Giving Form to Temporality: Extending Design Practices and Methodologies for 'Slow' Interaction

Amy Yo Sue Chen

Everyday Design Studio

School of Interactive

Arts and Technology

Simon Fraser University

Surrey, BC, Canada

chenamyc@sfu.ca

Abstract

With an aim to extend and enlarge the slow technology concept [18], this overview describes my dissertation goal of exploring the diversity of temporal design within HCI. My motivation started from the real-world need to better support people to live with their vast and still growing digital possessions. I adopt Research through Design methodology and plan to propose two quality design cases and following empirical studies in order to understand how 'slow' everyday technologies should be to provide alternative thinking in temporality and curious interactive experience with digital possessions. Building on my emerging body of published research, the research outcome will be anticipated to support the creation of methodological practice-based insights and to provoke different perspectives on designing future technologies as contributions to HCI communities.

Author Keywords

Temporality; slowness; slow technology; interaction design; research through design; data; metadata.

CSS Concepts

• **Human-centered computing~Interaction design process and methods** • Human-centered computing~Interaction design theory, concepts and paradigms • Human-centered computing~Empirical studies in interaction design

Research Goals

1. *WHY*: Meeting the need to expand slow technology concept through a more diverse temporal frame
2. *HOW*: Applying slowness to address a problem related to people's interactions and relationships with technologies
3. *WHAT*: Providing cases to better support people to live with their vast and still growing digital possessions

Research Situation

I am in the middle of my third year in the Ph.D. program in School of Interactive Arts and Technology at Simon Fraser University. All coursework has been completed in the first year. I have several publications in CHI and DIS 2019 in my second year, and one submission currently under review for CHI 2020. Currently, I am preparing for my comprehensive exam and aim to pass it in Spring 2020.

Motivation

The main problem my dissertation work focuses on is how to better support people to live with their vast, overwhelming and still growing digital possessions. Nowadays, people's incalculable and ongoing creation of personal data and digital archives have drawn HCI researchers' attention. Taking digital photos as an example, it is estimated that people took roughly 1.2 trillion digital photos in 2017 alone [32]. Yet, it is difficult for people to grasp just how big their digital photo archives are and what is contained within them [45]. This phenomenon indicates an issue that the placeless, spaceless and formless nature of data [29] challenges people's sense of owning and meaningful relationship with their belongings. The situation is implied to get drastically worse in the longer term, especially for younger generations [5, 30].

Over the past decade, there has been a growing emphasis placed on what roles digital possessions play in people's everyday lives in consumer research area [1, 2, 8, 9]. In HCI, the emerging investigations on digital heritage and features of digital possessions [25, 29, 30] have indicated the diversity of ways people generate, gain, preserve and dispose digital possessions. In addition, there has been an exploration of human-object relationships during difficult stages such as periods after a romantic breakup [21, 22, 34] and decease of an important other [27, 35]. Numerous studies have also indicated the need for more various approaches to designing interactive systems that support reminisce, reflection and curious exploration of digital archives over time [10, 26, 38, 39, 41, 42]. Although these investigations into experiences of owning, preserving, caring and forgetting digital possessions help to draw attention to people's living

experience with digital technologies, they have only explored either how people experience the existing digital media or how new technologies propose innovative expressions to interact with countable digital objects. Few works have explored how to look at personal data and digital possessions in more macro and meaningfully analytical ways through the lens of *extended self*, a concept that employs possessions to empower ourselves, represent who we are, maintain a sense of past and reconstruct self-identities [3]. As personal data and digital possessions both record timestamps upon creation and accumulate over time, I started to study works pertaining to temporality.

Why giving form to temporality?
In 2001, Hallnäs and Redström proposed slow technology as: "*a design agenda for technology aimed at reflection and moments of mental rest rather than efficiency in performance*" [18]. Ever since then, numerous research studies emerged to enforce the slow pacing to make room for reflection [7, 20, 26, 31, 39]. Moreover, it has transformed how designers make decisions to promote slowness [43, 44].

