

CRAFTING TEMPORALITY IN DESIGN

Introducing a designer-researcher approach through the creation of *Chronoscope*

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Introduction and background

We now live in a world where digital technologies mediate many aspects of people's everyday lives, and this situation challenges design-led research as it struggles to adapt its methods to the speed of rapid technological change. The convergence of social, cloud, and mobile computing have made it easy for people to stay constantly connected and to create and share personal data at rates faster and scales larger than ever before. For example, social media services currently receive approximately 21,000 photo uploads per second and 657 billion photos annually.¹ These new technologies have enabled people to create vast digital archives that capture their personal history and life experiences, which can be valuable resources for connecting with others and reflecting on one's own life. Technological trends toward constant connectivity and the proliferation of personal data have opened many benefits. However, wide-ranging experiences of overload are emerging as people struggle to make sense of the masses of digital data they now create and receive. People are experiencing loss of control over the digital archives that capture their life experiences as they become oversaturated and fragmented.² Therefore, there is a clear need to develop new ways to support people in making sense of their ever-increasing archives.

Technologies are being designed without a clear sense of how people could develop longer-term experiences with them and the digital media archives that they produce. This threatens the ability for digital media and technology to be enduring, valued resources for meaningful activities, such as reminiscence, contemplation, and social connection.³ These consequences are likely to become even more entangled and complex for future generations if current trends continue. As interaction design researchers, we cannot help but wonder: how can we advance design processes to enable digital artifacts to more appropriately support the meaningful activities of people's lives? How can technology be designed to become longer-term everyday resources that evolve over time? What kinds of interaction qualities and design decisions ought to be taken into account in design practice to engage with these issues?

In their original article on *slow technology*, Hallnäs and Redström⁴ advocate creating technology that persists for long time periods in people's lives. At the heart of this design philosophy is the aim to encourage experiences of self-reflection as well as critical reflection on technology itself; and to investigate 'what it means to design a relationship with a computational thing that will last and develop over time'.⁵ While slow technology offers promise for addressing digital overload, its conceptualization and translation into viable design strategies are still developing.

Research through Design (RtD) is an emerging interaction design research method that grounds theoretical investigations through the research-creation activity of design practice.⁶ The highly polished and robust design artifacts produced through RtD each operate as exemplars of theoretical ideas and conceptual propositions. They also offer concrete ways to reveal new knowledge about how complex social issues, like digital overload and supporting longer-term human-technology relations, can be reframed and approached.

In parallel, recent work in the computing and interaction design communities has highlighted the need to design technologies that express alternative representations of personal data capable of enabling experiences that expand beyond ‘an exclusive interest in performance, efficiency, and rational [self] analysis’.⁷ Yet, the examples of demonstrating and unpacking how the slow technology design philosophy can be put into practice are sparse. Early cases such as Long Living Chair,⁸ GoSlow,⁹ Olly,¹⁰ CrescendoMessage,¹¹ FamilyStories,¹² and Olo Radio¹³ have begun to demonstrate how such rich and unique engagements with personal data can be supported through the creation of new design artifacts.

To bring together research across these two areas and to ground our own thinking in this space, we designed *Chronoscope* – a tangible photo viewer that embodies the lifetime of digital photos a person has accumulated over their lifetime. Inspired by prior research on designing for slowness,¹⁴ key qualities of *Chronoscope*’s design include that it: takes time to understand; manifests change through time; and leverages different forms of time to prompt reflective experiences by manifesting their presence in everyday life. As Figure 3.5.1 shows, *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 personal digital photo archive. Its scope-like form not only suggests rotation-based tangible interaction but also invites its users to view and contemplate the viewed phenomena in an intentional, inquisitive way.



Figure 1 Leveraging the metadata of each digital photo, *Chronoscope* is a tangible device that enables interactions through and across time in one’s personal photo archive. The scope form and the monocular feature are designed to suggest its user a consciously focused viewing experience.

