

Designing for Domestic Memorialization and Remembrance: A Field Study of Fenestra in Japan

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ABSTRACT

We describe the design, implementation, and deployment of Fenestra, a domestic technology embodied in the form of a wirelessly connected round mirror, photo frame, and candle that displays photos of departed loved ones. Fenestra's interaction design, form, and materials are inspired by Japanese domestic practices of memorializing departed loved ones with a home altar called *butsudan*. We deployed Fenestra in three Japanese households to explore how this design artifact might support everyday domestic practices of memorialization, and where complications might potentially emerge. Findings reveal that a range of outcomes emerged across our participants' experiences of living with Fenestra—from profound remembrance to unexpected uses to unsettling encounters. These findings are interpreted to present opportunities for future research and practice initiatives in the HCI community.

Author Keywords

Domestic Memorialization; Thanatosensitive Design; Techno-Spirituality; Research through Design.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

While it can be a delicate and complex research area, technological trends are compelling the HCI community to engage with issues related to bereavement and memorialization. Recent work has begun to explore issues such as the appropriate transfer of the departed's digital data [e.g., 4,39] to how technology could better support grieving processes among various stakeholders [e.g., 33,34,35,41] to the ways in which digital content might be used in practices of memorialization [e.g., 23,28,37,38]. In this paper, we focus on expanding design-oriented research

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DOI: <http://dx.doi.org/10.1145/2858036.2858069>

in this latter theme: how digital materials can be embodied in interactive systems to open up new ways of supporting everyday practices of memorialization in the home.



Figure 1. Emi-H1 integrated a quilt made by her grandmother and other objects in this Fenestra installation displayed in her living room. Emi's reflection in the round mirror is subtly present in the backdrop of her grandmother's cropped image.

While people worldwide are amassing diverse kinds of digital possessions [44], this paper focuses specifically on digital photos—one of the most enduring and expansive contemporary forms of personal content. We wanted to investigate how new forms of interaction might enable meaningful experiences with photos in the context of everyday domestic experiences of memorialization. We also wanted to explore any unintended yet possible tensions that might result from creating new technologies in this nascent and sensitive design space.

Importantly, we situate our design work and field study in the greater Tokyo, Japan area. There is growing interest in the HCI community in understanding how interactive systems are intersecting with social, cultural, and spiritual practices concerning remembrance of one's ancestors [e.g., 2]. However, the majority of HCI research on bereavement and memorialization has emphasized on Western contexts. More generally, few examples exist of HCI research that has progressed beyond investigations of current practice to explore how people's everyday practices of memorializing the lives of departed loved ones could be supported through the design of new interactive systems.

With this in mind, we designed *Fenestra*—an interactive system embodied in the form of a wirelessly connected round mirror display, photo frame display, and candle (see figure 1). Fenestra's design draws inspiration from

butsudan—the Japanese Buddhist home altar that is a highly significant site for practices of memorializing departed loved ones. Lighting a candle in the candleholder activates the main interactive feature of Fenestra; indeterminate changes in the brightness and movement of its flame control how photos of the departed are surfaced, cycled through, and remain present on the photo frame and mirror displays. A secondary feature is triggered when the user gazes directly at the round mirror, which causes cropped digital portraits of the deceased to be displayed. We deployed Fenestra in the homes of three participants that each represented different life stages, but had experienced the loss of a family member in recent years. Findings revealed that participants drew on Fenestra as a resource for their everyday memorialization practices in valued and, at times, unexpected ways. They also reveal the need for new strategies to better support people's evolving self-determined practices of living with digital materials evoking the lives of departed loved ones. Our study also led to unanticipated encounters for household members, which revealed several critical issues bound to conducting research in this nascent and growing design space.

This paper makes two contributions. First, it offers a rare example of a research-through-design study situated within the non-western context of contemporary Japanese memorialization practices in the home. Second, it offers several considerations aimed at sensitizing the design space toward better supporting the work of living and engaging with digital materials evoking people's departed loved ones.

BACKGROUND AND RELATED WORK

There exists extensive literature from many perspectives within the social sciences that explore how people deal with death. While these works are expansive, *memorialization*—the intentional act of preserving the memory of a person or event—has gained significant attention. A central thread in this work explores how social and cultural values shape memorialization practices on individual and societal levels [e.g., 10,26]. Scholars have also turned their attention towards the materiality of memorials and the various roles they play in the lives of the bereaved over time [20]. Researchers have described how memorials can be leveraged as resources for the bereaved to move on from the death of a loved one [3], while others have documented how they can help maintain connections to departed ancestors [32,60]. Practices for memorializing the lives of departed loved ones have existed for hundreds of years in Japan [e.g., 29,50,57]. The widespread adoption of these practices is tied to traditional Buddhist rituals, where the Japanese Buddhist altar, the *butsudan*, plays a central role. Traditionally, each Japanese family would possess one altar. This family altar was handed down across generations through a patriarchal structure, from the eldest son to next oldest male within the family [1].

However, perspectives on traditional Buddhist home altar practices have been changing due to several reasons [51,58].