However, as opposed to the *delayed expression* [38] designed in the early slow technology examples, many researchers have recently turned to discuss alternative conceptualizations of time. Several works such as *rhythms of pause* [13], intersection of *clock time* and *digital time* [24], and *crescendo expression* [38] (my master's project) have articulated the temporal structures of experiences. In parallel, Pschetz [33] makes a compelling argument that it is essential for interaction design research to inquire into generating new possibilities for people to perceive and consider multiple temporalities. The temporal properties of

physical materials such as decay and patination are also explored through HCI studies (e.g., [40]). Albeit from a different perspective, Huang and Stolterman's work emphasizes awareness and analysis of temporality [23]. In sum, the form and expression of temporality have received considerable attention and given rise to questions: (i) whether the interactive pace should be in an extreme binary of fast and slow representations when designing technologies, and (ii) whether slow pacing is the only way to support reflection and mental rest. With these higher-level targets in mind, I developed my research questions and approaches that aim to apply and extend an enriched framing of slow technology to address a real-world problem in relation to people's experience with digital possessions.

Research Questions and Approaches

As prior works have shown the need to find more diverse ways to conceptualize and design with temporality, there is a design space to explore how slowness could be treated and incorporated differently in the way we design technologies (not just applying the slow pacing). In the context of designing interactive experience with digital possessions, there is one specific resource that could help to leverage reflection and self-representation as a design material—temporal metadata.

Using temporal metadata as design materials
As a by-product of people's interactions with digital devices and storage systems, a standardized, accessible form of timestamp metadata is generated that captures precisely when a digital file (e.g., text, photo, audio and video) was originally created. Yet, the productive application of metadata has been largely overlooked and under-explored as design materials to

support reflective and curious interactive experience. In recent years, there is a small growing amount of research projects that have investigated how personal data can be represented in new ways to support reflection on people's everyday experiences [11, 17, 29]. Therefore, my overarching research questions are:

1. How might meaningful experiences with personal digital archives be supported and sustained as they grow, expand, and age over time?

2. What opportunities exist for metadata to be leveraged as a design resource that supports new ways of experiencing the trajectory of digital data one has accumulated in their life?

To explore these questions and ground my own thinking, I adopt *Research through Design* methodology [46] and qualitative research methods to provide real-world designs and experiences as evidence and inquire what insights future interaction designers and researchers should take into consideration. My design attitude was influenced by several approaches including slow technology [18], ludic design [15, 16], reflective design [36]. These design practice-based approaches aim to explore possible futures with people's real-life experiences and to surface alternative perspectives and experiences in comparison with computational solutions where, most of the time, optimization is arbitrary. Moreover, the design lab and studio environment I am in have supported me to iteratively and simultaneously experiment with digital prototypes and physical forms. These resources enabled me to iteratively examine the interplay among interaction, temporal expression, physical form, and materials, and their individual and collective relation to my conceptual framing.

Previous Projects
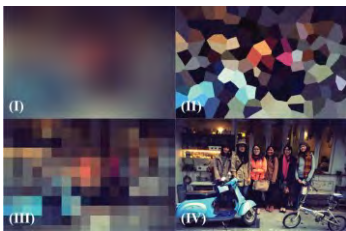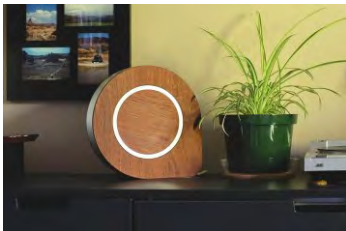

Figure 1: Mettle

Figure 2: CrescendoMessage

Figure 3: Olly

Figure 4: Slow Game

Research Accomplishments To Date

To date, I have accumulated and published several research papers and projects to support my investigation into the above research questions. For instance, *Mettle* (See Figure 1) [6] and *CrescendoMessage* (See Figure 2) [38], are two slow messaging design cases that elicit how gradational information exposure could trigger people's curiosity, anticipation and reflection. These experiences led me to join Everyday Design Studio and started my participation in projects such as Olly and Slow Game. As Figure 3 shows, *Olly* is a domestic music player that enables people to re-experience digital music they listened to in the past [28]. Olly uses its owner's Last.FM listening history metadata archive to occasionally select a song from their past but offers no user control over what is selected or when. This project allows us to explore how its slow pace might provoke reflections on the temporalities of personal data and technology. On the other hand, *Slow Game* (Figure 4) is a small 5cm cube, with a low-resolution display consisting of 64 tiny white lights that are muted through a thin veneer. Exploring various games (see [37]), we selected the classic mobile phone game 'snake', where the player maneuvers a line that grows in length, with the line itself being a primary obstacle. Our version of snake is played by physically rotating the cube, which turns the direction that the snake moves; the user can set the orientation of the next move, but it will only make the move about once per day. Overall, the above projects enable our thinking about time in different aspects, which directs me to first thesis project, Chronoscope.

