

# Tensions and Techniques in Investigating Longitudinal Experiences with Slow Technology Research Products

William Odom

**Abstract** How can technologies be created that take on a long-term place in people's lives and that coevolve with them over time? What kinds of qualities should designers consider in crafting such kinds of computational things? And, how should we study and evaluate such new technologies through a longer temporal frame? In this chapter, we draw on examples of longitudinal field studies of the Photobox and Olly research products to explore these questions and to detail tensions and techniques that emerged across these two cases. Our findings reveal key tensions that researchers ought to be wary of when conducting longitudinal field studies of slow technology research products and techniques that can be applied to mitigate them.

**Keywords** Research products · Slow technology · Research through design

## 1 Introduction

The convergence of social, cloud, and mobile computing has created a world in which people generate, access, manipulate, and share personal digital data at larger scales and faster rates than ever before. From digital photo albums to online music streaming services, these new technologies have enabled people to create vast archives of digital data that capture their life experiences. These shifts raise complex questions for the HCI community as we critically look to the future and consider their longer-term implications. As archives continue to grow, what roles can personal data play in supporting people's evolving understandings of self as they change over time? What kinds of qualities should designers consider in crafting a longer-term place for computational things in everyday life? How should we study and evaluate such new technologies through a longer temporal frame?

These questions are motivated by the fact that the form of contemporary personal data generation opens up new opportunities to enable people to re-experience past life experiences, relationships, tastes, patterns, and idiosyncrasies in new and potentially

William Odom  
School of Interactive Arts and Technology, Simon Fraser University. Surrey, BC,  
Canada  
e-mail: [wodom@sfu.ca](mailto:wodom@sfu.ca)

Final version published as:

Odom, W. (2021). Tensions and Techniques in Investigating Longitudinal Experiences with Slow Technology Research Products. In: Karapanos, E., Gerken, J., Kjeldskov, J., Skov, M.B. (eds) *Advances in Longitudinal HCI Research. Human-Computer Interaction Series*. Springer, Cham. 153-176.  
[https://doi.org/10.1007/978-3-030-67322-2\\_8](https://doi.org/10.1007/978-3-030-67322-2_8)

valuable ways. They also point to how little is known about what design strategies might be effective in designing meaningful experiences with personal data archives over time, and what concepts could help productively frame design inquiries in this emerging research territory. More generally, there are growing calls in the HCI community to develop design approaches that enable people to interact with their personal data in reflective, contemplative, and curious ways (e.g., [1, 2]). However, examples illustrating how such rich, open-ended engagements with personal data can be supported through the creation and longitudinal evaluation of new design artifacts remains sparse in HCI.

*Photobox* and *Olly* are two projects that aim to contribute precisely to this intersection. *Photobox* is a domestic technology embodied in the form of an antique wooden chest that prints four or five randomly selected photos from the owner's Flickr collection at random intervals each month (see [3, 4]). Three *Photoboxes* were deployed through longitudinal field studies in three different households simultaneously for fourteen months. *Olly* is a domestic music player that enables people to re-experience digital music they have listened to previously. *Olly* works by making use of its owner's Last.FM [5] personal music listening history archive to occasionally randomly select a song from its owner's past and make it available to be played (see [6, 7]). Three *Ollys* were deployed through longitudinal field studies in three different households simultaneously for fifteen months. In the case of both *Photobox* and *Olly*, study participants had no control over when the artifact would decide to select and surface personal data from their past or when. The behaviors of both *Photobox* and *Olly* occurred randomly and somewhat seldomly, but continued indefinitely. Taken together, these design artifacts investigate how new forms of interaction and experience design might enable personal data archives to be more materially present and temporally expressive in people's everyday lives to support ongoing experiences of reflection and reminiscence. These projects also aim to investigate the application of *slow technology* [8] and how this concept could challenge the idea of domestic technology being always on and accessible and lead to an interaction pace that might sustain longer-term experiences with personal data.

The design qualities of *Photobox* and *Olly* raise key questions for longitudinal HCI research: How should researchers approach conducting longitudinal field studies of design artifacts that intentionally aim to operate slowly, in the background of everyday life? What are effective techniques for opening a space for discussion on a slow technology with study participants, while also balancing the need to not force too much attention onto it? How should researchers explore participants' potentially changing relations with a slow technology that they may only occasionally interact with directly?

In this chapter, we draw on examples from the longitudinal field studies of *Photobox* and *Olly* to explore these questions and to detail tensions and techniques emerged across the two cases. Next, we offer a brief background on the *research product* methodology [9] that in part emerged out of the *Photobox* project and that subsequently influenced the *Olly* field study. Then, we describe and reflect on key

examples from each longitudinal field study. This chapter concludes with a discussion and reflection on lessons learned across these projects and techniques that can be mobilized in future HCI research.

## 2 Background and Approach: Research Products

Prototypes have had a long and important history in the HCI community. Prototyping has, and continues to be, an instrumental practice in supporting HCI researchers to develop, refine, and test theories, concepts, and interactive systems through an iterative, human-centered approach. The use of prototyping and prototypes to elicit feedback from people plays a significant role in pursuing the question of how new technologies can be created that are intelligible, usable, and enjoyable to interact with. Yet, prototypes are often of a limited fidelity and robustness which introduces challenges in using them in longitudinal field studies.

In parallel, the kinds of questions that HCI researchers are pursuing continue to expand. The focus of a growing portion of recent research in the HCI community has moved beyond designing for efficient use to investigating complex matters of human technology relations that often involve messy, intimate, and contested aspects of everyday life. These kinds of questions include: What roles could—or *should*—interactive technology play when we consider it as a long-term, evolving component of everyday life? How do technologies mediate between humans and their actions in the world? How do choices that go into the materials, form, and computation of interactive systems shape human relations to them? And, how do these relational qualities change over time?

While the fidelity of prototypes can range, they remain references to future products, systems, or services. In this way, prototypes are placeholders for *something else*; they are an instantiation of a future outcome [10]. Within HCI research, a prototype may be the manifestation of a theoretical concept not to be judged for its actuality or present state, but rather its potential [11]. Prototypes are also often assumed to be a point on a trajectory toward a fully realized commercial product used to test specified needs or unmet requirements. In either case, new knowledge and insights are produced through the use of research prototypes that has clear value. From a high level, the research product concept helps extend the capacity for developing new knowledge through the longitudinal study of design artifacts.

The concept of a research product emphasizes the nature of the engagement that people have with an artifact predicated on *what it is* as opposed to what it *might become*. It is this core distinction that led to the term ‘research product’ in reference to the final and actual nature of the artifact. This is in contrast to a ‘research prototype’ that refers to a final concept but the artifact itself may be transitional or in-progress. The term ‘research product’ emphasizes the actuality of the design artifact helping to overcome the limitations of prototypes when investigating complex matters of human technology relations over time. Importantly, the term ‘product’ does not aim to suggest these kinds of artifacts are intended to be commercial products,

or produced at commercial scale and volume. Research products exhibit key qualities that can help productively support longitudinal field studies of design artifacts in people's everyday lives. The conceptualization of the research product concept emerged through the ongoing design, deployment, and analysis of design artifacts (see [9] for more details). These qualities include the following:

***Inquiry driven:*** A research product aims to drive a research inquiry through the experience of a design artifact in a longitudinal study. Research products are designed to ask particular research questions about potential alternative futures. They embody theoretical stances on a research issue or set of issues. Photobox and Olly aimed to inquire into how the conceptual framing of slow technology could open up new ways of supporting rich, ongoing experiences with personal data for each of our respective field study participants.