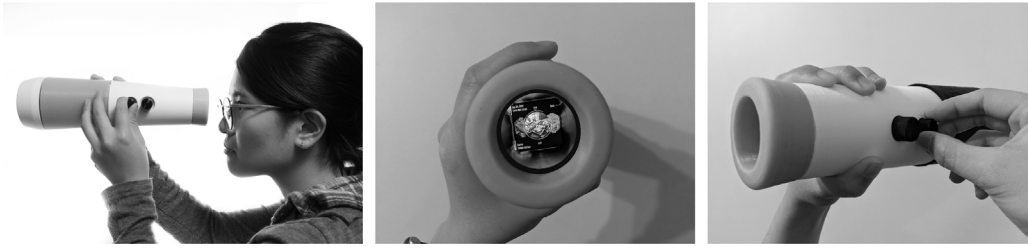


Figure 2 Left: The user manipulates a fully rotational black silicon surface (rotating clockwise moves ‘forward’ in time and rotating counter-clockwise goes deeper into the past). Middle: Peering into the turquoise eye piece through a magnified lens, the user views photos from his past. Right: The user manipulates a black metal knob that ‘tunes’ the granularity of photos that moved through in each rotation; the untouched knob toggles between timeframe modes.



Figure 3 The *Chronoscope* UI visualizes the central photo’s location in time and provides corresponding data around it.

When peering into *Chronoscope*, a single photo tied to the specific timestamp will be visible (see Figure 3.5.3). All the photos are reorganized in a chronological timeline. There are three rotational controls to navigate through the photo archive (see Figure 3.5.2). The primary rotating wheel controls the *viewing directions* in one timeline (clockwise to move forward and counter-clockwise to move backward). By rotating either direction, the user sees each photo in relation to a wide spectrum of other photos in the archive. The other two knobs on the side decide the *timeframe modes* and *viewing granularity*. For timeframe modes, users are allowed to switch between three timelines – *linear*, *date*, and *time*; each organizes photos based on different parts of the timestamp. As for viewing granularity, we use a rotational slider as a build-in support for ‘tuning’ the number of photos (from

1 to 300) that one could move through by each wheel rotation. More details could be found in our full paper, published in DIS'19.¹⁵

As a slow tech design practice, *Chronoscope* works slowly through offering alternative angles for people to curiously explore and reflect on their digital photo archives through and across time. Through designing in support for the presence of time and adding navigational controls for temporal exploration, several interaction qualities emerged during the design process and field testing of *Chronoscope*. Next, we draw on the design case of *Chronoscope* as a design example to introduce and reflect on our designer-research approach to practice-based research.

The designer-researcher approach

Over the past several years, we have adopted what we call a designer-researcher approach to making and reflecting on highly finished design artifacts as a form of practice-based research in and of itself. *Chronoscope* represents one of our latest projects in this line of work. The designer-researcher approach often involves a small but multi-disciplinary team that is reflexively focused on the experimental and novel outcomes of the design process that are critically and reflectively arrived at through design practice. To give a bigger picture, we introduce four main points that inspire and situate the position of our approach:

- research through design
- autobiographical design
- reflective conversation with materials
- research product

With these concepts in mind, we attend to key details in the creation of *Chronoscope* by oscillating between higher-level conceptual ideas and practice-based design decisions. In the following sections, we share with you a brief description of each point and how they specifically motivated the direction and development of our design process.

Research through design

We follow a research through design (RtD) method that directs interaction design researchers to engage ‘wicked problems’ through a real-world artifact to understand how the world could change from its current state to a preferred state.¹⁶ Through the production of a design artifact, this approach creates the context for a collaborative interdisciplinary research environment that could involve (but is not limited to) designers, engineers, anthropologists, and computer scientists.

Most importantly, there are four lenses to evaluate a RtD approach from the original paper:¹⁷

- *process* that could be reproduced with rigor and rationale
- *invention* built on concepts that could potentially answer the research questions
- *relevance* of real-world knowledge and a preferred state to achieve via artifacts
- *extensibility* that aspires the research insights to be applied in the future

Due to the qualitative nature of our research questions and the increased complexity in designing digital technologies, we decided to adopt RtD in the *Chronoscope* project. The four lenses were carefully applied throughout the entire process, from our overarching research goal to every nitty-gritty design decision.

First, we make sure our research *process* is reproduceable. The term ‘reproduceable’ does not necessarily mean to produce the exact same results but to report rigorous details with clear rationale.

