Dwelling Amongst a Ludic Internet of Things:
An Autobiographical Design Inquiry

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Abstract:

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As homes increasingly grow into ubiquitous computing environments, re-imagining the interplay of computing and everyday domestic life is pertinent to interaction designers. Building on the traditions of critical and speculative design within human-computer interaction, this thesis is an autobiographical design research inquiry of how Internet of Things (IoT) systems can be designed to support ludic communication between family members at home. By building two bespoke IoT systems and living with them over a six-month period, this research provides alternative visions, beyond efficiency and productivity, of how we might weave computing more deeply into the fabric of the home while supporting the life-giving values of rest, reflection, and familial connection.

Ludic

Dwelling amongst a Internet of Things

Aubree M. Ball | MDes

For Fred,
You were the first to take a creative risk on me—oh dear!
Now look what I've done.

Contents

Introduction

Introduction

This thesis is an autobiographical design research inquiry of how Internet of Things systems can be designed to support ludic communication between family members at home. During the project I designed interactions and artifacts to form two unique Internet of Things (IoT) systems for my family to use in our home. I watched and recorded how we lived with the systems, looking at how the introduction of the technology impacted our family communication, and how designers can use IoT principles to create ludic interactions between family members.

As homes increasingly grow into ubiquitous computing environments, re-imagining the role of computing in everyday domestic life is pertinent to the field of design. Building on the traditions of critical and speculative design within human-computer interaction, this thesis provides an alternative vision, beyond efficiency and productivity, of how we might weave computing more deeply into the fabric of the home. At the onset of the project, I wanted to know:

> How can the design of IoT systems for the home support ludic communication between family members?

To investigate this question, I created two bespoke IoT systems to support ludic communication. The Thought Projectors, and the Inter(net)coms embrace the principles of Ludic Design, introduced by designer and researcher Bill Gaver. The term ludic, stems from the concept of Homo Ludens and denotes that people are innately playful creatures [12]. The concept strategically opposes common assumptions about technology, that computers should be practical, unambiguous, and help us be as efficient as possible, even at home. A ludic design approach instead introduces domestic technologies that encourage curiosity, reflection, and simple delights.

The Thought Projectors are a pair of portable video projectors that play a collaborative YouTube playlist. The system is used to share non-urgent thoughts, curiosities, experiences, and interests between family members. In doing so, it creates a new tangible interface and media landscape for ambient ludic communication inside the home. The design intentionally creates opportunities for viewer interpretation by not providing a one-to-one relationship between the sender's intent and the viewer's understanding (or lack of). This opened conversations between family members and created opportunities to express their individuality.

The Inter(net)coms are a network of wireless home intercoms that were rebuilt from an existing system originally installed in the house in 1974. Using a voice-over internet protocol (VoIP) application and a private internet server, the intercoms function like walkie-talkies inside the house. Appropriating and

redesigning the house's existing and aging technology opened a space to explore how the technology placed in the home shapes interactions between inhabitants, how legacy technologies can inform us about how to live in the home, and how we can design technology to evolve with time.

The two personalized systems opened new spaces for meaningful conversation and simple pleasures shared between family members. They facilitated moments of reflection and expressions of self-identity between the children and parents, and introduced the concepts of slow technology to the ambiance of our home.

SECTION ONE

Background

Domestic computing today

Mark Weiser, commonly known as the 'father of ubiquitous computing', described his vision of the future of computing in the home in a short web article, entitled Open House. He wrote, "the third wave [of computing], just beginning, has many computers serving each person everywhere in the world. I call this last wave 'ubiquitous computing' or 'ubicomp'" [37:2].

Weiser's word choice, serving, is a good indication of his then-view of the role of computing in daily life… that is, that computers are meant to serve people, as tools serve us. He explains what his vision looks like: "clothes labels (to track washing), coffee cups (to alert cleaning staff to moldy cups), light switches (to save energy if no one is in the room)…" [35:3]. While researchers have increasingly looked to more holistic visions of technology applications in domestic spaces over the past decade [7,16,34], it is clear that Weiser's visions are manifest in the uses of Internet of Things (IoT) devices and systems in the home today.

In the past five years, a new genre of home computing has become commonplace in American households, that is, IoT systems and devices. The IoT is essentially devices which are connected to the internet or networked to other devices, with the purpose of sending data between them. The device uses the data received or sent to perform a task. This arrangement can be described as communication between objects, sensors, and data.

The Nest Thermostat, perhaps the most widely-known IoT device today, helped bring the concept of a "smart" or "networked" home into mainstream dialogue. The Nest, is a tool for automating and optimizing the home's heating and cooling system. Other widely adopted IoT devices in the home include the Google Home and Amazon's Alexa, two conversational interfaces known as "virtual assistants". They are both designed to schedule appointments, create shopping lists, play music on demand, and to automate other connected devices, such as motorized window coverings, robotic vacuums, home security systems, and home surveillance, all without the need to lift a finger.

Weiser's vision stems from computing's birthplace as a multi-function tool—centered on increasing productivity and efficiency in the workplace. Viewing computing as a tool for service in such an environment is logical. In the American industrial economy, humans extract value from creating goods or services. The faster and more easily they can do that, the higher their potential return on an investment of labor. When this model, though, is extracted from the context of workplace environments, and applied to the home, it does not appropriately fit its new context. Gaver draws on this point when he writes, "as

computing has emerged from the office and laboratory, it seems to have brought along values of the workplace: concerns for clarity, efficiency and productivity; a preoccupation with finding solutions to problems." [11:1]

The context of the home includes human needs, desires, and complex interpersonal interactions. The home is an especially nuanced and private environment where families share individual social behaviors and patterns of living [1]. Each home is distinct. Each family develops their own personal methods of cohabitating. The intricacies of how people conduct daily life are influenced by countless factors—not the least of which is by design.

Applying workplace heuristics to the design of computing artifacts and systems for daily domestic life is a flawed method, heavy with the impact it has on shifting cultural values. As computers become increasingly embedded into the fabric of people's homes (ubiquitous computing), designers must reconsider the role, nature, and interactions with computing systems in such private, complex and personalized spaces. Sengers writes, "Most importantly, it means recognizing the role, not just of fun but of serious play as a form of opening the conceptual space for designing, building, and interacting with the new systems with which we will share our lives." [30:28]

HCI research on domestic technologies

The home, with its inherent complexity, has also long been a place of interest to HCI researchers. Over the past twenty years, there has been an increasing interest in understanding and designing for computing in domestic environments, creating visions which look beyond efficiency and productivity [20].