***Finish:*** A research product is designed such that the nature of the engagement that people have with it is predicated on *what it is* as opposed to what it *might become*. It emphasizes the actuality of the design artifact. Photobox and Olly operated largely on their own, occasionally presenting elements from our respective participants' personal digital archives (e.g., in the form of a printed photo or a song from their past). Both of these design artifacts needed to have a high quality of finish such that participants could encounter these recurrently over a long period of time (more than one year) and reflect on their evolving relation to the them as well as the personal data that they slowly, yet continually surfaced.

***Fit:*** The aim of a research product is to be lived with in an everyday environment over time. Under these conditions, nuanced dimensions of human experience can emerge and be studied. In the cases of both Photobox and Olly, achieving a quality of fit was essential to investigating our participants situated experiences with and their perceptions of living with a slow technology. Fit requires the artifact to balance the delicate threshold between being neither too familiar nor too strange, such that cycles of direct engagement and interaction can emerge and while also enabling the design artifact to fade into the background of everyday life. Photobox was embodied in the form of an antique wooden chest that required a user to actively decide to open it up to see if a photo from their past was waiting for them inside. Olly was embodied in a more teardrop-like form factor that enabled it to operate in any orientation (i.e., lying flat on either side or in any orientation standing up). We anticipated this design feature would enable end users to integrate their Olly into wherever they deemed most appropriate in their home and to adapt it to new domestic environments and situations over time. In the case of both design artifacts, design decisions around their form were carefully guided by the need to achieve a high quality of fit in our participant's respective households.

***Independent:*** A research product operates effectively when it is freely deployable in the field for an extended amount of time. This means that from technical, material, and design perspectives, a research product can be lived with for a long duration in everyday conditions. The quality of independence was crucial for studying Photobox and Olly as they needed to remain robust and independently functioning even though they may only enact their computational behavior (e.g., printing a photo, or beginning to rotate when a song is selected) relatively rarely.

In summary, Photobox and Olly are research products—artifacts designed to drive a research inquiry and that have a high quality of finish such that people engage with them as is, rather than what they might become; and, that operate independently in everyday settings over time. Low-volume batches of Photobox (3 total) and Olly (3 total) were produced for longitudinal field studies of each. Next, we describe each case with a focus on how lessons learnt from the Photobox study productively influenced how we conducted the longitudinal field study of Olly.

### 3 Case 1: The Photobox Longitudinal Field Study

The Photobox is a WiFi-connected domestic technology embodied in the form of a well-worn antique chest that prints four or five randomly selected photos from the owner’s Flickr [5] photo collection at random intervals each month.

We intended the Photobox form to appear familiar to other non-digital cherished things, aiming for its material aesthetics to evoke a sense of warmth associated with older domestic artifacts. We settled on the final design because of its distance from contemporary ‘technology’ (i.e., oak compared to plastic). The two main components of Photobox are an antique oak chest and a Bluetooth-enabled Polaroid Pogo printer (which makes 2" × 3" prints). We decided on using a chest that had already gathered a healthy amount of patina as it seemed to symbolize a well-aged artifact that could support the idea of revisiting past experiences whose materials could inspire a sense of *perceived durability* [12]. To this end, we decided to use a printer to make digital photos material, contrasting the potential durability of paper prints with digital files. We augmented the oak chest with an upper panel to hide the technological components. The printer was installed behind the upper panel with a laser cut and press fitted acrylic case securing it to a small opening in the panel (to allow a photo to drop onto the central platform of the box). This helped integrate all technology used to print photos into a form that enabled it to be opened up and later put away. This choice was influenced by prior work articulating the value of *designing technologies to be put away* [13] (Fig. 1).

Every month, the Photobox prints four or five photos randomly pulled from its owner’s Flickr archive. To do this, at the beginning of each month, the participant’s Flickr archive is indexed. The.NET Photobox service application we developed then enacts the following set of procedures (which we call *layered randomness*). It randomly makes a binary decision to print either four or five photos that month. Then, it randomly selects four (or five) photos from the index and generates four (or five) randomly selected ‘future print times tamps,’ which specify the print time and date for each photo. Each photo is uniquely associated with a time stamp, respectively. When the date and time arrive associated with a time stamp, the matching photo is printed. This application runs on a laptop that communicates wirelessly with the Photobox printer via Bluetooth. We lived with the three Photobox prototypes for a four-month period to debug the system prior to deployment and to develop a general sense for how many photos should be printed each month.



**Fig. 1** Photobox occasionally randomly selects photos from its owners past and prints them. A wireless printer is mounted above the black rectangular opening in the upper cabinet; when a photo prints, it drops onto the bed of the chest. No information is provided to signal when or if a photo has printed

Photobox’s behavior was intentionally designed to be autonomous, not requiring input from the user. This choice was partly influenced by prior work describing how ceding autonomy to a system can enable new ways for people to meaningful experience their digital content [14] and, more generally, open a space for pause and contemplation [15]. We could have curated a special selection of photos from a person’s collection to appear in their Photobox. However, randomness was selected to introduce a potentially unfamiliar and disruptive machine behavior. We wanted to explore how people might confront a technology delving into their personal archive and how their perceptions might change over time.

### ***3.1 Field Study Method***

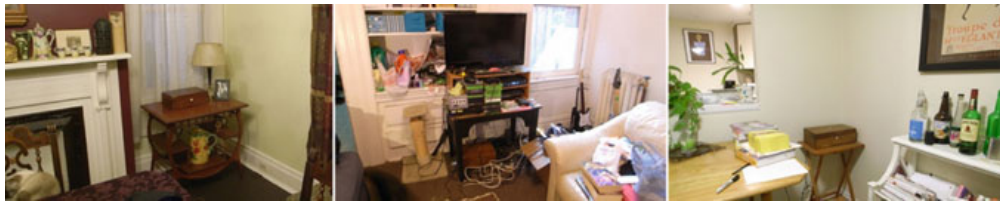
We deployed three nearly identical Photoboxes in three different households for 14 months from early 2012 to mid-2013 (see [3] for more details). Similar to the aim and ambition of the original technology probes paper [16], and several field studies since then (e.g., [17–19]), a smaller selection of households was initially selected to focus on in order to gain a richer descriptive understanding of the space as a whole to inform what might be salient issues for future research.

We recruited participants from three different households in the greater Pittsburgh, Pennsylvania (USA) metropolitan area for our field study. We use the term ‘primary participant’ to differentiate between the main ‘owner’ of the Flickr account that is embodied in a Photobox and ‘secondary participant’ as other household members that also lived with the Photobox during the study. All primary participants were familiar with technology, owned digital cameras, and at least one member of each household owned a Flickr account with unlimited storage. Pseudonyms are used to describe household members.