First, it is more common for family members to live long distances away from each other, often to pursue professional careers. Second, contemporary home life in urban settings, such as Tokyo, unfolds within small apartments, which are difficult to accommodate large traditional altars. Third, the patriarchal structure of traditional altar practices largely restricted women from living with their family's altar [1]. Hence, now smaller altars with modern aesthetics are beginning to emerge in the Japanese marketplace. Recent research has also indicated a trend toward memorializing departed loved ones with framed deceased's photos instead of traditional *butsudans* in Japanese households [51]. The proliferation of digital content presents an opportunity for rich new materials to support home memorialization practices in ways that could be more extensible and easier to mobilize than physical materials. Yet, little is known about how people would react to a digital materials and interactive technology augmenting home altar practices, and what the potential benefits and tensions might be.

Within the HCI community, there has been growing interest in how interactive technology is intersecting with experiences of bereavement. Massimi and others argue *thanatosensitive design*—design that engages with the many issues bound to mortality, dying, and death through the creation of interactive systems—is a critical emerging area for HCI research and practice [34]. A range of recent works has since explored issues, such as the transfer of digital possessions belonging to the departed [4,18,19,35,39] support for emotional grief [5,33], and even potential issues for researchers operating in the space themselves [40].

A handful of works in HCI have begun to consider how digital technology is intersecting with memorialization efforts. Foong and Kera [11] adopt a reflective design lens to interpreting experiences of digital memorials. Uriu et al. [54] propose a digital family shrine concept for people to remember deceased relatives. Following this work, Uriu & Okude [53] describe a speculative interactive altar for supporting ritual prayer with one's ancestors. Drawing on these examples and many others, Moncur and Kirk [38] offer a framework for designing digital memorials. They articulate the need for future research to explore how interactive systems shape practices related to the *post-self*—how the identity of the departed is socially constructed.

In parallel to these works, there has been an ongoing interest in the HCI community on how interactive technology and spiritual practices are becoming entangled. Bell [2] and Wyche et al. [62] describe emerging *techno-spiritual* practices and the implications they suggest for critically reframing the design of domestic technologies to better support extraordinary experiences in everyday life. With the exception of the Prayer Companion [13] and Sun Dial [61], few other research-through-design projects have emerged in the HCI community since Bell and Wyche et

al.'s seminal work [see 6]. More generally, the increasing prevalence of personal digital content, such as digital photos [e.g., 28,43,45], video [e.g., 47], audio [e.g., 46], and social media [7], has led to a stream of work in HCI exploring how experiences of reflection and reminiscence might be better supported.

Collectively, these strands of research have made important contributions to understanding how interactive technology is intersecting with experiences of memorialization. They also call attention to how complex and culturally situated this design space is and the need to better understand possible opportunities and tensions existing in it. Our work attempts to bring these strands together. We want to explore how interactive technologies could be designed to leverage pre-existing cultural rituals tied to contemporary domestic memorialization practices in Japan. We also want to understand how technology mediates people's experiences of living with digital representations of their departed loved ones. Beyond work that has gone before, we do this by grounding discussion around the design and deployment of the Fenestra system in three Japanese households.

METHODOLOGY

We designed Fenestra with the goal of exploring how embodying digital photos within a domestic technology could support everyday memorialization practices in Japan. The design of Fenestra's interaction and aesthetics draws inspiration from Japanese Buddhist home altars, and symbolic forms commonly found in Japanese Buddhist temples. We intended to craft an interaction design artifact that could provoke reflection on the system itself and encourage a dialogue about (and beyond) the potential future it embodies. Our methodology drew on several related approaches including reflective design [48], technology probes [24], and research through design [63].

Design Process and Rationale

In an earlier speculative design project, Uriu and Okude [53] developed an interactive installation called ThanatoFenestra (see Figure 2) that explored a potential future where bereaved family members could remember their ancestors by experiencing photographs projected onto a circular canvas. The installation used stock images and was far too fragile and cumbersome to viably deploy in a person's home. Yet the form and experience appeared compelling. In the Fenestra project, we wanted to develop a robust system that could more easily fit within people's everyday domestic settings.

The process leading to the development of Fenestra consisted of the following. We reviewed theoretical literature and empirical studies (a sample of which are noted in the prior section). We also conducted in-person observations of in-home practices for memorialization as well as several different traditional Japanese *Zen* Buddhist temples to help orient our design sensibility toward the forms, materials, and practices characterizing these sites. During our in-home visits, we interviewed and video-

recorded three different households, asking them to walk us through their practices of memorializing departed loved ones with and without utilizing traditional *butsudans*. When visiting public temples, we took photographs and field notes to document emerging insights.

We intended the design of Fenestra to reference some key elements emerging in our observations. Circle and square shaped windows were common across Buddhist temples we visited (see Right of Figure 2). Indeed, the name *Fenestra* is a reference to the Latin word for window. In Zen Buddhism, the circle symbolizes the afterlife paradise, whereas the square represents the lower (i.e. living) world. Candles also populated altars and temples, and are used in many different kinds of Buddhist ceremonies including funerals and memorial services. Here, candlelight symbolizes the journey of the departed's spirit to the afterlife.



Figure 2. Left: Prototype of ThanatoFenestra [53], Right: *Genko-an* temple (Kyoto-city, Japan) we visited during our design process; the circular window is symbolic of the afterlife; the square-shape entrance is a gate to the living world.

Fenestra consists of three artifacts—a mirror, photo frame, and candleholder. These artifacts are designed as a visual family, each handcrafted from teakwood. All technical components are embedded within the wooden cases. These design choices were motivated in part by our desire to craft artifacts whose materials could inspire a sense of *perceived durability* [42] often associated with domestic altars.