Researchers have examined the objects, (computing or not) which people choose to keep and discard [29], the ways people respond to and incorporate novel and bespoke technologies [12,15,18,19], or create their own systems for personal pleasure [13]. Designers have also co-speculated with participants on the purpose and role of future technologies for the home [20]. Methods have historically included ethnography [2,12,29] prototype deployments, cultural and technology probes [15,20] and participatory design [20].

This work, only a sample of contemporaneous research on domestic technologies, points to a growing interest and an open inquiry into the design of rich and personalized interactions with computing artifacts—those which are reflective of the home. Together, they probe aspects of technology which are counter to mainstream visions of computing, such as slowness [28], curiosity [12], reflection [31], ludic pleasure [11], and ambiguity [15].

Ludic design

Despite over two decades of interest in theHCI research community, slowness, curiosity, reflection, ludic pleasure and ambiguity remain esoteric notions and fail to emerge in mainstream domestic computing. The consumer product industry has continued creating tools, services and systems designed with a workplace ethos and marketed toward streamlining domestic chores. Their imagery promises to make life "better", though better, of course, remains undefined, unmeasured, and appears to be based on a worldview preoccupied with ever-greater personal productivity.

To counter this narrow vision, the concepts I put forth in this research draw on ludic design. In the context of domestic technologies, a ludic design approach "undermines assumptions about 'smart' appliances for the efficient and productive home and presents instead curious systems for exploration and reflection about domestic space," [14:3451].

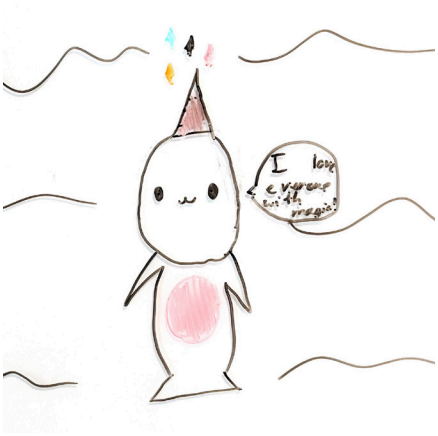
Observing ludic communication at home

Ludic communication is something I saw happening in my own unique home between my family members. The observation prompted me to situate my research within an autobiographical perspective. Its origins occur around my family's move from one house to another, which revealed changes in our interpersonal interactions and opportunities to reflect on how the structure of the house influenced the ways we lived together.

My partner and our two children, then aged 15 and 10, moved from a smaller-than-average house, of 800 sq. feet into a larger-than-average house of over 3,000 sq. feet. The change was dramatic and affected the patterns of interpersonal interactions between family members—where we met to make plans together, to have uncomfortable conversations, and to be playful. After three months of living in the new house, we found that one unique type of interaction was missing, what I term ludic communication.

Ludic communication, as experienced in my own home, is non-urgent, it is reflective of whatever state of mind the writer/speaker is in at the time. Somewhat like graffiti, it is often created as a means of self-expression, for another person's discovery. It can be playful and humorous, inquisitive, or nonsensical. It might, for example, be a drawing of narwhal surrounded by stars and commenting, "I love everyone with magic!"

There is no pressing need for a prompt reply when communicating ludically– nor even an expectation of a response. The intent of this kind of communication



[Image 1] Frankie's ludic sketch of a narwhal exclaiming, "I love everyone with magic."

is in stark contrast to more widely used verbal communication, text messaging, emailing, or talking by phone. In our case, it was also impermanent, with the ephemerality of sidewalk chalk.

Built in 1953, the house we moved from was a pacific northwest mid-century modern case study house with an open floor plan, similar to a modern loft. The interior had no enclosed rooms except for the bathroom. All of the space was shared by the four of us, me, Kurt, Mason and Frankie. The layout provided a flexible living arrangement—in which we frequently moved sleeping spaces and reconfigured the entertaining space. We were, basically, always trying new ways to get comfortable. The only place to be alone, or to seek privacy in the small house was in the centrally-located bathroom.

The shower walls of the bathroom were smooth and white, making a well-suited canvas to my first-grade daughter's whimsical drawings, jokes and notes, using washable soap crayons. There we drew pictures, asked questions back and forth, and frequently made fun of one another. I often used it as a place to express gratitude and affection to the children. I loved our written and sketched emergent conversations.

The impermanence of the soap lent itself to the reminder to be present in the moment, knowing the notes would be washed away within a few days, soon forgotten. I noticed that the asynchronous communication we shared on the shower walls was unique from other methods we used at home. It was created in a private, often reflective moment and shared with the whole family–by way of each person's passing through the shower.

A new house and new interactions

As our kids grew bigger, (our son into a tall, skinny teenager, our daughter into a "tween," not far behind him) we felt a need for more physical space, privacy, and places to host the kids' friends, who had also gotten bigger. We moved into a more traditional pacific northwestern style house with three typical rectangular bedrooms, bathrooms, a kitchen with an island, etcetera. The house was built in the late 1970's. With three bathrooms, we no longer share a shower.

The design of the small house enabled an unexpectedly playful and what we felt was a non-traditional, even ludic, style of living. The design of the new house, with all its square feet and enclosed rooms, on the other hand, lends itself better to a lack of communication, providing more space for isolation. Some family members, namely the teenaged one, prefer to withdraw into spaces of solitude.

What's more, we found that we did not communicate in the same non-urgent

ludic way that we used to, because we no longer share private-public spaces. We find ourselves instead sharing transition spaces (hallways, stairs, and entries), rarely sharing places which are occupied for moments of reflection and rest. The realization motivated me to look for opportunities to bring ludic communication into the new home, in ways which are responsive to how we live in this new house, while at the same time reflecting on our adoption of technology, and critically responding to the current state of “smart home” technologies, i.e. domestic IoT.

SECTION TWO

Methods

"In the post-industrial West, and especially in America, we have split experience into two: whereas life could be a steady stream of work intermingled with pleasure, we have disengaged the two, often preferring to lavish 'serious' attention only on the first." [28:20]

Methodological Approach

First-person research methods

The home is a highly nuanced and personal environment. Across socioeconomic scales, regions, cultures and subcultures, there is but one commonality: that each is as unique as the people inside. Such variability makes the home an especially sensitive place to conduct in-depth, long-term research in, and makes it a context suited to less-traditional research methods, like autobiographical design.

Autobiographical design research methods involve and record the designer's first-person accounts of the design intent, process, and lived-with experiences of an artifact or system. Research insights are derived from the personal and nuanced experiences of living-with the systems the designer builds herself [25].

Design iterations, or evolutions, occur over the course of living or working with the artifact or system over long periods of time. Periods on the order of weeks, months, years and decades are long-term in comparison to traditional design processes—in which a system might be tested in the course of hours or days on different user groups.