Design Study I: Investigating temporally diverse interaction with personal digital photo archives Chronoscope is a domestic technology that leverages temporal metadata embedded in digital photos as a resource to encourage more temporally diverse, rich, and open-ended experiences when re-visiting one's digital photo archive. It provides a design example of how people could experience differently with the massive personal digital photo archives through visual reorganizations of vast amount of photos based on temporal metadata generated at the moment the photo was taken.

Figure 5: The Chronoscope UI visualizes the central photo's location in time and provides corresponding data around it.

Chronoscope enables users to interact with their photo archive through three rotational controls on viewing directions, timeframe modes, and viewing granularity. When peering into Chronoscope, a single photo tied to the specific time that it was taken (based on its timestamp metadata) will be visible (see Figure 5). A rotating wheel, as the scope's main feature, controls two directions: navigating forward and backward in time within the selected timeframe mode (see Figure 7). Navigating in a timeframe mode occurs through a rotational movement (clockwise to move forward in

Figure 6: Chronoscope in a domestic context

Figure 7: Scenario of interacting with Chronoscope

Figure 8: Peering into the eye piece, the user views photos from her past.

Figure 9: The act of switching modes with the bigger knob

time and counterclockwise to move backward). We selected physical rotation for this input as a subtle analogy to the circular shape of clocks and the temporal flow evoked by their movement. By rotating either direction, the user sees each photo in relation to a wide spectrum of other photos in the archive. When the user stops the rotation, Chronoscope settles on the specific photo associated with where 'in time' the position is in relation to selected timeframe mode. When switching the bigger knob on the side of the scope (see Figure 9), users can seamlessly toggle between different temporal organizations of their archive through three timeframe modes (linear, date, time). When a new mode is selected, the center photo in view does not change, while the surrounding photos are replaced with ones from the new timeframe.

These design moves were key to the early success of our design process. However, we quickly encountered additional design issues. The sheer size of digital photo archives could easily leave users *stuck in time* – it could require days of continuous rotations simply to navigate through all of one's digital photos if one photo or a few advanced per one rotation (indeed it is easy to imagine that it could take weeks or months as we consider the size of digital photo archives in the near future). This prompted us to design an additional interaction feature that could enable users to 'tune' the number of photos that would be advanced per rotation. Yet, this introduced other challenges. If the upper threshold was too high, then a user could easily become *lost in time* as they navigated a large amount of photo in one turn (i.e., effectively flashing ahead into the future or back into the past without a clear point of reference). Ultimately, through an iterative process, we determined that an approximate threshold that would help mitigate

these collective design issues – at least for the time being.

With added control over the number of photos to be moved across in each degree of rotation, people would be able to 'tune' the speed through time that they move across elements in their photo archive. This decision was influenced in part by Gaver and colleagues' concept of balancing control and drift [15, 16]. The 'tuning' feature opens up more freedom and flexibility for the user to move through photos from minutes in a day to years of one's life, making it easy to slow down or speed up in real time. Ultimately, we found this design decision to be valuable in that it makes use of metadata to support not only movement *across* time (both the linear and non-linear modes), but also movement *through* time in a more extended or diverse way.

Future Dissertation Work
Empirical Study I: Exploring photo viewing experience through and across time in an everyday context (currently in progress)
Our design team aimed to describe, unpack, and critically reflect on the Chronoscope in a generative way to inspire future design-oriented research that inquiries into the place, pace, and expression of personal or social data in people's everyday environments. In this study, we aim to create a small batch of highly finished, robust Chronoscopes to deploy and study in the context of people's everyday lives. We want to further understand how temporal metadata can be applied as a design material to support linear and non-linear encounters with prior life experiences captured in personal digital photo archives. On a broader level, we hope that our detailed reflexive description of

Conclusion

In conclusion, the practice-based approach enables me to pursue why and how people's interaction with digital possessions are sometimes difficult to support reflection, contemplation and social interactions. After all, designing interactive systems that helps people understand, manipulate and speculate the meaning behind data creates opportunities to discuss and anchor the future world we desire.

Chronoscope and discussion of the resulting implications can be appreciated as an effort to better support design-oriented forms of knowledge production in the HCI community.