Fenestra artifacts, implementation, and interaction design

The *Round Mirror* is comprised of a custom cut circular piece of one-way mirror glass, which has an LCD display embedded behind it. An Arduino Fio paired with an Xbee module and an IR distance sensor are embedded in the front of the mirror stand; the IR sensor will detect obstruction within 300 mm from the mirror (e.g., if a person is directly in front of the mirror and not moving). We gave the mirror a circular form as a subtle cultural reference to the afterlife in Zen Buddhism. We used mirror glass to potentially evoke contemplation on the connection between the owner's life and their ancestors (e.g., through seeing the subtle reflection of one's own face while gazing at images of departed loved ones).

The *Photo Frame* consists of a tablet computer embedded in a wooden case; a Xbee Explorer module is housed in the base of the photo frame and connected to the tablet via USB. The module wirelessly receives signals from the candleholder and mirror. Swiping the photo frame touchscreen enables people to cycle through photos if desired. We gave the Photo Frame a quadrilateral, square-



Figure 3. From left to right: (A) current photos can be viewed on the photo frame through simple swipe interactions (no image appears on the round mirror); (B) changes in the candle flame’s brightness and movement unpredictably triggers how old photos (on the photo frame) and face photos (on the round mirror) surface and are cycled through; (C) if the IR sensor is obstructed by a person or object (in this case the candleholder) a face photo will appear on the round mirror, even if current photos are being display (such as in this case).

like form as a subtle symbolic reference to the type of digital content it presents—mostly images of people still existing in the ‘lower’, living world.

The *Candleholder* components include an Arduino Pro Mini paired with a Xbee module, two light (CdS) sensors, an infrared temperature sensor, a thermistor temperature sensor, and a lithium-ion battery; all are embedded within a handcrafted spherical candleholder. The candleholder is intended to hold a lit candle. The light sensors detect variations in the candle flame movement and brightness. The infrared sensor detects the temperature of candle flame, and the thermistor detects the temperature inside of the candleholder. The candleholder sits on top of a custom designed teak cradle with a micro USB connection for charging the lithium battery. While a candle is lit, all sensors continuously send data to the Photo Frame. This choice enabled the candle to be moved elsewhere in the home; this aimed to offer more flexibility for people to adapt Fenestra artifacts to their own practices and domestic spaces. We decided on using a candle as the primary ‘input’ sensed by the system for two main reasons: (i) it provided an opportunity to leverage a pre-existing cultural ritual tied to Japanese Buddhist memorialization practices and (ii) the ephemeral, wavering quality of the candlelight offered a poetic way to unpredictably surface digital content, while not requiring direct further interaction by the user(s).

Before installing Fenestra, we asked participants to assemble an archive of photos to include in the system. We also created high-resolution scanned images of any physical photographs they wanted to include in the system. While participants knew that Fenestra was related to home altar practices, no specific criteria were given to about the kinds of photos they should select. We did make participants aware that they could include photos that they may more generally want to display in the home if desired. We wanted to explore how a mix of digital content related to departed ancestors and one’s own everyday life might shape perceptions of Fenestra as a domestic technology.

Based on the images participants provided, three main types of photos were displayed through Fenestra: *Current*, *Old*, and *Face*. Current is the most general category and often consisted of images of living family or friends. They could

only be viewed on the Photo Frame when the candle was not lit (see Figure 3A).

Old photos consisted of (often scanned) images taken when the departed was still alive. We developed a script to generate cropped, circular portrait-like images of the departed in all instances in which she or he appeared. These Face photos would simultaneously appear on the Round Mirror when the corresponding Old photo was displayed on the Photo Frame. The cropped Face photos reference to the *iei*—a photo typically created by a third party Japanese funeral company. The *iei* photo is always edited to depict a portrait of the departed against a neutral background; a large print of it is then made, framed, and shown at the departed’s Japanese memorial ceremony. Since the *iei* photo is closely tied to formal ceremonies, we chose to not edit out the backgrounds of the Face photos to emphasize the everyday nature of Fenestra as a domestic technology. The mirror image in Figure 3B and C is an example of this cropped *iei* inspired Face photo.

When a candle is lit in the candleholder, the system transitions to showing Old Photos on the Photo Frame and Face photos of the Round Mirror (see Figure 3B). Additional pairings of Old/Face photos are surfaced depending changes in the candlelight’s brightness and movement. If the candlelight shimmered from a slight breeze, a similar shimmering visual effect manifests in the Old/Face Photo pairing. If the flame wavers more strongly, Fenestra cycles through Old/Face images in a motion closely tied to the flame’s movement. As the candle dims over time, the photos do too. When the candle goes out, all screens are dimmed and remain off to signify the end of the ritual (however, at any point after this, the owner could touch the Photo Frame to begin viewing Current Photos).

Face photos can also appear on the Round Mirror when the IR sensor is obstructed (see Figure 3C). This triggers a Face photo to randomly surface through the mirror, although the owner’s reflection in the mirror is still slightly visible. When the sensor is no longer obstructed the Face photo will disappear. In addition to gazing into the mirror, a person can trigger a Face photo by placing an object (or offering) directly in front of the mirror.