Observational records are from her own perspective, drawing extensively on her "personal experience, needs, and desires," [8:7] opening personal vantage points and recording rich details which are rarely accessible in other forms of HCI research.

Historically, designing for and conducting research on oneself is considered a "questionable approach in HCI research," [23:514]. Yet, there is a growing discourse on the need for more first-person research and autobiographical design approaches, "design research drawing on extensive, genuine usage by those creating or building a system" [23:514].

Neustaedter and Sengers point to autobiographical design for its potential to lead to valuable insights in such spaces [26]. Insights, they directly credit to the making-of and living-with things built expressly for the self. Unlike more traditional design methods, realizing a functional product by crafting it oneself is integral to autobiographical design methods.

"In the post-industrial West, and especially in America, we have split experience into two: whereas life could be a steady stream of work intermingled with pleasure, we have disengaged the two, often preferring to lavish 'serious' attention only on the first." [28:20] Sengers reminds us that the roles between work and home, or work and self, were not always delineated as many people strive for today.

Motivation to use autobiographical design

Outside mainstream research practice, autobiographical design is best suited to specific contexts. Because my inquiry stems from an observation of my family's unique interpersonal behavior, situating the research in the context of my own home—using autobiographical design—was a logical choice.

The master's thesis is an appropriate time for exploring new methods and topics of deeply personal interest. It is a unique opportunity in an academic journey to design one's own method of working, timelines, and expected outcomes. By living with the artifacts designed and built myself, I was dealing with and prototyping within, "the messiness of everyday life," bringing attention to the real impacts of my design choices [2:134], and cultivating a holistic, reflective design practice.

Autobiographical design in HCI

Within HCI, autobiographical design has been used to study relationships and communication in the workplace [32,33] and to build new and personalized tools for productivity [26]. The method has been used in domestic environments to design for personal pleasure [9,14], the maintenance of long-distance relationships [5], and to capture memories at home [18].

First reported in 2012 [26], and still considered an emerging method, autobiographical design has continued to gain credibility and methodological definition as researchers apply it to new domains and questions within HCI. A growing discourse has begun to explore methodological challenges, opportunities, and the benefits of using the method in future works [8,24], especially in private and personal spaces, such as the home.

Strengths & limitations of the method

An autobiographical design method lends itself to long-term projects for a number of reasons. When designing for the self, there is rarely a deadline—projects are not bound by a traditional client relationship—the designer is free to iterate as needed until she finds the right fit for her goals. In the purest definition of the method [8], autobiographical design for leisure or ludic pleasure, iteration cycles can happen according to the designer's own rhythm, around the schedule of other work, or according to personal and material availability.

The intimate and long-term experiences of living with a designed artifact can lead to deep understandings of the user/designer's needs, the real consequences of her design decisions, and the true-to-life constraints of

realizing a functional prototype, product, or system.

As with all research methods, autobiographical design is not without limitations. The method presents unique challenges and complexities to the researcher. Desjardins and I describe these complexities as Tensions [8]. Ethical tensions around research motivations and methods of reporting, as well as questions around privacy, and the difficulty of navigating the multiple roles of the researcher, make practicing autobiographical design uniquely complex. Further, because of its highly personal nature, research outcomes are often difficult to generalize.

Discussing frictions with trusted advisors who are practiced in using autobiographical design is critical to navigating challenges as they arise. Knowledge of the limitations and challenges of using the method can help designers prepare strategies and techniques for addressing difficulties during the project.

Data collection & analysis

While living with the research prototypes over a period of six months, I conducted qualitative research by recording detailed written observations of myself and my family. I simultaneously reflected on my observations and experiences, in the form of written journal entries.

Using open coding, axial coding and selective coding [6], I thematically analyzed data collected in the form of journal entries, sketches, photos and videos. In my analysis, I evaluated how the family appropriated the new systems in their daily life and what kinds of communication were occurring as a result. I used the analysis to look for how the design of IoT systems can support ludic engagement and communication at home in the future.

A rigorous autobiographical design research process also involves a continuous reflection on design motivations, decisions, and their impacts during the project. The reflective process is documented in journal entries and becomes a record of the design process, as well as how the designer navigates challenges, and in the case of this project, accounts of interpersonal communication in the research environment.

SECTION THREE

Design Process

"I love my stuffed animals. They keep me loved."
— Frankie

Design Process

The design of the Thought Projectors and the Inter(net)coms was an iterative and exploratory process, where design concepts were evaluated against their potential to help answer the research question, how can the design of IoT technologies for the home support ludic communication between family members? The research prototypes are a product of the process outlined chronologically below.

Exploring the problem space

Using an AEIOU analysis technique, I conducted autoethnographically-inspired participatory design exercises to look for a particular design opportunity in our home. AEIOU is a framework for organizing a research investigation by Activities, Environments, Interactions, Objects and Users [23].

Activity 1: love letters to objects

To better understand the 'research participants', I asked each to write a brief but eloquent letter expressing their deep affection for an object. The object could be either computational, or not; they decided. The exercise was intended to kick-off the research in a fun way, and to learn more about their individuality by asking each person about the objects they love and why. The method, The Love Letter and the Breakup Letter, was created by Smart Design in 2009. More info can be found in [23].

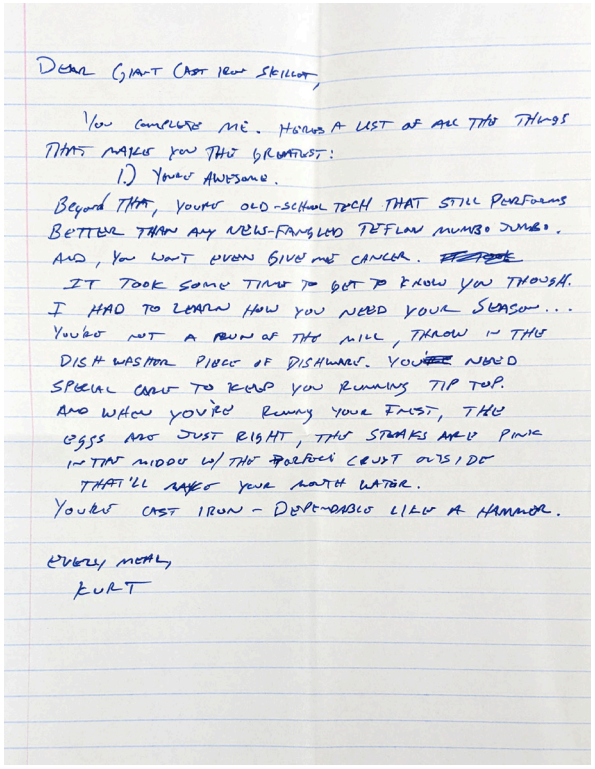
From the love letters, I learned that opportunities for maintenance and care, as well as long-term durability were important elements of building lasting relationships between the family members and our things. Things could elicit or facilitate emotional connections, for example, Mason's cell phone was a tool to emotionally connect with others, Frankie's stuffed animals were emotional support objects. I also found that significant memories could be evoked by interacting with special objects. For example, an object can evoke the vivid memory of receiving it as a gift.

