465.

[62] Linda Young. 2007. Is There a Museum in the House? Historic Houses as a Species of Museum. *Museum Management and Curatorship*, 22, 1, 59–77. https://doi.org/10.1080/09647770701264952

[63] John Zimmerman, Jodi Forlizzi, and Shelley Evenson. 2007. Research through design as a method for interaction design research in HCI. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '07)*. ACM, New York, NY, USA, 493-502. DOI: https://doi.org/10.1145/1240624.1240704