Participants, Data Collection, and Analysis

We recruited three primary participants from three different households from the Tokyo area to participate in our study. This approach clearly has limitations; for example, it makes the results hard to generalize to a wide population of users. Similar to the seminal technology probes paper [24], and several field studies since then [e.g., 14,22,43,52], we wanted to initially focus on a small selection of participants to gain a richer descriptive understanding of the space as a whole to inform what might be salient issues for future research and practice. Considering the sensitive nature of our study, flyers and advertisements did not prove effective for recruitment. By spreading information via word-of-mouth through a snowball sampling approach—beginning by asking many people we knew that exhibited various ages and occupations, and then asking them to pass along information about our study to their social contacts—we were recruited three participants; each represented very different life stages and domestic settings. We recruited this participant pool as it could offer a diverse range of experiences with home memorialization practices. We use pseudonyms to describe household members in this paper.

Our primary participant in household 1 (H1) is Emi, a woman in her mid-20s whom had lost her grandmother Yoshiko six months prior to the study. Emi lives alone in her apartment, often working at home as director of her design company. Her grandfather Joji lives a short walk away from her apartment and owns a Buddhist altar in his home. Emi uploaded 15 current, 29 old, 22 face photos.

Satoko was the primary participant in household 2 (H2); she was in her late-80s and lost her husband Kenta eight years ago. She had recently transitioned to living in an eldercare home, where she shared a room with three other elder women. Her daughter Masako and her granddaughter Chisa visited her frequently, as did care workers. She had a Buddhist altar with many material possessions owning to her departed husband at her home, but could no longer see them. Satoko uploaded 17 current, 14 old, and 14 face photos. Satoko passed away approximately one year after the conclusion of our field study.

Rikako, a woman in her late-50s, was the primary participant in household 3 (H3). She had lost her mother Toshiko six years ago and her father Shun two years prior. She lives with her husband Gen and second son Tsuyoshi; her first son Taku lives in an apartment nearby and visits frequently. Rikako purchased a Buddhist altar when Toshiko died; she has it featured centrally in her living room with two small framed photos of departed her parents. She uploaded 9 current, 22 old, and 34 face photos.

We deployed Fenestra in each household for one week. It is important to note that considerable discussion among our design research team shaped this field study deployment period. Recent research has indicated that even under ‘normal’ circumstances of the death of a loved one, individuals can experience complicated grief disorder

(CGD), which can prolong experiences of grief, causing imbalances in autobiographical and biographical memory [17]. CGD and related disorders (e.g., prolonged grief and depression) have been shown to be prevalent within the Japanese population [8,25]. While American Psychological Association (APA) metrics for questionnaires [e.g., 49] do exist to help screen participants for CGD, nearly all findings from prior studies that inform this approach are derived from Western cultures; their effectiveness within non-western cultures is not fully established [25]. Considering how little is known about the design space we are investigating—especially within a non-western context like Japan—we had to proceed cautiously. Fenestra could trigger unpredictable emotional reactions and we went to great lengths to make participants aware of the possible effects that could come from participating in our study. We decided on the one-week period as it presented enough time to understand participants’ everyday experiences, while not putting them at potential long-term risk of unanticipated effects. This duration does suggest limitations in terms of a possible novelty effect shaping participants’ perceptions of Fenestra. We were careful to be mindful of this throughout the development of our interview protocol, data analysis, and interpretation of the study findings.

We aimed to collect rich, descriptive accounts from participants through semi-structured interviews. This included an introductory interview when installing Fenestra and a final interview at the end of the deployment. During our initial home visit (which lasted 3-4 hours) we aimed to understand members’ everyday lives, personal memorialization practices, perceptions of digital or physical materials belonging to the departed, and general technology-usage. Our primary participants gave us a tour of their living spaces and decided where Fenestra should be installed. We also provided participants with candles, matches, a trash bin, and an iPad. Participants could use the iPad if they wanted to take pictures, videos, or voice recordings capturing their experiences with Fenestra (but this was not a requirement). We gave an introduction to how Fenestra works and provided a instructional pamphlet. We did not explicitly encourage participants to interact with the Fenestra and all were aware they could drop out of the study at any time. At the conclusion of each study, we conducted a final interview to understand participants’ experiences with Fenestra. Questions were designed to explore topics such as: initial impressions and shifting perceptions; potential unanticipated experiences; how others reacted to Fenestra. We also reviewed the experiences participants may have captured on the iPad.

All interview sessions were audio recorded. All recordings were transcribed first in Japanese; then, relevant segments (as opposed to idle chitchat) were translated into English. Researchers took field notes and documentary photographs during each interview session. Field notes were reviewed following each interview, and tentative insights were noted in reflective field memos [16]. We held ongoing meetings

to discuss emergent findings. Analysis of the data was an ongoing process. After each home visit, we conducted preliminary analysis, searching for emergent patterns across recordings, field notes, and photos to draw out underlying themes [36]. We coded raw data documents with these themes. We also created affinity diagrams to model connections and differences among households.

FINDINGS

Interviews, observations, and participants' diary reflections revealed that Fenestra was frequently used across all three primary participants. The references to Buddhist home altars and the ease with which other cherished objects could be integrated with Fenestra helped evoke a sense of familiarity around its place in everyday life. However, several differences surfaced in how household members adopted Fenestra. Extraordinary and unnerving encounters emerged in some cases as participants struggled to interpret unexpected behaviors exhibited by the system. In the following sections, we present examples taken from across our field study that help to capture these themes.

Pre-existing rituals and emergent practices

Interviews with participants revealed a range of ways that Fenestra was drawn on as a resource for supporting the memorialization and remembrance of departed loved ones. Yet each household represented different life stages, domestic configurations, and orientations toward Buddhist home altar practices. Next, we detail how Fenestra became uniquely situated within our primary participants' lives and practices, and perceptions that emerged.