Activity 2: personal inventories

To learn more about what kinds of objects and object interactions were meaningful to the family. I wanted to probe deeper into what causes them to form lasting relationships to their belongings. In the next exercise, I asked each person to take fifteen minutes to evaluate the things they owned, making a list of their most-meaningful things. We met in the kitchen to share the list aloud.

All four of us added a 'because' statement to each item we chose. Explaining why items were important mattered to us. Practice was a recurring theme, Mason wrote, "My cello, because it is just such a wonderful aspect of my life."

[Image 2, 3, 4, 5] →
Artifacts from the exploration of the problem space: Kurt's love letter to a cast-iron skillet, Frankie's personal inventory, annotated floorplan of the house, and ideation adjectives.



Dear Giant Cast Iron Skillet,

You completed me. Here's a list of all the things that make you the greatest:

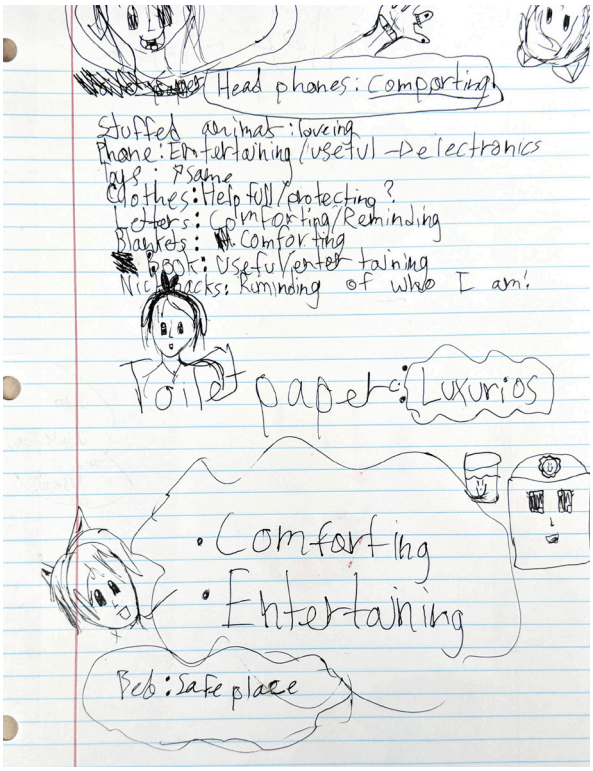
1.) You're awesome.

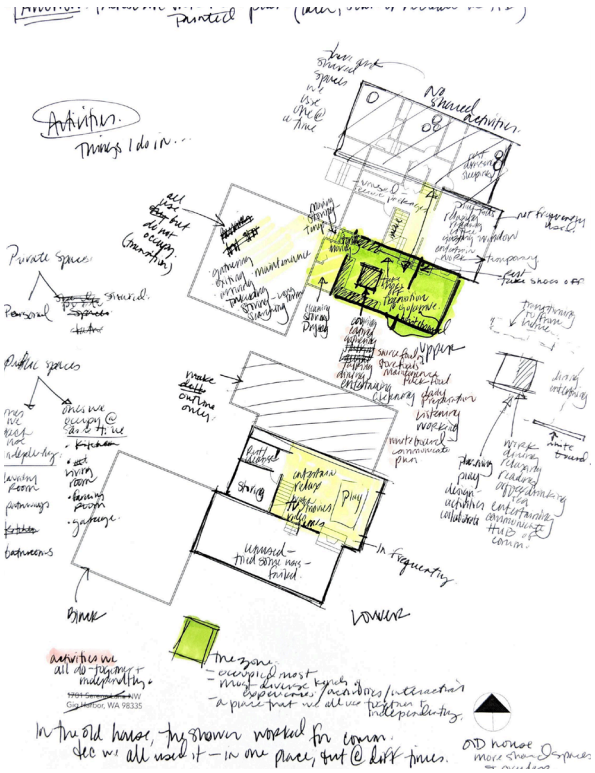
Beyond that, you're old-school tech that still performs better than any new-fangled Teflon mumbo jumbo. And, you won't even give me cancer. ~~Probably~~

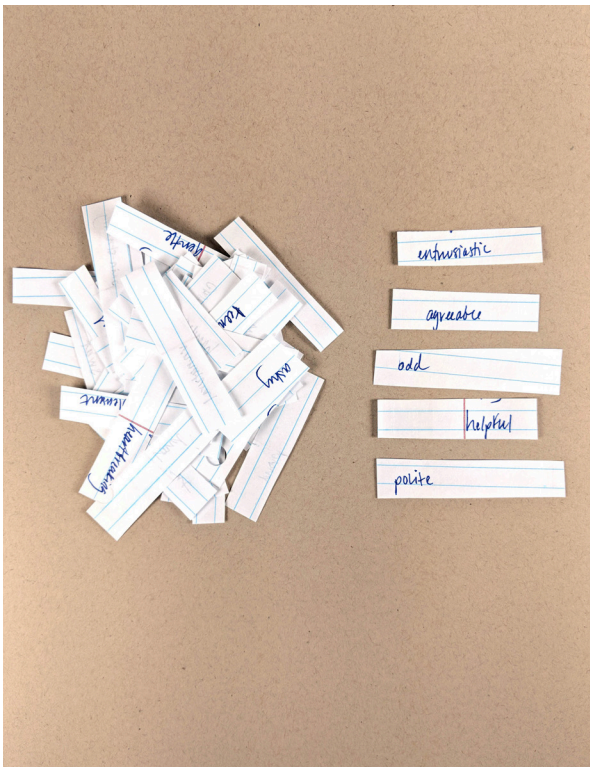
It took some time to get to know you though. I had to learn how you need your season... You're not a run of the mill, throw in the dishwasher piece of dishware. You need special care to keep you running tip top. And when you're running your finest, the eggs are just right, the steaks are pink in the middle w/ the perfect crust outside that'll make your mouth water.

You're cast iron - dependable like a hammer.