Design Study II: Investigating temporally diverse interaction for inter-generational understanding of contextual and biographical data (currently starting)
Expanding Chronoscope's insights of experiencing digital possessions through and across time, I am getting interested in how these tuning features could be experienced in social interaction. Oftentimes, inter-generational communication is hard to grasp as people are not fully provided with enough information of the cultural and political context in different generation eras. Inspired by Elsden et al.'s work of *documentary informatics* [12], I plan to propose a long-term design service that facilitates families to document their life story data privately, and then share their stories in person with control over timeframe modes and time granularity. Moreover, this design service includes another dimension called <u>timeline</u> *calibration*, which enables people to explore stories either based on the absolute calendar time or based on human lifespan. The story data types and visualization styles will be brainstormed in our studio. I aim to build the service system and finish this design study by the end of 2020.

Empirical Study II: Exploring people's attitude and relationship in composing and sharing documentary informatics over time
After the design exploration, I will be focusing on the social aspects of presenting and querying data *through* and *across* time *between* data owners. I aim to recruit a small but varied sample of families to participate in the empirical study.

Current and Expected Contributions

My doctoral research will hopefully extend and bring together a range of previous studies of slow technology and temporal interaction design. I plan to make three research contributions.

Contribution I: Providing design cases with subjectivity
By conducting the two design studies, we as a design team gets to dig into design details and, through the experience of crafting, cultivates a sense of *meaningful temporal relations* to people. Most importantly, we are able to showcase two unique but concrete examples for future researchers to take consideration of giving form to temporality.

Contribution II: Collecting empirical data for objectivity
Once we complete the design process, it is essential to understand how people's lived experience with the proposed design cases vary or converge. This approach not only confirms the objectivity of our research but also leads to insights that we as researchers could never imagine.

Contribution III: Surfacing methodological practice-based insights for more temporally diverse design
Along with the two design cases and the following empirical studies, I aim to view the works through a theoretical lens by creating an annotated portfolio [4, 14, 19]. By doing so, the prior & ongoing works would possibly help surface several practice-based insights to answer the questions we have for advancing slow technology concept, and to explore how temporality could be approached and expressed in certain relational forms (e.g., different organizations of temporal data).

References

[1] Amber L. Cushing 2014. A Balance of Primary and Secondary Values: Exploring a Digital Legacy. *International Journal of Knowledge Content Development and Technology*. 3, 2 (2014), 67–94. DOI:https://doi.org/10.5865/IJKCT.2013.3.2.067.

[2] Belk, R.W. 2013. Extended Self in a Digital World. *Journal of Consumer Research*. 40, 3 (Oct. 2013), 477–500. DOI:https://doi.org/10.1086/671052.

[3] Belk, R.W. 1990. The Role of Possessions in Constructing and Maintaining a Sense of Past. *Advances in Consumer Research North American Advances*. (1990).

[4] Bowers, J. 2012. The Logic of Annotated Portfolios: Communicating the Value of "Research Through Design." *Proceedings of the Designing Interactive Systems Conference* (New York, NY, USA, 2012), 68–77.

[5] Boyd, D. 2007. *Why Youth (Heart) Social Network Sites: The Role of Networked Publics in Teenage Social Life*. Technical Report #ID 1518924. Social Science Research Network.

[6] Chen, A.Y.S., Liang, R. and Liang, R. 2015. Mettle: Reframing Messaging as a Felt Anticipation. *HCI International 2015 - Posters' Extended Abstracts*. Springer International Publishing. 84–90.

[7] Cheng, J., Bapat, A., Thomas, G., Tse, K., Nawathe, N., Crockett, J. and Leshed, G. 2011. GoSlow: Designing for Slowness, Reflection and Solitude. *CHI '11 Extended Abstracts on Human Factors in Computing Systems* (New York, NY, USA, 2011), 429–438.

[8] Cushing, A.L. 2013. "It's stuff that speaks to me": Exploring the characteristics of digital possessions. *Journal of the American Society for Information Science and Technology*. 64, 8 (2013), 1723–1734. DOI:https://doi.org/10.1002/asi.22864.

[9] Cushing, A.L. 2011. Self extension and the desire to preserve digital possessions. *Proceedings of the American Society for Information Science and Technology*. 48, 1 (2011), 1–3. DOI:https://doi.org/10.1002/meet.2011.14504801304.

[10] Durrant, A., Frohlich, D., Sellen, A. and Lyons, E. 2009. Home curation versus teenage photography: Photo displays in the family home. *International Journal of Human-Computer Studies*. 67, 12 (2009), 1005–1023.

[11] Elsden, C., Kirk, D., Selby, M. and Speed, C. 2015. Beyond Personal Informatics: Designing for Experiences with Data. *Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems* (New York, NY, USA, 2015), 2341–2344.