While Emi-H1 had a few possessions that she used to remember her departed grandmother Yoshiko's life, she did not have a butsudan in her small apartment. She noted that her grandfather Joji-H1 had purchased a traditional butsudan following the death of his wife, but felt inclined to follow traditional Japanese Buddhist practices and not integrate any materials belonging to her life into the altar. Emi-H1 described growing dissatisfaction over this choice: *"It's all about praying for butsudan itself and not much about grandmother [Yoshiko]."* This issue produced an ongoing unresolved tension for her. She expressed disinterest in traditional Japanese Buddhist practice and a reluctance to visit her grandfather's home altar.

Emi-H1 situated Fenestra on a table in her living room near where she spends most her time working from home. Soon after the initial installation, she integrated a quilt her grandmother had made under the photo frame, along with a small plant that symbolized Yoshiko's love of nature (see Figure 1). Emi-H1 later noted that these decisions were highly meaningful in enabling Fenestra to find its place within her home by bringing the few material possessions belonging to her grandmother into an ensemble with the more expansive digital materials embodied in Fenestra. In this way, the openness of Fenestra's design enabled Emi-H1 to create a unique assembly of material traces and

digital artifacts associated with her grandmother's life in a way that was intimately situated to her home.

Emi-H1 also reported that she was able to easily engage in practices with Fenestra and highlighted the significance of the candle as a control mechanism for the system. She lit the candle every night and sometimes in the morning. During these times, her attention oscillated between the photo frame, mirror, and the candle flame itself when a subtle visual flickering effect manifested on the photos. She described an emergent practice of exhaling a deep breathe onto the candle to trigger it to cycle to a different juxtaposition of photos on the mirror and frame. When reflecting on her experience, Emi-H1 emphasized how this subtle kind interaction paired with not having direct control over the specific photos manifested through Fenestra enabled her to better concentrate on contemplating her grandmother's life.

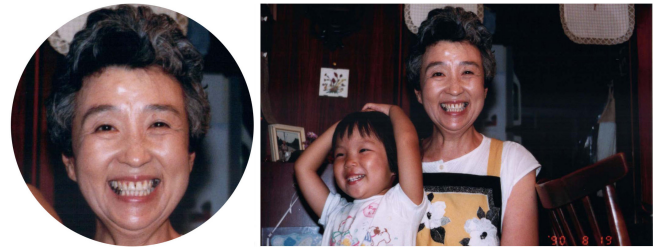


Figure 4. Emi-H1 favored contemplating juxtapositions of images on the mirror and photo frame that depicted intimate, one-to-one social relationships that shaped the life of her grandmother.

As Emi-H1's experiences accumulated, she described becoming particularly drawn to instances in which images highlighting one-to-one social bonds appeared: *"I love photos showing only me and grandma (e.g. Figure 4), which is the best combination for me. ... I [also] love the photo of my grandparents Yoshiko and Joji that my father took during his childhood."* Emi noted that the combination of the photo frame image depicting a deeply meaningful one-to-one social bond, paired with viewing the photo of her grandmother's face slightly imposed over the reflection of her own face produced a meaningful space for remembrance and reflection. Interestingly, Emi-H1 stated that other *old* images depicting her grandmother in larger groups of people often did not produce the same result. For her, they drew emphasis away from honoring the intimacy bound to social relationships between her grandmother, other specific people, and her desire to contemplate how these bonds shaped her own life. She desired to have a curated set of photos that reflected these kinds of instances.

Similar to Emi-H1, Satoko-H2 did not currently inhabit a dwelling with a butsudan. She had purchased one after her husband Kenta's death six years ago and frequently drew on it as a resource for memorializing his life, but had been separated from it since moving to the care facility. Masako-H2 and Chisa-H2 helped Satoko-H2 set up Fenestra on a shelf next to her bed (see Figure 5). Fenestra's simple tangible interaction design enabled Satoko-H2 to fluidly

adopt it into an everyday practice. She contrasted Fenestra's use of familiar input mechanisms (i.e. a candle) and her comfortable relation to it with other contemporary digital technologies, which she perceived as designed for younger generations and had largely avoided. Satoko described engaging with Fenestra several times each day from morning until evening. She habitually cared for the system by covering the photo frame with a special cover each night. Satoko also ritualistically closed the curtain to the outside facing window each night as a way of symbolically bidding her departed husband farewell before going to bed: *"I could meet Kenta everyday, but have to say 'Good bye' when I sleep at night. Please close this curtain now. He [Kenta] does not appear when it is too bright!"*



Figure 5. Fenestra near Satoko-H2's bed where it was habitually cared for and sometimes triggered extraordinary experiences.

When we probed further on this statement, it became clear that the subtle changes in light produced when Satoko closed the curtain could sometimes trigger the IR sensor in the round mirror to momentarily display an image of her deceased husband. Interestingly, when this accidental sensing occurred Satoko reported always perceiving it as an extraordinary serendipitous encounter. She interpreted these instances as good omens—*"like he's watching over me"*—making her feel calm before going to bed. Further, Satoko enthusiastically noted *"Kenta sometimes appeared even at midnight"* and described seeing a momentary image of him a handful of times when she had briefly awoken during the night. This kind of unexpected accidental sensing resulted in positive serendipitous experiences for Satoko and catalyzed a meaningful nightly ritual. However, as we describe later, other instances of accidental sensing did not always produce such positively perceived effects.