The gist is to clarify why the process proceeds with certain decisions in each step and how it arrives at the final insights. For example, we started the *Chronoscope* idea based on a rotational photo viewing control with an analogy of clock (e.g., clockwise to move forward in time). Therefore, we settled on its scope-like form because it suggests rotation-based tangible interaction and invites people to view their digital photos in an intentional, inquisitive way. With this decision, we moved on to polish its color and texture to ensure that every little design feature meets our research need. By reasoning details, the process can be examined, learned, and applied by other researchers.

Through another lens, *invention*, we conducted extensive literature reviews in relation to digital possessions, personal informatics, photographic practices, and memory studies to situate our subject in an academic standpoint. *Chronoscope* is deeply researched on the characteristics of data that have challenged people's original sense of owning physical objects,¹⁸ such as being intangible and pervasive in its nature.¹⁹ Without proper tools and structures, people have difficulty making sense of, organizing, and using photos.²⁰ Thus, we looked into how reflective and curious experience could be supported by exploring alternative ideas such as the 'circulation' concept between personal memories and memory objects.²¹ Our design attitude for this exploration was also influenced by theoretical approaches such as ludic design,²² reflective design,²³ and, especially, slow technology.²⁴ Building on these collective works, we invented *Chronoscope* to demonstrate its potential for advancing from the current state of the art.

As mentioned in the introduction, this project was initiated by both a real-world problem regarding accumulating digital photos and a goal of exploring innovative ways to build people's long-term intimacy with their photo archives. From this, *relevance* is achieved as *Chronoscope* was designed to fit in a domestic context and created as a vehicle to embody temporal relations among digital photos in its visual representation and tangible design. Without an actual artifact to interact with, it is exceedingly challenging for people to make sense of how big their digital photo archive is and how their photos could relate to each other in a much more macro view. Hence, a *preferred state* was explored through the *Chronoscope* design to enable a potentially more curious, reflective, and engaging experience with vast digital photo archives.

In terms of *extensibility*, the insights derived from *Chronoscope* are applicable to future interaction design research. Our inquiry led to *interaction qualities* that allow people to explore their digital possessions with ease and pleasure and grow more lasting and interactive relationships with them. The *temporal design features* could also inspire more application and development of any digital material that has a timestamp embedded in its file format. Overall, these insights were provided with an aim to open up new possibilities in future research.

In sum, our designer-research approach relies heavily on RtD as a research method that uses design artifacts as instruments to ask questions and test ideas. The four RtD lenses directly shaped the ways we connected *Chronoscope* to a real-world problem and communicated its value to the broader research design research community. Next, we unpack details of how our *process* was guided through first-person experiences shared among the design research team.

Autobiographical design

While our practice-led designer-researcher approach shares some similarities with first-person and autobiographical design (AD) approaches,²⁵ there are still some notable differences. Neustaeder and Sengers characterize autobiographical design as 'design research drawing on extensive, genuine usage by those creating or building a system'.²⁶ It focuses on the genuine needs of researchers, which embody their own experiences in the system design and concept exploration through a cycle of *building, learning, evaluating, and iterating* the design. While facing a challenge of reporting with objectivity, AD has benefits that include shortening the feedback cycle, anticipating and solving key issues before testing the design with research participants in the field, and uncovering the nuanced

understandings of one's lived experience with the design artifact. AD is conducted by a single researcher, although others may also be present in the research (e.g., such as the researcher's family members).

In contrast with AD, our designer-researcher approach involves four special focuses:

- *originality* – initiating an idea that emerged from personal expertise and research trajectories
- *diversity* – forming a small but interdisciplinary team to ensure the quality of design artifacts
- *provocativeness* – pursuing both robustness and creativity reflexively through crafting and living with design artifacts
- *unity* – having a unified narrative voice to report our research outcomes