**Household 1** (H1) consisted of Tim (aged 48, bookstore clerk) and Britt (42, librarian), a married couple who had lived in their current home for ten years. Tim and Britt shared their Flickr account, contributing photos to it nearly equally; they had approximately 4,500 photos in their 7-year-old archive at the start of the study.

**Household 2** (H2) consisted of five roommates (two female, three male): Heather (31, massage therapist), Zack (28, grocery store employee), Thomas (30, technician), Jenn (29, postal service employee), and James (29, barista). They had been living together for 18 months. Heather was the primary participant in household two and the sole owner of the Flickr account; several of her roommates are featured in many photos in it. She had approximately 2500 photos in her 5-year-old archive at the start of the study. **Household 3** (H3) consisted of Samuel (35, insurance salesman) and Shelly (34, legal clerk), a couple who had been living together in the same apartment for nearly two years. Samuel was the primary participant and the sole owner of his 6-year-old Flickr account. He had approximately 3000 photos in it at the start of the study (Fig. 2).

Participants owning the Flickr accounts used in this study all reported similar shifts in interaction with that service over time. Initially, they had been active members in the Flickr community, using the service to support social relationships, and as an outlet for self-expression (these trends in behavior match findings from prior research on Flickr) [20]. However, all account owners had become much less active in the Flickr community. At the time of this study, participants’ primary use of their Flickr accounts was as storage for their digital photo collections (approximately between five to sixty photos were uploaded each month). Consequently, our participant pool helped support our goal of exploring how people might more meaningfully revisit their photo archive on a general level.



**Fig. 2** From left to right. H1’s Photobox after the laptop was moved under a living room couch (in month six of the study). H2’s Photobox kept alongside many electronics and entertainment technologies. H3’s Photobox kept near the kitchen and living room

We recruited participants with large Flickr photo archives for a few key reasons. First, these large archives would enable us to provide participants with glimpses into past experiences that stretched over several years. During preliminary research, we found many people’s locally stored photo archives were fragmented across various hard drives and physical media (e.g., DVDs). As a result, we decided against using locally stored digital photographs, as the effort required to make these archives cohesive would have complicated our goal to easily introduce a prototype into the home. Second, at the time we created the Photoboxes, the Flickr API emerged as the most flexible and robust option for the.NET application we developed.

Through our longitudinal field study, we aimed to collect rich accounts from participants about the rhythms and activities of the home through semi-structured interviews that took place bimonthly. This interview schedule included an introductory interview when installing the Photobox and a final interview at the end of the deployment. During our initial home visit (which lasted 2–3 h), the research team aimed to develop an understanding of members’ everyday lives, common domestic activities, perceptions of their photo collections, and technology usage trends. Household members gave us a home tour and decided where the Photobox should be installed (all Photoboxes were installed in or near living rooms). We deliberately gave brief descriptions of the Photobox, noting it will occasionally print a photo from the owner’s Flickr archive. We wanted participants to develop their own interpretations over time. We did not explicitly encourage participants to interact with their respective Photobox, and all were aware they could drop out of the study at any time.

All interview sessions over this fourteen-month period were audio recorded, producing 40+ hours of content. Relevant segments of recordings were transcribed. We also took field notes and documentary photographs during each interview. Field notes were reviewed immediately following each interview, and tentative insights were noted in reflective field memos [21]. Weekly meetings were held among the research team to discuss emergent findings. Analysis of the data was an ongoing process. After each home visit, we conducted preliminary analysis, searching for emergent (and shifting) patterns across recordings field notes and photos to draw out underlying themes [22]. We coded raw data documents with these themes. We also created conceptual models and affinity diagrams to reveal unexpected connections and differences among households.

### ***3.2 Reflections on the Field Study of Photobox***

Our field study of the Photoboxes was highly influenced by Gaver et al.’s [17] concept of the *trajectory of appreciation* to analyze how new technology design artifacts might (or might not) be accepted by people living with them. Through the lens of this trajectory, a new technology may initially be embraced with excitement because it is novel. As novelty wears off and if expectations are unmet, people may become frustrated. Over time, the technology should normalize into a state of understanding



for people—it is either abandoned or accepted. If accepted, people’s experiences with it may improve as they develop ways to work around the difficulties they faced, and the technology can be integrated into everyday life.

While individual trajectories somewhat varied, all three households followed a similar path in the Photobox study: a period of initial excitement in the first few weeks, which were followed by tensions that emerged around a lack of control Photobox as well as broader confusion (and even disbelief) over the goal of our research project. Eventually, key moments of acceptance occurred with the Photobox, yet it took a considerable amount of time (e.g., 4–7 months) for participants to fully understand the nature of Photobox as a design artifact and integrate it into their lives.

### ***3.3 The First Home Visits: Miscalibration of Photobox’s Initial Description***

Prior to initially visiting households, we asked participants to consider where in their home they would like to have their Photobox installed. In the first visit to each household, participants gave us a brief tour of their home to help the research team develop a sense of their everyday lives and interests. We then configured and deployed a Photobox in the location participants desired it to be in their respective homes. During this time, we manually triggered the Photobox to print one randomly selected photo from its owner’s Flickr archive to ensure it was working properly with participants’ home network system and to generally demonstrate how it works. Here, we noted that when a photo prints it will drop onto the internal bed of the chest and that the main ‘interaction’ with the Photobox would be opening the chest to see whether or not a photo from one’s past is there. We also mentioned that the Photobox will ‘occasionally’ print a photo from their past. At the time, we did not want participants to know that their Photobox prints either four or five photos per month because this could have changed their impression that Photobox has an ongoing, slow yet perpetual behavior. For example, we anticipated that if a participant had already received five photos in a month, they may lose interest entirely in the device. We also wanted participants to come to their own impressions and interpretations of their Photobox over time. Thus, we did not want to overly discuss how it is engineered to operate. We described that our field study was open-ended and exploratory and noted that our research goal was to understand participants’ experiences with their Photobox. We made sure participants were aware that the study would last for approximately fourteen months and that they could drop out of the study at any time.

In hindsight, during this point of the initial deployment, it would have been advantageous for us to have spent more time communicating and reinforcing the motivations for our study and its uniqueness. All participants were avid digital photographers, and it was clear that the ability to re-experience photographs from their past in an unpredictable and tangible way through Photobox was appealing to them. Although Photobox seemed like an ‘easy’ design artifact to live with, it was hard

for participants (and the research team) to imagine how they would react to living with it over time. When we departed from the initial deployment and interview sessions, participants seemed content to begin living with their Photobox and did not have many questions for us. They were aware that the research team would visit their household again in two months to interview them about their experiences with Photobox.

### ***3.4 Emergent Tensions and Skepticisms as the Field Study Progresses***

In returning two months later for our first bimonthly interview, the research team found tensions had emerged in each household. On the surface, these tensions appeared to stem from participants living with a slow technology that they wanted to have more control over. Across participants, there was a desire to increase the ‘speed’ of the system such that they would receive more photos from their past or even have the ability to receive them on demand (e.g., having a button that, when pressed, would print a photo from the past). These were exactly the kinds of tensions we expected might emerge. We wanted to understand how people would react to living with a system that exhibited an intentionally slowed down pace and if this might ultimately to valued cycles of an anticipation. A key motivation for conducting our longitudinal study was to explore if such tensions would eventually fade away and the Photobox would be accepted, or if they would be too great and Photobox would be viewed in a negative light and rejected. Thus, it was interesting to find that in month two of our field study participants described the complex trade-off around wanting to have more control over the Photobox while equally recognizing that ceding autonomy to it played a key role in the surprising, anticipatory, and, at times, serendipitous experiences that were slowly emerging with it. Better understanding the experiential qualities around these tensions and how they might change over time was core to our research and conversations with participants on these tensions were highly insightful across our study.