Rikako-H3 possessed a very large, immobile butsudan in her home, which she purchased six years ago after the death of her mother (her father had since passed away). Among our participants, Rikako-H3 most strictly adhered to norms surrounding Buddhist altar practices. She displayed formal, framed *iei* pictures of each of her deceased parents in the butsudan, where she frequently lit candles and incense sticks, and placed food offerings for the departed loved ones (a ceremonial Buddhist practice).

Throughout the field study, several instances emerged that illustrated how Rikako-H3 developed a different, yet

significant relation to Fenestra compared to her traditional butsudan. Rikako-H3 situated Fenestra as a fixture in her living room, making it available for casual encounters and direct, purposed engagements. She contrasted this decision with the location of her butsudan in a small nearby room that was only used for altar rituals. Rikako-H3 also viewed Fenestra as an opportunity to integrate cherished material possessions within a domestic display honoring her parents, which she perceived were not appropriate for her traditional butsudan. She recognized the references to Buddhist forms embodied in the Fenestra, which prompted her to artfully situate preserved flowers from her mother's memorial service between the photo frame and the mirror as a symbol of her journey from the lower-world to the afterlife. She also placed dolls alongside Fenestra that she had acquired when living in Spain with her parents and brought back many memories from this time in her life (see Figure 6).

In Rikako-H3's initial Fenestra deployment, we had generated two different cropped images (one for each departed parent) to appear on her round mirror. After using Fenestra during the initial interview, she asked us to depart from the reference to customary *iei* portrait photos (where only one person can be featured). Since she perceived Fenestra as existing outside of butsudan norms and believed her parents would have wanted to be together, we were asked to generate a new set of mirror images in which they were collocated (one such image is visible in Figure 6).



Figure 6. Rikako's practice of placing the candleholder in front of the mirror to trigger a collocated image of her parents to 'show' them a more recent photo frame image of her nephew's wedding.

This subtle decision led to an emergent valued ritual. Rikako-H3 described that when the photo frame displayed her current photos, she would subtly orient the mirror toward the frame and place the candleholder in front of it, triggering a collocated cropped image of her parents to appear. She perceived this action as enabling her parents, together, to view experiences in her life that she wished they could have attended. Rikako-H3 reflects on enacting this practice when a photo of her nephew Sayaka's recent wedding reception appeared on the photo frame: *"It's a way for them to celebrate the wedding. ...I love the combination. The faces [of my parents] on the mirror and the recent photos on the photo frame. ...It felt like it [Fenestra] provided an experience of living with the deceased in a way that very different from [traditional] Buddhist altars."*

When reflecting further on this distinction, Rikako-H3 characterized Fenestra as having a lightweight quality that could exist in her everyday life and easily shift between being directly experienced and simply being lived with. She contrasted this with the more involved process of dedicated contemplation and honoring of ancestors at her butsudo. For Rikako-H3, Fenestra emerged as a resource for seeing her departed parents, momentarily “*greeting them*”, perhaps showing them a part of her life that they had missed, and then letting them fade away into the background as the mirror eclipsed their image. She reflected further: “*gradually I began to feel the calm presence of my parents. ...When I woke up in the morning or came back home, the photos are changing, which made me happy to take a few moments to see them.*”

Collectively, these reflections illustrate how on a general level Fenestra functioned as a valued resource for supporting everyday memorialization practices in our participants’ lives. They also reveal that the specific ways it was drawn on varied considerably and, at times, in unexpected ways as participants sought to adapt it to their domestic practices and values in unique self-determined ways. In the next section we describe how Fenestra intersected with our participants’ broader everyday domestic environments as others also encountered it.

Broader intersections and effects in everyday life

While Fenestra was arranged for our three main participants, unexpected experiences were triggered by its situation in domestic spaces. Next, we present examples that illustrate how the everyday orientation of Fenestra produced both positive outcomes and unsettling encounters.

Emergent social interactions triggered by Fenestra

All participants reported that the tangible nature of Fenestra opened it up to being noticed and manipulated by other people occupying their domestic environment. For example, Rikako-H3’s son Taku initiated a practice of lighting a candle and bringing the candleholder to the dining table when household 3 had dinner. The simple presence of the candleholder itself during meals could stimulate recollection and discussion of fond memories associated with Rikako’s departed parents. In some cases, family members reported enjoying the anticipation that grew around which photos might be displayed when they returned to Fenestra with the candle. Yet, household 3 described equally appreciating that if their discussion continued on and the candle faded out, so too would the images on Fenestra. The photos flickered and disappeared against the backdrop of domestic life just as the candlelight had, instead of lingering on and demanding the attention of family members.

In Satoko-H2’s case, the presence of Fenestra triggered a resurgence of social activity in her everyday life. Visiting family members and care facility workers described a remarkable change in Satoko-H2’s desire to engage others in conversations about her own life. Both Masako-H2 and

Chisa-H2 conveyed unresolved reservations about Satoko-H2’s living for years separated from nearly all material possessions reminiscent of her husband. They described how the range of images embodied through Fenestra prompted Satoko-H2 to tell rarely heard stories about the life she shared with her husband. One example centered on when an image of Satoko-H2’s husband against the backdrop of many tents surfaced (see Figure 7), Masako-H2 and Chisa-H2 learned about the meaning and significance of the photograph they had never known, but were soon going to inherit. Yet, it is unclear if this kind of behavior would have continued in a longer study. This example does illustrate how the extensibility of digital materials embodied in Fenestra provided a resource for Satoko-H2 to memorialize and remember her husband’s life in ways that largely would have been impossible with material possessions due to her living conditions.