Every meal,
Kurt







[Image 6] The cello affords co-shaping: Mason's most-cherished object is his cello. Over long periods of time the musician's body is adapted to the instrument, meanwhile, the wood of the instrument changes with contact from the musician's body.

Preciousness was also an important attribute, “my grandmother’s blue plate—it is the only thing I have from her.” -Aubree
“That blue monkey I’ve been living with for the past fifteen years.” -Mason
And humor made a surprise appearance, “toilet paper is luxurious.” Toilet paper says, “I am awesome and useful.” -Frankie, accompanied by a sketch

Activity 3: environment analysis

Recalling the shower as a communication space in our previous home, I wanted to identify spaces that each family member used, sometimes alone and other times together. Knowing would help me identify a place to install the research prototypes where they would be used frequently by each member of the family. Understanding how the space was used would also help inform the design intervention.

Kurt and I diagrammed places in the house where human-to-human interactions occur, for example, teaching, planning and collaborating. As well as places where human-to-thing interactions happen and what kinds occur there: playful, productive, maintenance and care interactions. We noted where thing-to-thing, physical interactions took place, and we identified shared, private and in-between spaces in the house. We found the most-frequently occupied space with the highest number of diverse interaction types, which is used by the family members together and at other times, individually. We named it the green zone, a particular place in the kitchen, adjacent to and including the island.

Activity 4: participatory ideation

To begin generating unexpected design ideas for the research prototypes, and to include the family members in the design process I conducted a participatory ideation exercise.

I generated 100 random adjectives using an online tool, transcribed them on individual strips of paper and placed them in a hat. Sitting together in the kitchen’s green zone, each family member chose two words and then imagined how the words could be embodied in an internet-connected artifact for our home. The object had no limitations or set goals. Each person generated nine or ten concepts over the course of 40 minutes.

The word pairings were a fun and helpful prompt, but the ideas we generated were not particularly helpful. The exercise did reveal that the family was as interested in concepts exploring affective computing as productivity systems, and that they were equally open to negative and positive emotive interactions. A breakdown of the kinds of concepts which emerged:

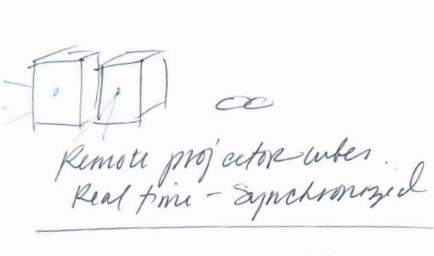
- Companions: 10
- Tool/assistant: 11

- Positive emotional response: 8
- Negative emotional response: 10

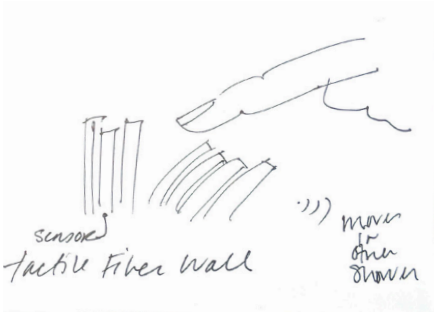
Culminating design principles

On the completion of exploratory research activities, I outlined the following design principles:
These principles reflect my research goals, insights gained during initial background research, and the new knowledge of my family's values reflected in my autoethnographic research.

1. The design permits the manipulation of a ludic engagement by all four family members.
2. It allows for open-ended and unexpected uses.
3. It supports reflection, curiosity, and imagination.
4. It supports communication which is emergent, playful, non-urgent, and unconcerned with productivity, efficiency or practicality.
5. It has qualities of impermanence.
6. Its physical form should be made of durable materials requiring long-term care and allowing for co-shaping.
7. It should be unique and personal, evoking preciousness.
8. It utilizes Internet-of-Things technologies.



[Image 7] Initial projector concept sketch



[Image 8] Tactile concept sketch

Concept ideation

The design process began with a series of ideation sessions and concept refinements. I set aside the design principles temporarily while I generated several dozen prototype concepts in phases—this allowed me to generate ideas more freely, without considering all of the constraints of my research.

After each ideation phase, I returned to my research question and design guidelines to evaluate the ideas. Concepts that were best-suited to probing the research question and goals were used to spark further iteration. I explored concepts including whimsical furniture with unexpected interactive qualities, 'dumb' spaces (or technology-free zones), and tactile interactive surfaces, to name a few.

The two concepts selected for physical prototyping were 1) a set of projectors allowing family members to send each other videos, and 2) a home intercom system, allowing family members to leave messages for one another in different places inside the house.

[Image 9]
The Thought Projector research prototype. To inspire and observe more natural responses to such a technology, the prototype was designed with a high-fidelity finish and intended to reduce the feelings of "prototyping" during interactions it at home. In this way, research participants are encouraged to focus on appropriations, rather than on aspects they think are unfinished, or undeveloped.

Research Prototype 1

The Thought Projectors

The Thought Projectors are a set of bespoke video projectors. Each plays a single collaborative YouTube playlist which is shared by the family members. Family members upload video content to the playlist using a YouTube app or web interface on their cell phone or computer.

The idea was to create a private interaction that could be expressed in a public space at home. Family members can privately browse for a particular video from any location (i.e. their bedroom, at work, etc.) and add it to the playlist. The projector then displays the video on the wall at home.

The design of the projectors was an iterative and collaborative process. Throughout which I tried multiple projectors of different sizes, with a variety of interaction methods. The goal was to create an ambient display of asynchronous, ludic communication between the family members.

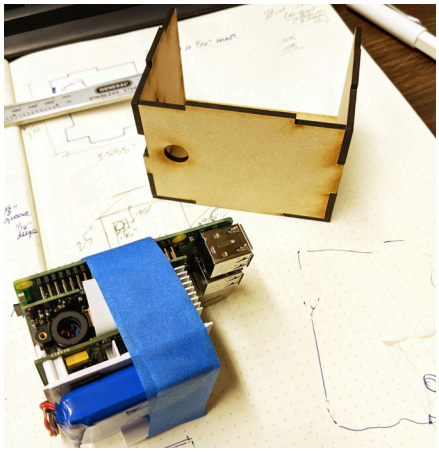
With the help of Mason and Frankie, I set up a playlist on my personal YouTube account and connected an old, unused laptop computer. The computer was big and slow—within a few days I wanted a simpler interface, and I replaced the laptop with an old iPhone.

After only a few weeks, the projector failed. Kurt and I took it apart to see if we could replace the bulb or fix it simply. Taking it apart allowed us to explore its inner workings and we started to ideate around building a new, unique projector. In the meantime, we used another off-the-shelf projector, this one with an internet connection and a YouTube app.