However, we were surprised to find an emerging skepticism across participants about the genuineness of our field study. In wrestling with the tensions described above and prospectively considering the longitudinal duration of the field study, participants had begun to question if our project had ulterior motives that we had not initially been forthcoming about. Could academic researchers *really* be interested in people’s experiences with such a slow acting system? Or was the study they were participating in about something entirely different?

These sneaking suspicions had led to participants developing various folk theories to explain how and why the Photobox operated and, in some cases, to speculate on what the ‘real’ study was about. The algorithm we designed for selecting which photo would print, when it would print, and whether four or five photos would print each month was completely random. However, by the end of month, two participants

had started to think otherwise. For example, Tim (household 1) was convinced that his Photobox would only print photos of people if they were wearing a hat. He was unsure of what we, the research team, wanted to find out by implementing this into the algorithm. Two months into the study (and nine printed photos later), coincidentally only hat-wearing people had emerged in his photographs (only four of the nine photos had people in them). Tim speculated this must have had some significance in relation to the seemingly innocuous, but increasingly unusual research study he was participating in.

More extraordinarily, Heather (household two) speculated that her Photobox may have knowledge of and perhaps even be predicting her love life after a photo of her ex-lover was consecutively followed by one of her current boyfriend. Heather described that this surprising instance prompted her to consider if she had been secretly surveilled by the Photobox and that the field study actually aimed to focus on factors influencing her decision making in romantic relationships.

Interestingly, Samuel's (household 3) account of two months into the study also revealed anxieties over possible surveillance; he had considered that his Photobox might actually be designed to track his movements around the house as he passed by it daily. Motivated by these emergent concerns and general curiosity, Samuel confessed to having partially disassembled his Photobox to examine the internal components. He discovered a wireless printer, acrylic case, and electrical wiring inside. While this discovery countered his theory that there may be more sophisticated sensing technology for tracking his everyday movements, he remained skeptical of our field study's actual goal.

### ***3.5 Addressing Our Initial Misstep: Re-emphasizing the Goal and Aim of Our Longitudinal Field Study***

Collectively, the skepticisms experienced by our participants were not extreme enough to motivate them to drop out of the study. All participants reported highly positive experiences emerging from receiving photos from their past within their respective Photobox. The tensions participants reported on related to lack of control and the slow pacing of the printing rate were precisely what our field study aimed to explore. Yet, it was clear the skepticisms needed to be addressed. When we began our study, our hope was that through causally explaining what the Photobox is and what it does, and it would create a space for participants to come to their own interpretations of it. However, the combination of a somewhat ambiguous details on how the Photobox works, and the unusualness of participating in a longitudinal study of a largely inactive domestic technology had triggered participants to question the goal of our study and develop diverse speculations on its focus. During our month two interview, we re-emphasized the goals of our field study to participants. We also provided more specific details on precisely how the Photobox works and that the algorithm driving its behavior is purely random. This gentle reinforcement appeared

to address our participants' emergent concerns around the focus, scope, and goal of our project.

However, these issues had drawn a high amount of attention to the Photobox. While we hoped participants would engage with the Photobox, we also aimed to explore the extent to which this slow technology could subtly fade in and out of the background of domestic life. This motivated us to explore developing a technique that would allow us to create a space for discussion with participants about their experiences with Photobox while not forcing it. Initially, we decided to adopt a bimonthly semi-structured interview approach in our field study because we felt that including a diary or camera study might overly require participants to engage with the Photobox (i.e., on our terms, not theirs). Conducting semi-structured interviews would provide an infrequent, but consistent format to have deep conversations about participants' experiences over time. Yet, in practice during our month two interview, this felt overly formal.

### ***3.6 The Emergence and Application of 'Maintenance Visits'***

Coincidentally, we had also decided on the bimonthly interview schedule because the Photobox came with a key constraint: The wireless photo printer embedded inside of the chest could only hold ten pieces of thermal photo paper that the photos are printed onto. We used this constraint as an opportunity to reframe our bimonthly interactions with participants to be 'maintenance visits' instead of planned interviews. This shift enabled us to have concrete times planned to visit each household where the primary goal would be to refill the Photobox's printer paper. In month 4, we found this technique was effective at creating a more informal atmosphere in our visits. Upon visiting each household, we first navigated to the Photobox and began servicing it (e.g., opening it, unscrewing the acrylic case in the upper cabinet of the chest, inserting a new module of photo printer paper, etc.). This provided time for participants to adjust to us being in their home and triggered informal conversation which often (but not always) segued into participants discussing their experiences with the Photobox over the past couple of months. If our discussions transitioned to talking about the Photobox, only then would the research team ask permission to start recording the discussion. At the conclusion of each visit, the research team immediately wrote in-depth field notes to capture the experience of the visit and details (e.g., changes to the spatial arrangement of the Photobox in relation to other physical artifacts in the home, the emergence of printed photos in the home and their movement to different locations, etc.). These field notes were paired with data from field discussions in an ongoing analysis which progressively built up to the final, in-depth concluding semi-structured interview with each household. These interviews typically lasted two hours, and we referred to emergent themes in our findings, specific discussions, and observations captured in field notes across the 14-month period. This approach was ultimately effective at capturing ongoing changes in participants' relations to their Photobox and then confirming and retrospectively

exploring them in the final interview. We found that early tensions emerging from lack of control over the Photobox faded over time across households and that it was accepted as a valued artifact in our participants' everyday lives.

The 'maintenance visit' technique offered several important outcomes for conducting our longitudinal field study of the Photobox. It shifted expectations and softened the 'researcher-participant' dynamic. Participants could approach the research team to share their experiences with the Photobox if they desired. But, this was not a requirement since the ostensible goal of our bimonthly visits was to refill the photo printer paper. After all, the Photobox was a slowly operating technology; if participants did not engage with it frequently within a month or two, we did not view this as a failure. A key example of this was Samuel (household 1) going on holiday to subsequently to come back to a 'treasure trove' of photos capturing memories from the past that had accumulated over a month he was away. By utilizing a technique that did not 'force' participants to report on their experiences, we were able to more effectively balance the subtlety and nuances of conducting a longitudinal study of a slow technology without drawing too much attention to it.