Figure 7. Fenestra emerged as a ‘ticket to talk’ about the personal and historical significance of old photos depicting Satoko-H2’s life with Kenta that her family members had never heard.

Fenestra also provided a platform for family members from different generations to express their opinions on shifting perspectives in Japan around the butsudo and memorialization rituals. For example, Emi-H1’s grandfather Joji-H1 visited her home while she was living with Fenestra. To her surprise, after lighting a candle and interacting with Fenestra during his visit, he was highly receptive to its presence within her home. While it was a topic they seldom discussed, Joji-H1 opened up about his thoughts on the needs of the younger generation in Tokyo today: “*I don’t know what we should pray with [in my] butsudo to memorialize them. There is nothing there that really reminds us them. ...Traditional rituals should be updated for the contemporary needs that people have to remember their lost loved ones. ...Japanese people don’t have to use butsudo anymore. ...[Fenestra] could be an alternative. It could even be produced in Buddhist temples. ... We can all actually remember the deceased with it.*”

Unexpected re-animations of the departed through Fenestra

Despite the optimism voiced in Joji’s statement above, several unsettling experiences also emerged when participants struggled to interpret unexpected behaviors exhibited by Fenestra. Nearly all of these cases centered on instances in which the IR sensor was accidentally triggered, causing an image of a departed loved one to momentarily manifest on the round mirror and then disappear. Emi-H1 reflects on how this effect could have a disruptive effect on her everyday routine of working from home: “*I had a kind of dark mood when seeing photos that sometimes appeared on the mirror when I was busy working in daytime. I*

thought photos of the deceased should have been shown only when I lit the candle. I love grandma and want to remember her, but not all of the time." This example illustrates how accidental sensing introduced digital content into Emi's domestic life at a time that was socially inappropriate. She also speculated that if her grandmother had not passed away in such a peaceful way, this kind of unrequested momentary manifestation could have serious emotional consequences.

Family members in household 3 also reported occasionally encountering temporary manifestations of a departed loved one. As these experiences accumulated, household members decided to unplug Fenestra at night when they go to bed: *"We decided to switch it off every night when we go to sleep. It started when my son came back home late one night and saw it [accidentally trigger]. He felt scared and turned it off"* (Rikako-H3). Gen-H3 then noted: *"And, when I went to the rest room late at night I was scared. The deceased's face appeared!"* These experiences prompted household 3 to reflect on their own everyday domestic practices and consider activities that, as Rikako-H3 noted, *"wouldn't want the deceased to see."* As a preemptive practice, household 3 began unplugging Fenestra when they watched television together in the living room. Similar to Emi-H1, they wanted to avoid a momentary re-animation of the departed disrupting the social order of the home (e.g., during family leisure time). Comparable to both Emi-H1 and Rikako-H3's accounts, a night manager at Satoko-H2's care facility described the uneasy effects generated from occasionally encountering an unexpected flicker of her elderly client's deceased husband in the middle of the night.

Collectively, these examples highlight unintended consequences that emerged when images of the departed unexpectedly manifested through Fenestra. While some participants developed workarounds, these undesired intrusions complicated the social and moral expectations that our participants had for a technology like Fenestra.

DISCUSSION AND IMPLICATIONS

Our findings reveal various ways households desired to draw on Fenestra. In several instances participants desired to further situate Fenestra to their own unique, self-determined memorialization practices. Other cases suggested how technology could better support a wider range of experiences bound to domestic memorialization beyond direct interaction. Our study also raises several consequences that could emerge if critical consideration is not given to new technological interventions. Next, we present several research and design considerations for the HCI community that emerged from our work.

Designing for momentary and lived-with experiences—

A core goal of our study was to explore how the design of Fenestra could leverage people's pre-existing material practices. We decided on using candlelight as a primary material for interaction because it drew on a familiar cultural practice with Japanese memorialization ceremonies.

We also felt that the candle flame could offer a poetic quality to the experience of Fenestra. Similar to how it can be challenging for people to connect with and imagine death, candle flames too are complex. It can be difficult to anticipate how they will move and, like life, a candle flame can quickly be blown out unexpectedly. Participants reflected on how the input method of candlelight offered a simple, appropriate way to open up contemplative rituals with Fenestra (e.g., Emi-H1's practice of navigating photos through slow, deep exhalations). Surprisingly, participants did not report tensions in abdicating control over photo selection to changes to the unpredictable, indeterminate nature of the candlelight. Rather, this design choice was often cited as helping participants to momentarily concentrate on the lives of departed loved ones, growing anticipation around the digital photos, and enabling experiences with Fenestra fade to a close as the candlelight dimmed and went out.

While prior work has explored how qualities of randomness and machine autonomy can productively open up experiences of pause, reflection, and anticipation [e.g., 14, 22,30,31,43,59], nearly all research to date has manifested these qualities of experience through hidden computational processes. Our study contributes to this growing area of HCI research by demonstrating the value and potential in leveraging easy to manipulate, ephemeral input [9,23, 53,55], which, in our case manifested a quality of unpredictability that supported rich experiences and rituals for memorializing the departed. There is an opportunity to explore how additional kinds of highly sensorial, momentary input (e.g., incense smoke, light from multiple candles, etc.) could be combined with other forms of digital content (e.g., audio, video, music) to artfully support experiences of memorialization. Developing more meaningful strategies for supporting the remembrance of lost loved ones through carefully crafted ways of re-experiencing digital content in everyday life marks a clear space for future research in the HCI community.