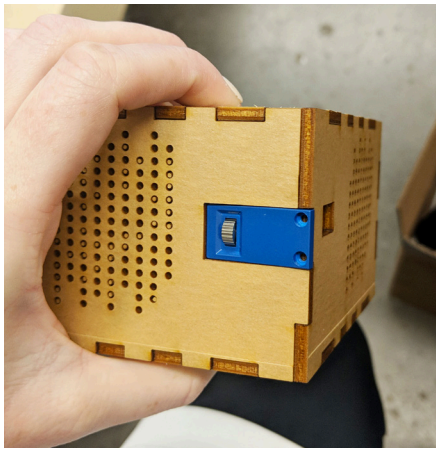
Watching others search for videos on the new interface made it difficult for people to convey an element of surprise, and reduced sender-viewer interpretation, a desired quality. By seeing what someone searched for, the viewer could often intuit the sender's intent. To add privacy, I created a collaborative playlist that we could each access via our cell phones. This was also helpful for data collection. I could see who added which video and when.

Thought Projector fabrication

To support the sense of mobility and touchability, I wanted the Thought Projectors to fit in the palm of the hand. By testing multiple projectors, I selected the smallest one with an acceptable video output quality. A pre-fabricated Pico projector with a removable plastic shell was a good candidate for deconstruction and became the "guts" of the research prototype.

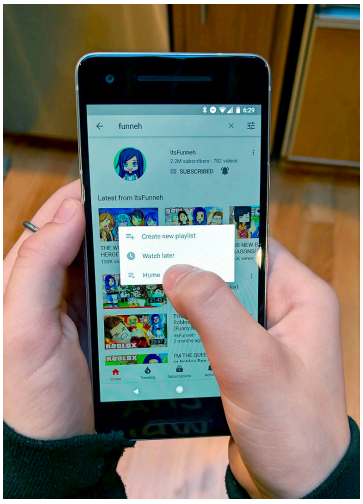


[Image 10] tests of projector-case fit



[Image 11] laser-cut wood projector body

[Image 12] laser-cut wood veneer



[Image 13] (left)
Frankie using the YouTube interface on her cell phone to add a video to the collaborative playlist

[Image 14] (right)
Frankie placed the Thought Projector on her nightstand and projected her favorite music videos

Connecting a Raspberry Pi provided a wifi access point and the computing power to run the projector and playlist autonomously. A power cord with a single on/off switch was added to power both the projector and the pi simultaneously. When on, the pi booted up and was programmed to display the playlist.

Returning to insights from earlier research into the family members' meaningful objects, I chose an organic, durable material which required routine care for the prototype's body. A teak veneer was laminated to a laser-cut birch box. Regularly applying a new coat of bee's wax to the teak brings out the luster of the wood grain and changes the appearance of the projector over time.

Designed for relocation inside the home, the projectors each rest on a flexible beanbag that makes it easy to project from a variety of surfaces. The colors of the beanbag fabric, and matching focus dial details were chosen to match the palette of the intercoms.

Research Prototype 2

The Inter(net)coms

The Inter(net)coms are a refurbished network of home intercoms that use a VoIP server to host a private chat room inside the home. The concept was to adapt the aging, partially functional system already installed in the home to explore how it would change our interactions in the new space. Originally, I wanted to be able to leave messages "inside" the intercoms for later retrieval by family members—similar to the delayed communication we used in the shower.

Asynchronous communication necessitates data storage and retrieval. Audio files add an additional layer of complexity, being both difficult to record and requiring a large amount of data storage. This level of complexity was beyond my technical limitations within the time constraints of the project and the realization led to designing a real-time press-to-talk function, similar to the old intercom.
Using the existing wall interface of the intercom was a 'low-barrier to entry' approach to building a new intercom system. Choosing to reuse the plastic front

(next spread)
The Inter(net)com research prototype installed on the wall.


NuTone
Scovill

[Image 16]
The author using an online tutorial as a guide, soldering the Inter(net)com components at her desk in the graduate design studio of the School of Art + Art History + Design.

provided design constraints that helped me focus on the interactions rather than on designing a new physical enclosure. Because the prototypes are not designed as final artifacts, but rather as an iterative research tool, I continue to envision new forms and interactions while we live with them.

Inter(net)com fabrication

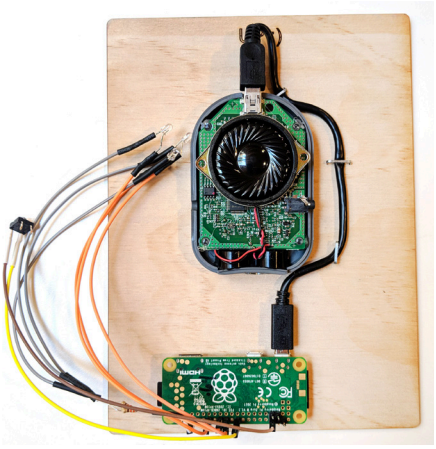
I adapted two DIY online tutorials to design my own system. I started by assembling the intercom components on bread boards and placing them in different places throughout the house. Each intercom was made up of a Raspberry Pi Zero, a usb speaker-phone (a microphone and speaker in one unit), and a set of indication lights, 3 LEDS. All three of the intercoms connected to one Raspberry Pi hosting a private web server. We lived with the intercom this way for several weeks while I tested and configured the system, troubleshooting reliability and connection issues and moving it to different places in the house.

To build the research prototype I deconstructed the old intercoms, removing all of their components, saving the plastic wall cover. I lasercut a new 1/8" plywood back which fit inside the cover and allowing the it to sit flush on the wall. The plywood back created a surface to mount the new components.

Frankie and I chose a color palette to repaint the plastic covers. Each bedroom had a color unique to the person, because I learned that uniqueness was an important element of how my family related to their objects. A new wood veneer was laser cut to replace the plastic wood laminate. The natural wood united the intercoms aesthetically to the projectors and provided opportunities for maintenance interactions over time.

Because only one button was necessary in the new design, the existing buttons were removed and the interface was redesigned with indication lights. Three pin-sized holes in the wood veneer were illuminated when 1) the intercom was connected to the internet, 2) the intercom was connected to the server, 3) the transmission button was depressed (i.e. someone was speaking into it).

The old volume knob was replaced by a 3-D printed plastic button mechanism I designed to fit the unique tiered hole. A new aluminum button was milled by a close friend and fabricator to add polish.



[Image 17] Inter(net)com components

[Image 18] drilling holes for the new button

[Image 19] Frankie selecting the color palette

Kurt projecting a video in the kitchen of a cyclist he enjoyed watching and imitating when he was a boy. He used the space and the video to draw on his memory, to reconnect with a younger-self, and to share it with his family.