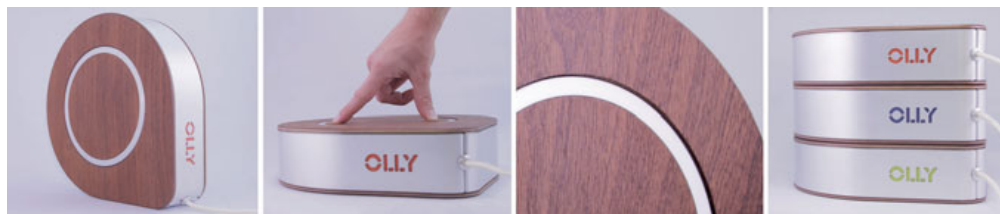
The maintenance visit technique also provided opportunities to have more interactions with other household members that lived with a Photobox but did not have their Flickr account linked to it. For example, several instances emerged in which the primary owner of a Photobox (that had their account linked to it) was unavailable and other household members greeted the research team for a maintenance visit. These interactions were valuable in providing additional perspectives on how the Photobox became integrated in the broader household over time. For example, during maintenance visits in months six and ten, various roommates of Heather (household two) shared impromptu reflections on their own experiences of the Photobox during and after it was serviced by our research team. In other households, similar situations emerged where the research team had opportunities to have open-ended discussions with members that lived with Photobox while primary participant was not present. This helped build rapport with all members in our households and, as a result, all members in each household opted to join the final, in-depth interview at the conclusion of our study. Importantly, this helped us better understand the experiences and interactions that the Photobox catalyzed among our primary participants and others living with it. In this, it provided a space for group reflection on how emergent tensions faded away, why Photobox was eventually accepted as a novel domestic technology in each household, and what kinds of social practices it catalyzed and mediated. Ultimately, the maintenance visit technique enabled us to obtain depth on various dimensions to understand the process through which the Photobox was ecologically adopted in and across households over time.

## 4 Case 2: The Olly Field Study

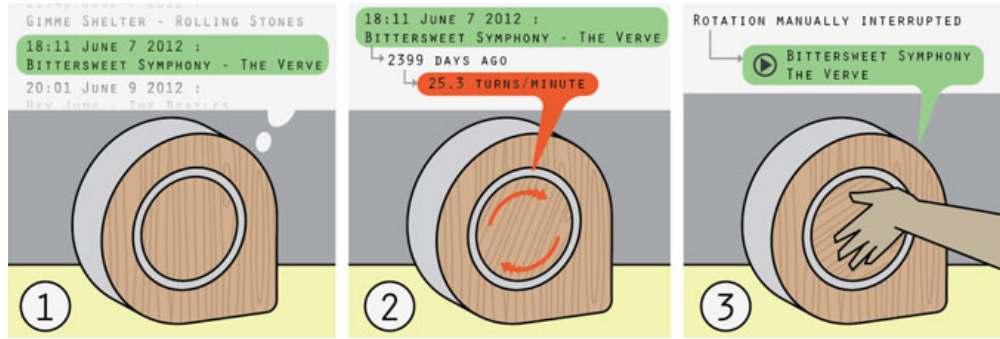
The next longitudinal field study in our research program focused on a design artifact named Olly. Olly is a domestic music player that explores how a framing of slowness might be applied to a person’s digital music listening history to support reflective experiences with this data over time. Olly works by making use of its owner’s personal music listening history metadata archive to randomly select a song from its owner’s past and make it available to be played. The random selection algorithm we designed provides an interaction pacing of about nine random selections per week. Olly’s central feature is its internal wooden disk encircled in aluminum (see Fig. 3). When a song is surfaced from the past, it is not immediately played. First, the disk begins rotating to subtly indicate a song has been selected and is available to be played (i.e., similar to a ‘pending’ state). The speed of the disk’s rotation is relative to how deep into the past the song was listened to by Olly’s owner (e.g., the deeper into the past, the slower the rotational speed). To play the song, the owner must tangibly spin the rotating disk. If the song is not played within a relatively brief time window (e.g., about 10 min), Olly will abandon it and stop spinning until another song is eventually surfaced. This process continues indefinitely (for more details on the design process, please see [6]).

A crucial part of Olly’s implementation is its connection to its owner’s Last.FM [23] online database. Last.FM is a commercial application and online service that runs across a user’s devices (e.g., laptop, iPod, smartphone, etc.) and automatically creates a detailed, time-stamped log of each instance of when they listen to a song. In simple terms, Last.FM is a personal metadata repository of the digital music one has actively played and listened to in the past; it captures and logs when digital music is listened to locally (e.g., mp3 song files stored on one’s phone or personal computer) and via streaming services (e.g., Spotify, Tidal, YouTube). In existence since 2002, Last.FM offers unusually rare access to extensive personal music listening histories, which Olly uses to surface songs from its owner’s past. Thus, when Olly selects a song from one’s past to be listened to, it is presenting a precise instance in the past of when that song was played (see Figs. 4 and 5).

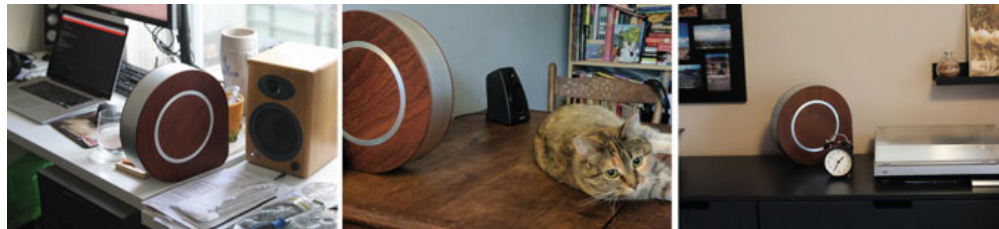
Another important part of Olly’s design is that it causes all instances in a user’s Last.FM database to slowly age over time because their ‘age’ is relative to today’s current date. For example, Olly’s absolute fastest rotation could only be triggered



**Fig. 3** Left to right. Olly can operate standing up (or lying flat); a pending song is played by gently spinning the rotating disk (pictured here when lying flat); woodgrains move in and out of alignment as the disk rotates; three Olly research products deployed with participants



**Fig. 4** (1) Olly’s algorithm has a ‘success’, and it randomly selects a specific listening instance from its owner’s Last.FM library; in this case, the song Bittersweet Symphony that was listened to on 18:11 June 7, 2012, is selected. (2) The internal disk begins to rotate indicating that a song is availability to be played; in this case, the listening instance is quite old which causing the disk’s rotational speed to be quite slow. (3) The user notices the rotation and manually spins the disk to trigger the song to play



**Fig. 5** From left to right. Jim-H1’s Olly, kept in his home office, was easily visible from the bed and living room; Suzie-H2’s Olly kept in her living room with cat Terry; an earlier image of Tom-H3’s Olly soon after he moved it from the living room into his bedroom

if it selected a listening instance that the user had listened to the previous week (and its slowest possible rotation would be triggered if Olly selected songs at the very beginning of the Last.FM archive). Thus, since the rotational speed is relative to today’s date, all of the songs in the Olly database will continue to slowly grow older irrespective of the actions of its owner. These decisions made it possible to use Last.FM metadata to encode an added layer of temporal expressiveness into Olly’s manifestation of songs listened to at precise points in a user’s past. Beyond the speed of rotation, no other information is offered about the specific listening instance when it is surfaced and made available to be played. Understanding the rotational speed relative to each specific music listening instance will likely require the user to take time to interpret and make sense of. We speculated that, over time, these subtle differences might become more discernible and personally meaningful. We were interested in exploring if study participants’ perceptions of Olly might evolve over time if they developed a sensibility for ‘reading’, interacting, and living with it. Similar to the Photobox field study, we also did not want to draw too much attention to these subtle design qualities and wanted participants to come to their own judgment of Olly’s character over time.