[12] Elsden, C., Kirk, D.S., Durrant, A.C. and Chatting, D. 2017. Designing Documentary Informatics. *Proceedings of the 2017 Conference on Designing Interactive Systems* (New York, New York, USA, 2017), 649–661.

[13] Friedman, B. and Yoo, D. 2017. Pause: A Multi-lifespan Design Mechanism. *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (New York, NY, USA, 2017), 460–464.

[14] Gaver, B. and Bowers, J. 2012. Annotated Portfolios. *Interactions*. 19, 4 (Jul. 2012), 40–49. DOI:https://doi.org/10.1145/2212877.2212889.

[15] Gaver, W., Boucher, A., Bowers, J., Blythe, M., Jarvis, N., Cameron, D., Kerridge, T., Wilkie, A., Phillips, R. and Wright, P. 2011. The Photostroller: Supporting Diverse Care Home Residents in Engaging with the World. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (New York, NY, USA, 2011), 1757–1766.

[16] Gaver, W.W., Bowers, J., Boucher, A., Gellerson, H., Pennington, S., Schmidt, A., Steed, A., Villars, N. and Walker, B. 2004. The Drift Table: Designing for Ludic Engagement. *CHI '04 Extended Abstracts on Human Factors in Computing Systems* (New York, NY, USA, 2004), 885–900.

[17] Gulotta, R., Sciuto, A., Kelliher, A. and Forlizzi, J. 2015. Curatorial Agents: How Systems Shape Our Understanding of Personal and Familial Digital Information. *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems* (New York, NY, USA, 2015), 3453–3462.

[18] Hallnäs, L. and Redström, J. 2001. Slow Technology – Designing for Reflection. *Personal Ubiquitous Comput.* 5, 3 (Jan. 2001), 201–212. DOI:https://doi.org/10.1007/PL00000019.

[19] Hauser, S., Oogjes, D., Wakkary, R. and Verbeek, P.-P. 2018. An Annotated Portfolio on Doing Postphenomenology Through Research Products. *Proceedings of the 2018 Designing Interactive Systems Conference* (New York, NY, USA, 2018), 459–471.

[20] Hawkins, D., Neustaedter, C. and Procyk, J. 2015. Postulater: the design and evaluation of a time-delayed media sharing system. *Proceedings of the 41st Graphics Interface Conference* (2015), 249–256.

[21] Herron, D., Moncur, W. and van den Hoven, E. 2017. Digital Decoupling and Disentangling: Towards Design for Romantic Break Up. *Proceedings of the 2017 Conference on Designing Interactive Systems* (New York, NY, USA, 2017), 1175–1185.

[22] Herron, D., Moncur, W. and van den Hoven, E. 2016. Digital Possessions After a Romantic Break Up. *Proceedings of the 9th Nordic Conference on Human-Computer Interaction* (New York, NY, USA, 2016), 36:1–36:10.

[23] Huang, C.-C. and Stolterman, E. 2011. Temporality in Interaction Design. *Proceedings of the 2011 Conference on Designing Pleasurable Products and Interfaces* (New York, NY, USA, 2011), 62:1–62:8.

[24] Lindley, S.E. 2015. Making Time. *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing* (New York, NY, USA, 2015), 1442–1452.

[25] Odom, W., Banks, R., Kirk, D., Harper, R., Lindley, S. and Sellen, A. 2012. Technology Heirlooms?: Considerations for Passing Down and Inheriting Digital Materials. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (New York, NY, USA, 2012), 337–346.

[26] Odom, W., Selby, M., Sellen, A., Kirk, D., Banks, R. and Regan, T. 2012. Photobox: On the Design of a Slow Technology. *Proceedings of the Designing Interactive Systems Conference* (New York, NY, USA, 2012), 665–668.

[27] Odom, W., Uriu, D., Kirk, D., Banks, R. and Wakkary, R. 2018. Experiences in Designing Technologies for Honoring Deceased Loved Ones.

Design Issues. 34, 1 (2018), 54–66. DOI:https://doi.org/10.1162/DESI_a_00476.

[28] Odom, W., Wakkary, R., Hol, J., Naus, B., Verburg, P., Amram, T. and Chen, A.Y.S. 2019. Investigating Slowness As a Frame to Design Longer-Term Experiences with Personal Data: A Field Study of Olly. *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (New York, NY, USA, 2019), 34:1–34:16.

[29] Odom, W., Zimmerman, J. and Forlizzi, J. 2014. Placelessness , Spacelessness , and Formlessness : Experiential Qualities of Virtual Possessions. (2014), 985–994.