While AD emphasizes the genuine usage and exploration cycle in the long-term testing part, our approach values it and the technology creation part equally. Therefore, new ideas usually originate from design researchers' expertise in certain design materials and relate heavily to their own research trajectories. With a background in computer science and a special focus on digital photos, Amy Yo Sue Chen (co-author) joined Everyday Design Studio in 2017 as a PhD student supervised by William Odom (co-author), who co-directs the academic design studio and has investigated slow technology as a lens to design new kinds of experiences with photographs, music, and other digital media for several years. Motivated by the Photobox,²⁷ CrescendoMessage,²⁸ and Olo Radio prototype,²⁹ we (Chen and Odom) started the discussion of the *Chronoscope* project with an idea of having a handheld, telescope-like form as an alternative way to interact with digital photo collections. Without our research backgrounds, expertise, and positionality of accumulated works as key factors, we would not have initiated this difficult R+D project; however, because of it we felt positively that it would produce new knowledge that could only be explored through new design.

However, producing a highly resolved design artifact is not easy. In the *Chronoscope* project, we needed to involve other investigators and research assistants with expertise in electronics prototyping, form design, and digital fabrication to create the artifacts. By co-leading a small but interdisciplinary team, we were able to circulate thoughts and exchange *diverse* perspectives to overcome challenges. We see our designer-researcher approach as *reflexive* and with the goal of delivering first-hand insights through ongoing individual and collective design practice, group critiques, material explorations, and experiences of living with prototypes collectively in our studio as well as individually in our own homes. In addition to AD's core concept of trouble-shooting and iterating systems in their personal use and living with the design artifacts, our approach pursues unexpected but desired design features for longer-term lived experience that could not be imagined or foreseen without design researchers' keen observation and criticality. The sensitivity used to explore the design comes from both deep understanding of the design itself by the researchers and the intuition to critique and make changes as designers.

While embracing the benefits of having a wider range of expertise and opinions, a designer-researcher approach has a particular challenge of reporting research outcomes in a *unified* narrative voice across our design team. Hence, our approach requires one or two project leaders to constantly synthesize perspectives and distill insights from the various creative understandings among the team members. The attachment between researchers and the system design is formed through not only the individual practice-based creation process but also numerous collaborative discussions. We see this challenge as the most important part as it shapes how our first-person approach is interpreted and presented to the research communities.

Building on the first person-oriented nature of AD, the designer-researcher approach offers a related but different form of practice-based research. Although the designer-research approach requires extra work to unify voices across the design team, we find this most challenging part also to be the most rewarding. This reflexive process itself requires project leaders to reflect on their original

goal, which can catalyze additional insights and research opportunities. Next, we talk about how *invention* comes into being in details.

Reflective conversation with materials

To begin our design research inquiry of *Chronoscope*, we explored potential design materials that pertain specifically to the temporal metadata in digital photos. We initiate our observation by virtue of trust in a reflective, practice-based process. We believe:

the designer-researcher approach can contribute a highly insightful, first-hand, and reflexive view of practices of making design artifacts in relation to higher-level concepts framing key decisions in the design process and in light of attendant materials, tools, methods, and competencies.³⁰

We see this approach as highly aligned with Schön and Bennet's characterization of design practice as a *reflective conversation with materials*.³¹ A designer-researcher approach to practice-based research heavily emphasizes a designer's knowing-in-action that involves sensory and bodily understanding in relation to the team's evolving understanding of materials. This is a recurring process where the materials 'talk back' through a back-and-forth process that progressively leads to a refined understanding of the overall design and, ultimately, the final resolved design artifact. This approach gives prominence to first-hand insights that emerge through iteratively working with materials to ground conceptual ideas through the creation of new things: 'a process of moving from the universal, general and particular to the ultimate particular – the specific design'.³²

In the *Chronoscope* project, the 'material' we worked with came in the form of digital photos and their attendant metadata, which is a series of information encoded into each digital photo at the moment the file is created. The digital photo metadata material includes information such as the camera specifications, geolocation, image size and compression style, and the timestamp capturing when the photo was created. We were most interested in 'speaking to' the timestamp data because it stands as a potential medium that provokes a tracing and reasoning experience of specific memories.