## 4.1 *Field Study Method*

We created three nearly identical Olly research products, and they were deployed with three different households in a field study over the course of 15 months from early June 2017 to late August 2018. We recruited three participants from the greater Vancouver, British Columbia (Canada) metropolitan area, to participate in our study. All participants were familiar with technology, owned digital devices (e.g., music players, smartphones, computers), and had Last.FM accounts that were still in use. We recruited participants that had large existing Last.FM archives; coincidentally all three participants' accounts were started in 2006. This enabled us to provide participants with glimpses into music from their past that stretched over a decade (see Fig. 5). It is important to acknowledge that due to our participants' preexisting interest in using Last.FM, they likely already had some interest in exploring past music tastes and trends.

**Household 1** consisted of Jim (mid-30 s, full-time bike mechanic and freelance graphic designer). Jim lived with his wife Sally in a two bedroom apartment. Jim was the primary participant in this household and had a Last.FM that account contained 82,230 entries (an average of 18 songs per day over 12 years). **Household 2** consisted of Suzie (mid-50 s, massage therapist). Suzie lived alone with her cat Terry in a one bedroom apartment. Suzie's Last.FM account contained 136,988 entries (an average of 30 songs per day over 12 years). **Household 3** consisted of Tom (mid-20 s, restaurant waiter and part-time college student). Tom shared a house with three roommates. Tom was the primary participant in this household; he had started his Last.FM account in early high school, and it contained 163,436 entries (35 songs per day over 12 years). The average amount of music participants listened to daily remained similar to their respective averages in our study.

We aimed to collect rich accounts from participants about the rhythms and activities of the home through semi-structured interviews that took place monthly. This interview schedule included an introductory interview when installing Olly and an in-depth final interview at the end of the 15-month longitudinal study. During our initial home visit (which lasted 1–2 h), we aimed to develop an understanding of participants' everyday lives, common activities, interests in music, music listening practices, and technology usage trends. Participants gave us a home tour and decided where Olly should be installed and where the Raspberry Pi for music playback should be connected. We designed Olly to be easily movable once connected to home WiFi, simply requiring it to be unplugged, moved, and plugged back in wherever desired. Using our web dashboard, we then manually triggered Olly to randomly select a listening instance to test for reliability and demonstrate how Olly works. All were aware they could drop out of the study at any time.

After the initial home visit, we conducted monthly interviews to probe and record participants' unfolding experiences with Olly in a structured, yet informal manner. We viewed Olly as a somewhat more sophisticated and unusual design artifact in comparison with Photobox. We desired to carefully capture and explore participants'



potentially changing experiences with and perceptions of their respective Olly. Additionally, the Photobox field study had made us well aware of the potential pitfalls and tensions that can come with studying slow technology research product in situ over time. Thus, these reasons motivated our decision to conduct monthly interviews with participants (as opposed to the bimonthly interviews schedule in the Photobox study). Monthly interview sessions with participants typically lasted 30–60 min. At the conclusion of the study, we visited each household to conduct in-depth interviews (these sessions lasted 2–2.5 h). We commonly referred to field notes and recordings capturing participants’ earlier experiences to explore possible changes in attitudes toward and experiences with Olly and participants Last.FM archives over time.

All interview sessions over this 15-month period were audio recorded. Relevant segments of recordings were transcribed. Researchers also took field notes and documentary photographs during each interview. Field notes were reviewed immediately following each interview, and tentative insights were noted in reflective field memos [21]. Analysis of the data was an ongoing process. After each home visit, we conducted a preliminary analysis, searching for emergent, stabilizing, and shifting patterns across recordings, field notes, and photos to draw out underlying themes [22]. We coded raw documents with these themes. We also created affinity diagrams to model connections and differences among households.

## ***4.2 Reflections on the Field Study of Olly***

Similar to our prior field study, we drew inspiration from the trajectory of appreciation [17] to map our participants’ perceptions of Olly as they explored if it would be embraced and accepted into their everyday practices or be rejected and abandoned. Following lessons from the Photobox field study, we had the foresight to ensure participants understood how Olly worked and that the goal of our research project was clearly communicated and its legitimacy was reinforced. We also anticipated it would be important to create a space for participants to share their experiences and potentially shifting perceptions of Olly with us, while not forcing these interactions.

We asked participants to consider where they would like Olly to initially be placed within their home. In addition to requiring an electrical outlet and a wireless Internet connection, Olly also needed to be in proximity to an audio speaker system in participants’ home so that they could easily listen to a song if they decided to trigger it to play when one was selected. When we arrived at participants’ respective homes, we took a brief tour and then installed Olly in their desired location. During the installation period, we took care to do a demonstration of the system for participants. We manually triggered Olly to randomly select a song from their Last.FM archive, described to them that the rotational speed of the song that was just selected is relative to how deep into the past this specific instance had been listened to. We then invited them to tangibly spin the rotating disk to become familiar with the interaction that triggers the pending song to play.

We also made clear to participants that the song selection algorithm we designed is entirely random and will surface about nine songs per week, although precisely when this will happen is also random and thus unpredictable. We used the informed consent research ethics form as an opportunity to reinforce that this project is funded by a national research council, and our sole objective is to understand participants' experiences with Olly. Participants were made aware that two other Olly devices were simultaneously deployed in other households in the greater Vancouver area. Participants in particular appeared to positively respond to this point, both in terms recognizing our aim to develop comparative insights based on multiple empirical field studies conducted simultaneously as well as with curiosity around how others might experience re-encounters with respective personal music listening history.

In addition to demonstrating how Olly functions during our initial interview, we also opened up the exterior enclosure of Olly to visibly show participants the internal mechanics and engineering of the device as it operated in real time (see Fig. 6). We had intentionally designed Olly's enclosure to be easily openable to support long-term repair and modifications. We used this opportunity to show participants the internal timing belt and narrow tolerances that it physically operates within to produce the actuated rotation of the internal disk. In this, we primed participants with expectation that the research team will need to conduct bimonthly 'maintenance visits' to ensure that the internal belt is functioning properly or if it is in need of repair. We made participants aware that we would be conducting these lightweight bimonthly visits over the course of the field study, which would build up to an in-depth final interview at the study's conclusion. We also briefly described the Photobox field study and that this was a common practice in our prior work.

While these are seemingly lower-level methodological details, in practice we found they were highly effective at mitigating the unwanted tensions and distractions that we encountered in the Photobox study. Participants collectively had a clear vision of the goal and validity of the field study; and, suspicions about potential ulterior motives did not arise. Over the course of the fifteen-month field study, our maintenance visits worked reliably as a technique to subtly invite discussion about Olly without forcing it. We found that participants did experience some tensions triggered by Olly's slow pacing and their own lack of control over it. Interestingly, these tensions related to pacing and control faded away faster than in the Photobox study.