We also found that participants created and re-configured assemblies of material possessions with Fenestra. While subtle, these actions enabled Fenestra to bring into relation digital materials, physical things, domestic space, and household members in ways that were unique, nuanced, and evolving. As these kinds of actions accumulated, Fenestra emerged as a *background technology*—one that could dynamically shift from the forefront of domestic experience, to being passively encountered, to fading out of sight entirely. In this way, Fenestra offers an example of how digital materials can be embodied with material qualities that enable them to be situated in the familiar context of artifact-mediated memorialization practices. These findings build on and expand prior work articulating the need for new design strategies that move beyond designing explicitly for 'use' and emphasize the aesthetics of integrating cherished digital materials into environments in more holistic ways over time [e.g., 15,21,43,48].

Supporting evolving personalization of digital materials for domestic memorialization—Another goal of our study was to explore how digital photos could provide a meaningful resource for domestic memorialization. The spaceless quality of digital photos—that an archive could be manifested through Fenestra in ways that could not have been easily achieved with physical photos—created opportunities to support memorialization activities. For Emi-H1 and Satoko-H2 it provided a resource to support practices that their material conditions had largely prevented. For Rikako-H3, Fenestra enabled her to draw on new materials that opened up a wider range of experiences than would have not been permitted in her formal butsudan. Yet participants also desired to augment Fenestra in diverse and unexpected ways. Emi-H1 wanted to only include images that highlighted one-to-one social bonds to honor these relationships and her grandmother’s life. While Rikako-H3 requested that both of her parents be present in the cropped mirror image, which prompted her ritual of ‘showing’ her parents photos of experiences she wished they could have been present at.

These examples help illustrate the complex, idiosyncratic, and evolving processes of socially constructing the identity of a departed loved one. As conceptualizations of the departed’s identity change, so too might rituals and practices of memorializing their life. However, tools to support these shifts as they unfold over time remain underdeveloped. These findings are in parallel to recent efforts in the HCI community articulating the need to critically consider how interactive systems might shape people’s practices over long periods of time [e.g., 12,39]. There is a need for future research to explore more flexible ways new technologies might be designed to represent digital content associated with a departed loved one’s life as perspectives change, practices evolve, and these technologies themselves may change hands across generations in the future.

Unintended consequences and broader implications—Undesirable encounters also emerged with Fenestra. These instances were triggered when the IR sensor embedded in the round mirror was inadvertently triggered by lighting changes in the local environment. Although Satoko-H2 interpreted such instances as extraordinary encounters, they produced uncomfortable emotions for other participants. These findings illustrate the sensitive threshold memorialization technologies operate on and how serious consequences can emerge if the system manifests behaviors that are unexpected and difficult interpret.

One possibility is that future research could engineer a higher degree of contextual awareness into memorialization systems to avoid such disruptions. Yet, it is possible that other disturbing encounters could emerge from errors in computational inferences about who is socially present and what digital content ought to be manifested. Our goal was not to engineer a perfect ‘solution’ to digital domestic

memorialization. Rather, we aimed to sensitize this nascent design space for future exploration within the HCI community. These findings make clear that sensing processes within memorialization technologies need to be treated with critical caution and come with significant potential pitfalls.

On a broader level, this study produced an unexpected dilemma for our own research team. Fenestra is a bespoke design artifact that participants knew they would not live with after the study concluded. However, participants did develop visible emotional connections to Fenestra and removing it from their lives left us, the research team, feeling uneasy. Yet, it is likely unrealistic (or impossible) for researchers to provide robust bespoke systems for participants to have and use indefinitely into the future. New initiatives are emerging to support the appropriate transfer of the departed’s online accounts to the bereaved [4,39]. However, it remains unclear how these issues should be handled with bespoke design artifacts—they could open up radically new way of conceptualizing memorialization technologies, but also come with potentially serious consequences. Recent work is starting to articulate potential dangers for researchers operating in this nascent research space [40]. There is a need to expand this discourse to develop more effective strategies for sensitively handling potential issues for all stakeholders surrounding the deployment (and possible extraction) of research products and prototypes in the future.

CONCLUSION

We designed Fenestra to critically explore how interactive technology could open up new opportunities for leveraging digital materials to support practices of domestic memorialization in Japan. Findings revealed opportunities to support such practices in unique and meaningful ways, and unintended consequences that new systems could raise. Our study provided a rare example of a research-through-design project situated in the context of Tokyo, Japan. There is a clear need for future work to expand to sites and practices elsewhere in the world. Ultimately, we hope this research will inspire the HCI community to explore designing technology aimed at supporting people’s self-determined, evolving practices of memorializing and remembrance, now and well into the future.

ACKNOWLEDGMENTS

We thank Naohito Okude, Masa Inakage, Hideki Sunahara, Masahiko Inami, and Susumu Shimazono for their supervision on the Fenestra project. We also thank our study participants, the reviewers for their insightful suggestions, and Carman Neustaedter and Rebecca Gulotta for feedback on earlier drafts of this paper. This work is supported in part by Keio University Graduate School of Media Design and a Banting Postdoctoral Fellowship through the Social Science and Humanities Research Council of Canada.

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