[30] Odom, W., Zimmerman, J., Forlizzi, J., Choi, H., Meier, S. and Park, A. 2012. Investigating the Presence, Form and Behavior of Virtual Possessions in the Context of a Teen Bedroom. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (New York, NY, USA, 2012), 327–336.

[31] Odom, W.T., Sellen, A.J., Banks, R., Kirk, D.S., Regan, T., Selby, M., Forlizzi, J.L. and Zimmerman, J. 2014. Designing for Slowness, Anticipation and Re-visitation: A Long Term Field Study of the Photobox. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (New York, NY, USA, 2014), 1961–1970.

[32] People will take 1.2 trillion digital photos this year: 2018. *htp://www.businessinsider.com/12-trillion-photos-to-be-taken-in-2017-thanks-to-smartphones-chart-2017-8*.

[33] Pschetz, L. and Bastian, M. 2018. Temporal Design: Rethinking time in design. *Design Studies*. 56, (May 2018), 169–184.

DOI:https://doi.org/10.1016/j.destud.2017.10.007.

[34] Sas, C. and Whittaker, S. 2013. Design for Forgetting: Disposing of Digital Possessions After a Breakup. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (New York, NY, USA, 2013), 1823–1832.

[35] Sas, C., Whittaker, S. and Zimmerman, J. 2016. Design for Rituals of Letting Go: An Embodiment Perspective on Disposal Practices Informed by Grief Therapy. *ACM Trans. Comput.-Hum. Interact.* 23, 4 (Aug. 2016), 21:1–21:37. DOI:https://doi.org/10.1145/2926714.

[36] Sengers, P., Boehner, K., David, S. and Kaye, J. 2005. Reflective design. *Proceedings of the 4th decennial conference on Critical computing: between sense and sensibility* (2005), 49–58.

[37] Slow Game Website: 2015. *ishback.com/slowgames/*.

[38] Tsai, W.-C., Chen, A.Y.S., Hsu, S.-Y. and Liang, R.-H. 2015. CrescendoMessage: interacting with slow messaging. *Proceedings of the 2015 International Association of Societies of Design Research Conference (IASDR'15)* (2015).

[39] Tsai, W.-C., Wang, P.-H., Lee, H.-C., Liang, R.-H. and Hsu, J. 2014. The Reflexive Printer: Toward Making Sense of Perceived Drawbacks in Technology-mediated Reminiscence. *Proceedings of the 2014 Conference on Designing Interactive Systems* (New York, NY, USA, 2014), 995–1004.

[40] Tsaknaki, V., Cohn, M., Boer, L., Fernaeus, Y. and Vallgarda, A. 2016. Things Fall Apart: Unpacking the Temporalities of Impermanence for HCI. *Proceedings of the 9th Nordic Conference on Human-Computer Interaction* (New York, NY, USA, 2016), 141:1–141:3.

[41] Uriu, D. and Okude, N. 2010. ThanatoFenestra: Photographic Family Altar Supporting a Ritual to Pray for the Deceased. *Proceedings of the 8th ACM Conference on Designing Interactive Systems* (New York, NY, USA, 2010), 422–425.

[42] Uriu, D., Shiratori, N., Hashimoto, S., Ishibashi, S. and Okude, N. 2009. CaraClock: An Interactive Photo Viewer Designed for Family Memories. *CHI '09 Extended Abstracts on Human Factors in Computing Systems* (New York, NY, USA, 2009), 3205–3210.

[43] Vallg\a arda, A. 2013. Giving form to computational things: developing a practice of interaction design. *Personal and Ubiquitous Computing*. 18, 3 (Jun. 2013), 577–592. DOI:https://doi.org/10.1007/s00779-013-0685-8.

[44] Vallgarda, A., Winther, M., Mørch, N. and Vizer, E.E. 2015. Temporal form in interaction design. *International Journal of Design*. 9, 3 (2015).

[45] Whittaker, S., Bergman, O. and Clough, P. 2010. Easy on That Trigger Dad: A Study of Long Term Family Photo Retrieval. *Personal Ubiquitous Comput.* 14, 1 (Jan. 2010), 31–43. DOI:https://doi.org/10.1007/s00779-009-0218-7.

[46] Zimmerman, J., Forlizzi, J. and Evenson, S. 2007. Research Through Design As a Method for Interaction Design Research in HCI. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (New York, NY, USA, 2007), 493–502.