**Fig. 6** From left to right. The exterior enclosure included a cabinet bracket for easy access to internal components during maintenance visits; the belt that actuates Olly's rotational movement using a stepper motor; Exploded view of various modular components that fit within Olly's alumni enclosure when assembled

Additionally, for both Jim (household 1) and Tom (household 3), the maintenance visits provided valuable opportunities to engage in discussion with secondary participants in the household about their perceptions of Olly. Over the course of our field study, all secondary participants eventually had direct experiences with Olly through listening to music it played back from the primary participant's Last.FM archive and, in some cases, through triggering it to play music by tangibly manipulating the disk when a song was pending. Similar to the Photobox study, all secondary participants across households decided to join the final in-depth interview at the conclusion of our study (with the exception of household two where Suzie lived alone). The situated accounts of secondary participants proved invaluable to developing a deeper holistic understanding of how Olly mediated reflective experiences for our primary participants as well as triggered social interactions and practices around it with others. These group discussions also opened up to broader dialog on that questioned the motives and values that shape the design of contemporary consumer technologies which was unexpected but ultimately became an important part of our overall research findings and the design implications resulting from our study.

## 5 Discussion

Developing approaches to creating and studying new technologies that mediate people's practices of reflecting on their life experiences, sense of self, and desires for the future raises important opportunities and issues for the HCI community. With these new possibilities comes complex questions around what kinds of qualities researchers ought to consider when designing technologies that might take on a long-term place in people's everyday lives and how we might study these systems over time. The slow technology design philosophy offers a promising conceptual lens to frame inquiries into crafting longer-term relationships with computational things. Key to creating a slow technology that can be successfully taken up and sustained in people's practices is generating an interaction pacing that balances the design artifact's ability to it to be directly engaged with as well as to fade into the background of everyday life. Methodological approaches such as technology probes [16] and research products [9] offer important advances for guiding HCI researchers in conducting longitudinal field studies of design artifacts in the real and situated complexities of people's daily lives. Yet, longitudinal studies of slow technologies have particular concerns that can shape the potential for successfully conducting a longitudinal field study. As detailed in this chapter, implementing an approach that does not attract 'too much' attention to a slow technology deployed in a participant's everyday environment while maintaining implicit openings for discussion initiated by participants on their own terms are important parts of conducting a longitudinal field study. Next, we reflect further on experiences from our field studies of Photobox and Olly describe to distill practical considerations for conducting longitudinal studies of slow technologies in future HCI research.

## ***5.1 Understanding Where Tensions are Occurring and What Triggers Them***

In the case of the Photobox field study, our aim to create a situation in which participants can come to their own interpretations of the design artifact caused the research team to be somewhat ambiguous in the initial deployment installation when describing how it operated. We felt that such in-depth knowledge of the Photobox might adversely shape participants' unique subjective perspective of the design artifact and perceptions on how it might fit (or not fit) into their lives over time. We also anticipated this might draw too much attention to the Photobox. While well intentioned, this technique began to derail our study. It led to a 'guessing game' situation where participants' felt that part of the study might involve them determining what it was *really* about. This triggered participants to develop various folks theories that were used to explain how the Photobox 'actually' works and how such explanations tie to alternative conceptualizations of what the 'true' goals of the longitudinal study are. These experiences helped remind us that, from a study participant's perspective, receiving and living with a slow technology can be highly unusual because they operate relatively seldomly and often study participants have little control over them. After the initial adjustment period of living with the Photobox, its unpredictability and long periods of inaction paired with the longitudinal trajectory of the field study raised questions and introduced distractions for our participants. Ultimately, we were able to correct the course of field study early on by clarifying and reinforcing the aim of the Photobox project. We leveraged these insights in planning our protocol for the Olly project and were mindful to be highly transparent about describing its functionality and the specific questions that our study inquired into. As this study progressed, participants across households raised no skepticisms about the Olly design artifact or the broader aims of the research project itself. The lesson learned here is that taking extra care to clearly explain how a slow technology works, why it was designed to work this way, and reinforcing the legitimacy of the research project is important to establishing the scaffolding to conduct a successful longitudinal field study.

The lesson described immediately above must be treated with care. Conducting a successful longitudinal study of a slow technology does not mean or require that participants always 'enjoyed' living with the design artifact or did not encounter tensions. Slow technologies, like Photobox and Olly, aim to empirically explore conceptual propositions that are subtle and nuanced: They take time to understand, slowly move between the foreground and background of everyday life, and manifest change over time. These qualities can trigger tensions for participants through living with them. Better understanding what specific elements of a slow technology triggers such tensions and how they are grappled with over time by participants is often a key goal of the longitudinal field study. New knowledge in this area will improve our understanding of how slow technologies could be designed in ways that better support end user adoption. Thus, when tensions emerge, critical consideration needs to go into questioning if they are the 'right' tensions. The research team must be prepared to disentangle emergent tensions that may be distractions and complicate

achieving the goal of the field study versus tensions that need to unfold over time and be faced by participants to advance new knowledge on their experiences—potentially changing perceptions—of the design artifact over time.

## ***5.2 Maintenance Visits as a Technique to Open Implicit Spaces for Dialog Over Time***

This presents a complex balance and nuanced methodological issue to contend with. We found that establishing an occasional, yet consistent routine of maintenance visits to our participants' households offered a technique for productively navigating these difficulties. Conducting maintenance visits gave the research team a practical task to complete as a part of the field study that eased the nature of our engagement with study participants. They did not have to feel the pressure to be prepared to 'report' on their use or experiences with Photobox or Olly. This helped provide the needed space and time for participants to develop their own interpretations of the slow technology that they lived with, while providing a routine opportunity to engage in discussions if desired. This technique was productive in shifting the researcher–participant dynamic by implicitly communicating to participants that the research team was committed to the project (e.g., through the planned manual labor of maintaining the design artifacts), while subtly reinforcing that we wanted participants to engage with the design artifacts on their own terms.

The maintenance visits also provided opportunities to engage with other secondary participants in households that our slow technologies were deployed in. Discussions with secondary participants were highly valuable because they helped us further develop rapport with households over the course of the study, and, importantly, they provided additional perspectives on how each design artifact became unique embedded in the social and environmental ecology of the home. Ultimately, all secondary participants across household in the Photobox and Olly field studies joined our final in-depth interview sessions. This created an opportunity for exploring similarities and differences among perceptions of primary and secondary participants and probing how they collectively may have changed over time. These discussions also often opened up to prospective group reflections on the potential future role and place that slow technologies could have in their lives in the future. Both primary and secondary participants often referenced key experiences they had with our design artifacts and described how they triggered different ways that technology could be designed differently during these speculative, future-oriented discussions. While we did not initially anticipate that the final interviews would include group reflections among primary and secondary participants, they provided valuable insights into the ecological validity of our longitudinal field studies and, importantly, social and environmental factors that may affect the adoption of slow technologies in the future.