"By focusing on how users react, rather than on the internal content of the software, a simple computational artefact can be used to communicate a rich and complex idea." [29:26]

SECTION FOUR

Observations

Mason used the projector to show things he might find harder to say in words.

Observations

New channels of communication: show & Tell

The Thought Projectors opened a new channel for family members to engage in "show-and-tell" behaviors.

The children used the projectors to share things they were learning about in school, celebrities and events they were interested in, techniques and various skills, and things they found humorous or interesting.

One evening, Mason shared video excerpts of airplanes engaged in "dog-fighting" from a favorite Hollywood film. He used it as an opportunity to passionately educate Frankie and I about the film's inaccuracies,

> "...that's not what it would sound like! That gun fires at [x] rounds/sec, it sounds like dah-dah-dah-dah!"

Other times, Kurt and I used the projectors to show the kids places we were each traveling for work and what kinds of things we were doing or working on. I shared videos of how to build a 3D spatial tracking environment to show the family what problems I was trying to solve while building a proof-of-concept.

On Mother's Day, Mason used the projector to tell me he loved and cherished me by adding a looping video of quotes by famous leaders about their beloved mothers.

Reminiscence & expressions of the sense-of-self

HCI researchers have speculated that technology can be designed to provoke meaningful digital media interactions which support reflection and expressions of self-identity [17,27,36]. Adding a unique aspect to show-and-tell behaviors, the projectors frequently became a platform for experiencing and expressing the sense-of-self.

> "I walked into the kitchen to find Kurt smiling slightly to himself and watching this video that looked like it was from the late eighties or early nineties—it was an extreme mountain biker doing stunts. Kurt looked lost in memory and I watched it with him for a moment and asked him what it was, he explained that he used to love this guy when he was a kid and try to do these tricks himself. I envisioned Kurt as a twelve-year-old, on his bike, and I knew him a little bit more in that moment." 4/12/18

Others used the projectors to display their present moods, their aspirations, and the things or people they identify with.

> "Frankie asked if she could change the video. She projected her favorite YouTuber. She said, "he is my celebrity crush." I had never seen or heard of him before. I felt closer to her knowing more about what she was watching and interested in, and I enjoyed the YouTuber, which surprised me. I could see why she liked it. It was funny." 1/31/18

Spaces for delighting in simple pleasures

When homemaking, a balance is struck between making space for restorative acts (rest, relaxation) and accommodating the needs of everyday life (chores), IoT at home can also strive to support such a balance. In the fashion of homemaking negotiations, the intercoms straddled an invisible border between a practical tool, and a device for delighting in nonsensical behaviors.

The intercom, while used for traditionally productive tasks—speaking from one room to another—usually included a playful twist:

> "Reading with Frankie in bed, she wanted her water bottle filled, so she hopped over to the intercom and called into the kitchen:
>
> 'Kurt, it's me, Aubree, your wife. Come tuck in the child we're raising together.' -Frankie
>
> Kurt popped his head in the door, Frankie laughed and handed him her water bottle. He took it and left to fill it. Frankie turned to me, 'I got him trained' she said laughing." 4/16/18

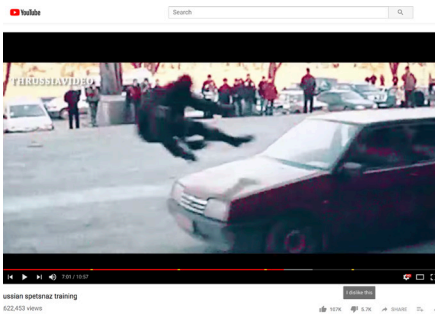
Both systems created space in the home to delight in playfulness. In doing so, they fostered feelings of closeness among family members by supporting shared ludic experiences.

Conversation starters

If you have ever watched YouTube, you are probably familiar with the concept of a 'rabbit-hole'. In this context, the concept is akin to a traditional dinner host's placement of a 'conversation starter' on the dining table. The projectors were especially effective as conversation starters at dinner.
One night before dinner Mason added a video parody comparing American Navy Seals to the Army's Green Berets. It was visible from where we ate, prompting conversation around their different skills and tactics and led to Mason exclaiming, "But have you seen the Spetsnaz?!" To which he described their acrobatic maneuvers—jumping through windshields and things Frankie

[Image 21] Mason excitedly sharing knowledge

[Image 22] Night-time view of the projection



[Image 23] Mason's Spetsnatz video

and I had never heard of but were immediately curious to see. From there the conversation led to other feats of human strength and so on, until we had spent more than an hour in unexpected, dramatic, purposeless, and fun conversation.

Intentional calm & slowness

Over the past decade, slow technology, a "philosophy aimed at supporting experiences of reflection through and on technology in everyday life" [1:1], has been explored in depth within the HCI community. More recently, Internet of Things systems are also beginning to receive the attention of researchers interested in systems designed to elicit calm ambiance at home [22]. (Productivity and efficiency are still dominant motivators; in the case of [22], to reduce energy consumption.)

The Thought Projectors introduced ambient video and 'slow TV' to our home. Videos with fixed-vantage points of snow storms, grasses blowing in the wind, and trains traveling across European countries were fan-favorites. They were especially calming during periods of quiet in the home.

One winter evening when the projector was still new, I left the house to pick Mason up from an activity. When we returned, the house had fallen dark but the kitchen was illuminated by the light of the projector displaying tall beach grass blowing during a hurricane.

On entering the kitchen, Mason said, "Wow, that is aesthetic."

Months later, while building the new projectors, I was troubleshooting the Raspberry Pi's programming. Frustrated with the task, I had worked on the same issue for several days. When it finally played the YouTube playlist, it started with a video of a dark storm on the ocean. The video not only filled me with joy because it was working, but it caused me to take a deep breath—I was reminded what the point of the work was, and I was calmed by the steadiness of the storm on the sea.

Adapting existing systems

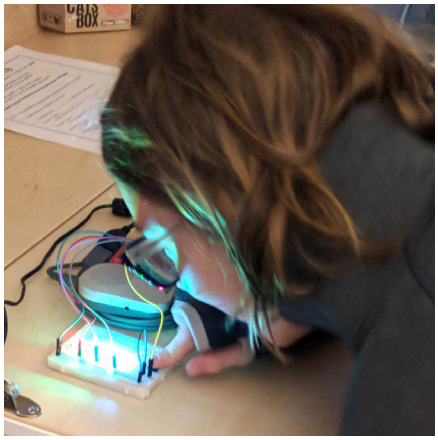
Adapting the house's existing intercom system created an opportunity to learn from the people who lived in it before us. By noticing and evaluating the communication tools they used, our habitual methods were brought to attention. To speak to someone in our previous house, one walked to where the other was. Another person was never more than twenty feet away. In the new house, the same method was inefficient, sometimes leading to searching. The physical distances between us had become greater, and there were new barriers we

were not used to living with. Multi-leveled floors, walls, and large rooms created chasms.