Timestamp is numeric and sequential in its nature, and the way to make use of this type of data requires a specified format (e.g., YYYY/MM/DD). From observing how various formats frame our cognitive understanding to systematically absorb and compare those photo content in a list view, we arrived at a linear 'timeline' design that visualizes clear *sequential events*.³³ We rapidly programmed an interactive processing³⁴ script and an iOS mobile application as prototypes in order to automatically capture, structure, and organize digital photos chronologically. By giving prominence to the presence of temporality hidden in every digital photo as an anchor point to make sense of the sorting order, we were enabled to actually see the possibly consequential connections between photos and to explore those connections through moving the photo collection backward or forward in time. This back-and-forth visual interaction provides a clear pathway for each specific photo memory to 'talk back' to us not just about their relative location in time but also their relations to other photo stories in a macro level.

However, the mere chronological timeline design felt somewhat limited and underwhelming. On one hand, the linear photo collection on the prototype has ends on both sides and therefore does not provide a sense of continuity to encourage exploration. On the other hand, those photo memories flow in an order of how we exactly experienced and remembered them. Crucially, the processing prototype enabled us to move quickly across a large number of photos in an archive and simultaneously saw timestamp information separated by time of day and date. The separation of information not only prompted us to stimulate recollection of past experiences peripheral to the central photo but also triggered our imagination of having non-chronological 'timeframe modes' that reorganize

photos *across* the archive based on existing meaningful temporal patterns. Built upon prior works that have discussed how clock time³⁵ and digital time³⁶ have reframed the personal and collective rhythms of everyday life, we brainstormed in designing non-chronological ways of photo viewing that offer multilayer and cyclical perspectives (based on date or time of day, irrespective of year). Our interest in this notably wider spectrum of potential interactions is in part inspired by the concept of *ecphoria*,³⁷ which refers to the experience of recalling a fuzzy or entirely forgotten memory when prompted by sensory input – in our case, digital photos from one’s past.

In a nutshell, the gist of having a reflective conversation with materials includes three parts:

- understanding the nature of design materials
- exploring various forms and expressions made of the materials
- observing the interaction dynamics with appropriate tools

We arrived at the final design features of *Chronoscope* that may not have been achieved without the support of powerful computing tools. These contributed to our dialogue with the materials and supported the potential of experience design into realms of reflection and curiosity through and across personal memories. Next, we discuss the benefits of shaping a design artifact into a research product.

Research product

In our design research studio, we polish our design artifacts to become *research products*³⁸ that fully support the final and actual deployment in the complex real-world setting to ask research questions. Research products are intended to be lived with over longer-time periods and achieve a high quality of fit in, and among, things in people’s everyday environments. Thus, a key part of this process involves different design team members living with various prototype versions of the design artifacts we are making to fine-tune qualities of use (e.g., the pacing or rhythm of a slowly changing system), exploring living with different forms and materials, and field testing for technical robustness.

To put it concisely, there are two critical steps in the framework of *research product*:

- creating a highly finished research product that functions and lasts in an everyday context
- living with the research product over a long period of time

In order to inquire how people exactly experience *Chronoscope* and their relationship with it over time, a tangible version was created with full functionality for the everyday rather than laboratory/studio context. We loaded programming code to a microcontroller board that controls electronic components such as a tiny display, three rotational actuators, and a light-weight battery. To store them in a small size form that best supports handholding, we meticulously designed the interior space of the scope and outsourced the 3D printing to a more professional service provider to achieve the highest resolution. This design process required numerous group discussions but also very personal moments of cultivating the sensitivity of feeling how tangible rotation manipulates the reaction of photos showing on the tiny display embedded in the scope. Through extensive trouble-shooting and fine-tuning in the iterations, we arrive at a robust and highly finished version of *Chronoscope*.

Before we deployed it to people’s houses, our design team members lived with the product over a long period of time and made adjustments to counteract the frictions we encountered. The first friction was related to the sheer size of the photo archive. For instance, when a user has 20,000 photos and she aims to navigate to a specific time of her photo collection, it would take her about 2.77 hours to get there since each rotation moves through the photo archive by only one photo as a unit (and it takes about 0.5 second per rotation); this led to a sensation of being ‘stuck in time’. This issue would very likely complicate people’s ability to form long-term relations to *Chronoscope*

and hinder our aim of making it a research product. This friction triggered our decision to include blending as a support for ‘tuning’ the number of photos (or *granularity*) that one moved through for each rotation. With this support, people could move through their photo archives in very slow, precise, and considered ways (i.e., one photo per rotation) to encounter a set of photos that triggered deep reflection or examination or, equally, quickly move across vast numbers of photos without an excessive number of rotations, while retaining a subtle awareness of what had been passed over (i.e., 100 photos per rotation). In order to solve the friction, the added ‘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.