## 6 Conclusion

Longitudinal field studies of research prototypes or research products deployed in the real and situated complexity of people's everyday lives are challenging. In this chapter, we have described tensions that emerged when conducting longitudinal field studies of the Photobox and Olly slow technology design artifacts and reflected on lessons learned to help mitigate emergent tensions. Indeed, field studies of slow technologies come with added constraints as the research team must critically consider (and disentangle) tensions that participants experience over time to guide the investigation to a successful conclusion. This requires providing a space for ongoing discussion with study participants while being mindful to not force these interactions or draw too much attention to the design artifact itself. We found that taking care to offer in-depth demonstrations of the design artifacts when they were installed as well as explanations of the research project's goal and intent helped mitigate initial distractions that can negatively affect a longitudinal field study's progress. Maintenance visits offered a technique to open implicit spaces for dialog with primary and secondary participants. This was highly valuable for the research team to understand the nuances of how our design artifacts were adopted into the social and material ecologies of participating households. This technique was also effective at developing and sustaining rapport with households over time and creating a context for individual and group reflections in our final in-depth interview. Our goal in introducing maintenance visits is to offer a technique for better supporting HCI researchers interested in investigating questions concerning how human technology relations change over time with design artifacts. Importantly, our aim is not to be prescriptive nor conclusive. Rather, the aim is to offer a foundation to help frame future generative work and open up the lessons and techniques discussed here for further development. As the HCI community continues to explore the potential role, pace, and place of technology in people's everyday lives, we hope our work can contribute to a complementary framing for conducting longitudinal research of slow technologies in the HCI community over time and into the future.

**Acknowledgements** There are many colleagues that I have had the good fortune of working with across the Photobox and Olly projects described in this chapter. For the Photobox project: many thanks to Mark Selby, Abigail Sellen, Richard Banks, David Kirk, and Tim Regan for their essential roles in the Photobox design, implementation, and field study. The Photobox project was supported primarily by Microsoft Research. Additionally, Ron Wakkary, Youn-kyung Lim, and Audrey Desjardins for their collaboration on developing the research product methodology. For the Olly project: many thanks to Jeroen Hol, Bram Naus, and Pepijn Verburg for their essential roles in the Olly design, implementation and field study, as well as Ron Wakkary. The Olly project was funded by the Social Sciences and Humanities Research Council of Canada (SSHRC), Natural Sciences and Engineering Research Council of Canada (NSERC), and 4TU Design United. Finally, many thanks to the research participants themselves that provided considerable time and commitment to participating in these longitudinal studies.

## References

1. Elsdon C, Selby M, Durrant A, Kirk D (2016) Fitter, happier, more productive: what to ask of a data-driven life. *Interactions* 23(5):45–45
2. Wallace J, Rogers J, Shorter M, Thomas P, Skelly M, Cook R (2018) The SelfReflector: design, IoT and the high street. In: *Proceedings of the 2018 CHI conference on human factors in computing systems (CHI '18)*. ACM, New York, NY, USA, pp 423:1–423:12
3. Odom W, Sellen AJ, Banks R, Kirk DS, Regan T, Selby M, Forlizzi JL, Zimmerman J (2014) Designing for slowness, anticipation and re-visitation: a long term field study of the photobox. In: *Proceedings of the SIGCHI conference on human factors in computing systems (CHI '14)*. ACM, New York, NY, USA, pp 1961–1970
4. Odom W, Wakkary R (2015) Intersecting with unaware objects. In: *Proceedings of the 2015 ACM SIGCHI conference on creativity and cognition (C&C '15)*. Association for Computing Machinery, New York, NY, USA, pp 33–42
5. Flickr. Retrieved 20 April 2020 from <https://www.flickr.com>
6. Odom W, Wakkary R, Bertran I, Harkness M, Hertz G, Hol J, Lin H, Naus B, Tan P, Verburg P (2018) Attending to slowness and temporality with olly and slow game: a design inquiry into supporting longer-term relations with everyday computational objects. In: *Proceedings of the 2018 CHI conference on human factors in computing systems (CHI '18)*. ACM, New York, NY, USA, pp 77:1–77:13
7. Odom W, Wakkary R, Hol J, Naus B, Verburg P, Amram T, Chen AYS (2019) Investigating slowness as a frame to design longer-term experiences with personal data: a field study of olly. In: *Proceedings of the 2019 CHI conference on human factors in computing systems (CHI '19)*. Association for Computing Machinery, New York, NY, USA, Paper 34, pp 1–16
8. Hallnäs L, Redström J (Jan 2001) Slow technology—designing for reflection. *Personal Ubiquitous Comput* 5(3):201–212
9. Odom W, Wakkary R, Lim Y-K, Desjardins A, Hengeveld B, Banks R (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, pp 2549–2561
10. Lim Y-K, Stolterman E, Tenenberg J (2008) The anatomy of prototypes: prototypes as filters, prototypes as manifestations of design ideas. *ACM Trans Comput-Hum Interact* 15(2):7:1–7:27
11. Houde S, Hill C (1997) What do prototypes prototype?. In: *Handbook of human-computer interaction*. North-Holland, pp 367–381
12. Odom W, Pierce J, Stolterman E, Blevis E (2009) Understanding why we preserve some things and discard others in the context of interaction design. In: *Proceedings of the SIGCHI conference on human factors in computing systems (CHI '09)*. ACM, New York, NY, USA, pp 1053–1062
13. Odom W, Banks R, Kirk D, Harper R, Lindley S, Sellen A (2012) Technology heirlooms?: Considerations for passing down and inheriting digital materials. In: *Proceedings of the SIGCHI conference on human factors in computing systems (CHI '12)*. ACM, New York, NY, USA, pp 337–346
14. Leong T, Vetere F, Howard S (2008) Abdicating choice: the rewards of letting go. *Digital Creativity* 19(4):233–243
15. Woodruff A, Augustin S, Foucault B (2007) Sabbath day home automation: “It’s like mixing technology and religion”. In: *Proceedings of the 2007 CHI conference on human factors in computing systems (CHI '07)*. ACM, New York, NY, USA, pp 527–536
16. Hutchinson H, Mackay W, Westerlund B, Bederson BB, Druin A, Plaisant C, Beaudouin-Lafon M, Conversy S, Evans H, Hansen H, Roussel N, Eiderbäck B (2003) Technology probes: inspiring design for and with families. In *Proceedings of the SIGCHI conference on human factors in computing systems (CHI '03)*. Association for Computing Machinery, New York, NY, USA, pp 17–24
17. Gaver W, Bowers J, Boucher A, Law A, Pennington S, Villar N (2006) The history tablecloth: illuminating domestic activity. In *Proceedings of the 6th conference on Designing Interactive systems (DIS '06)*. Association for Computing Machinery, New York, NY, USA, pp 199–208

18. Gaver W, Sengers P, Kerridge T, Kaye J, Bowers J (2007) Enhancing ubiquitous computing with user interpretation: field testing the home health horoscope. In: Proceedings of the SIGCHI conference on human factors in computing systems (CHI '07). Association for Computing Machinery, New York, NY, USA, pp 537–546
19. Helmes J, Taylor AS, Cao X, Höök K, Schmitt P, Villar N (2010) Rudiments 1, 2 & 3: design speculations on autonomy. In: Proceedings of the fifth international conference on Tangible, embedded, and embodied interaction (TEI '11). Association for Computing Machinery, New York, NY, USA, pp 145–152
20. Van Dijck J (2011) Flick and the culture of connectivity: sharing views, experiences, memories. *Mem Stud* 4(4):401–415
21. Glaser B, Strauss A (2017) *Discover of grounded theory: strategies for qualitative research*. Routledge
22. Miles M, Michel Huberman A (1994) *Qualitative data analysis: an expanded sourcebook*. Sage
23. Last.FM. Last.fm. Retrieved 20 April 2020 from <https://www.last.fm/home>