As the research product was designed to be a slow technology (see earlier), it is very likely that the artifact would be experienced differently as time passes by, and as researchers we need to negotiate this factor in order to make sense of micro-interaction. As a slow technology design takes time to understand and gradually evolved over time, *Chronoscope* introduced other challenges of the granularity control. If the upper threshold was too high, then a user could easily become ‘lost in time’ as they navigated a large number of photos in one turn (i.e., effectively flashing ahead into the future or back into the past without a clear point of reference). Through an iterative process, we determined that setting upper and lower boundaries of the granularity helped to mitigate these design issues in support of our higher-level goal of manifesting different forms of time in support of ongoing reflective experiences. However, such boundaries need to be dynamically alterable and able to evolve with the photo archive as it continues to grow over time. Our design team went through several rounds of prototyping with different types of interactions, forms, and levels of fidelity of the interface to arrive at thresholds that seem suitable to the modern average size of digital archives.

While the four points in our designer-researcher approach provide a foundation for making high-level decisions across all of our research projects, each project never quite follows the same pathway to form a unified narrative voice from synthesizing perspectives and experiences across the design team.³⁹ Our overarching goal in the *Chronoscope* project was to contribute concrete insights into unpacking how diverse temporal interactions might be designed with personal data through the form of an everyday artifact that is intended to be lived with over time. In this, we have emphasized where its key theoretical, methodological, and practical challenges emerged and our design moves to resolve them.

Discussion and conclusion

In this chapter, our piecemeal, practice-based designer-research approach enabled us to create a design artifact that extended core approaches to designing slow technologies by building in a high degree of end user control, while retaining design qualities that are closely tied to the original conceptual vision of slow technology. The case of *Chronoscope* illustrates that future practice-based approaches to crafting slowness and temporality into new artifacts may require added time for reflection and adaption that may be counter to the often frenetic, time-constrained norms of contemporary interaction design practice. This methodological insight is revealing about the need for design practice to evolve and is also reflective of the original vision of slow technology:

As computers are increasingly woven into the fabric of everyday life, interaction design may have to change – from creating only fast and efficient tools to be used during a limited time in specific situations, to creating technology that surrounds us and therefore is a part of our activities for long periods of time.⁴⁰

We have described and reflected on how slow artifacts can provide alternatives to how we might conceptualize supporting longer-term relations to our everyday technologies and personal data – and

how such inquiries can be grounded in design practice. However, without our designer–researcher approach, the discoveries and insights would not have arisen.

Ultimately, we describe our designer–researcher approach and offer a reflection on how its four critical points – research through design, autobiographical design, reflective conversation with materials, and research product – could be exemplified through unpacking the process of crafting a design case. From these four points as keys to developing the practice-based insights, we would like to offer four takeaways of what practice-based research usually involves:

- shaping and manifesting the research questions and proposals into practices
- first-person perspectives both as an individual and a team
- deep reflection on the resources and people’s perception of them
- adapting the practices to real-world contexts and negotiating them when friction arises

In conclusion, an additional goal here is to help readers to take a step toward understanding how our designer–researcher approach could potentially be applied and explored in their own fields. We see opportunities for bringing together philosophers and social scientists who explore differing theories of temporality with practitioners who are skilled in manipulating temporal media (e.g., musicians, composers, poets, new media artists, etc.) to collectively develop new ways of grounding theoretical concepts related to time through creative practice. Ultimately, we hope our research methods can support future practice-based initiatives that are aimed at investigating the complex and evolving subject of human relations with technology over time.

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Notes

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- 2 Odom et al. (2014), Sellen and Whittaker (2010).
- 3 Whittaker et al. (2010).
- 4 Hallnäs and Redström (2001).
- 5 Mazé and Redström (2005, p. 11).
- 6 Frayling (1994), Gaver (2012), Redström (2017).
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