Conceptually, it was like discovering a previous owner's tool organization system in a garage. Adapting it, or using it as a launchpad to update and personalize the system, is a heuristic often applied to homemaking, but not to home technology. It is, perhaps, one method that could help us design technology for longer-term adoption and flexibility in the home.

The intercoms also opened a space for considering how technology can be designed to accommodate adaptations and flexibility for future uses. The physical interface of the intercom is still relevant, recognized, and appreciated in our home today, despite being over forty years old. Indeed, it is the intercom's historic styling, in conjunction with its new polish, that creates a bespoke, familiar-yet-curious, design.

Repairing the intercom revealed a relationship between the technology, the space, and the people's interactions in the home.



[Image 24] Frankie using breadboard intercom

[Image 25] central hub of the old intercom

SECTION FIVE

Reflection

Implications for Design

Reflecting on my personal values, design process, and observations of my family interacting with two bespoke IoT systems, brought my attention to considerations for the future of designing interactions with home technologies. Other designers creating systems for domestic settings can support ludic communication by designing with the following information in mind.

When looking to the future of IoT for the home, designers can also choose to create technologies that support tangible, embodied and shared interactions. This is not to say that meaningful connections do not happen in virtual environments or non-tangible interactions, but rather that when designing for the physical environment of the home in particular, shared ludic interactions can contribute to feelings of connectedness and understanding between family members. Such interactions can further support ludic communication between family members by provoking open-ended dialogue and intentional rabbit holes.

Currently, IoT systems are used to control the environmental conditions of the home, but imaginative designers can think beyond these practical uses and consider more abstract modes of environmental activation. Concepts such as calm and slow-technology, with epistemologies in long-term and systems-thinking design are particularly relevant to domestic IoT systems.

Houses and homes evolve over long periods of time, on the order of decades, lifetimes, and eras. While people's particular behaviors evolve with their homes, our fundamental needs are slow to change. When I looked to the house for cues about how to use it, by examining the tools people before me had used, I found that I had a similar need to the people who lived here before: in this case, to communicate across a large space. Instead of removing and 'updating' systems on changing ownership, new owners can look to existing technology in the house to help transition into, and discover, their new living patterns in the space.

Reusing components, connections and access points, as well as giving preference to tangible interfaces, are worthwhile design pursuits—especially in the context of the home, where hobbyists and tinkerers engage in ludic making. Designing for disassembly, repair, and 'hacking', can create opportunities for unknown future appropriations.

This research points to an opportunity for designers to envision more and different ways that IoT for the home can be designed to support meaningful interpersonal communication between family members. The home, after all, is place of creating traditions and memories, and it is largely where people develop and cultivate the sense of self. When creating technologies for such an intimate and diverse space—designers can strive to shape experiences that cultivate, develop and express the values of the unique individuals inside.

Using first-person methods

In addition to reflecting on the design process and resulting insights, below I offer a reflection on the use of first-person methods in design research. As the discourse of autobiographical design continues to grow, first-hand accounts of the strengths and tensions of using it will help researchers understand and articulate the uniqueness of the method with more nuance and rigor.

Intimate understanding of the research context

Unlike more traditional HCI research methods such as fieldwork studies [4,13,34] or simulated environments (i.e. "living labs") [21,35], situating the research in the context of my own home provided long-term access and intimate knowledge of the research participants (my family and myself). Such intimacy fostered nuanced observations and upon reflection, a holistic understanding of their contextual meanings, allowing me "… to investigate the lived experience from within, generating deep, evocative, and rich insights." [2:754]

Ingrained intimate knowledge of the participants and systems also revealed how design decisions impacted familial interactions, and how the family dynamic was altered over the course of the research in subtle ways. Such personal, private and difficult to quantify—or even articulate—qualities may not have been perceivable in a more traditional researcher-participant relationship. While researchers use a variety of approaches to understand the nuanced social-emotional contexts of the home, investigating the home as an "embedded expert" allows the first-person researcher to investigate the intimate details of the home more deeply.

Empathy for the role of the participant

Beyond practicing as an ethical researcher, concerns for my partner and children's privacy seemed intuitive and aligned to caring for my family well. Navigating boundary decisions as a participant, a mother and a compassionate partner first, then a researcher, and finally as a designer helped me weigh decisions around how much personal information to share, in what format, and in which publications. This topic is evaluated and discussed further in [8].

Embodying these four roles simultaneously over the course of the year-long project gave me a unique opportunity to evaluate their, at times, conflicting motivations and responses, which is also explored in [8]. Ultimately, it created a foundation of deep respect and care for the privacy and safety of my research participants, enabling me to empathize with a role I had not occupied before and will continue to engage with in the future.

Engaging my children through autoethnographically-inspired methods

One of the primary goals of this thesis was to develop a more holistic design practice, which respected (though perhaps it even celebrated) my passion for being a mother—rather than subjugating it, as I had so often experienced building a career as a professional designer.

Design is both a process and a creative act. While I cannot speculate on every designer's process, when I am under stress, I cannot pursue my deepest and most creative thought. Design is cut short. It becomes production, lacking the richness and process I find inspiring. The conflict between giving my time to mothering and to work had become a chronic stressor and graduate school exacerbated it.

Using autoethnographically-inspired methods of observation and interviewing, I was able to reengage with my children in a deep and immensely satisfying way during the research. I learned about their interests in detail, asking open-ended questions designed to elicit their thoughts. I spent time being close in order to observe their behaviors and to understand their context. "Why does Frankie like watching YouTubers?" Through our interactions with the systems I created, I came to know them better and appreciate their individuality more.

Identifying the designerly self through an autobiographical design process

Designing the research project for myself in my own home, revealed things about my deeply rooted motivations and values as a designer. It raised my awareness to conflicts between my desire for control over the design outcome and desire for a participatory process. It revealed new information about my relationship to the design context—my home—in both the old house and the new house. This is not to suggest that all autobiographical design processes lead to deep insight into the designer herself, but in this case, it did.

There is great value in understanding and knowing the designerly self. With knowledge which stems from a critical analysis of one's design motivations, challenges, strengths and passions, designers can engage in work which complements their individuality and supports their long-term wellbeing. Autobiographical design supports such reflective introspection and can therefore make a meaningful impact on the development of designers.

Conclusion

Through a critical design lens, this research-through-design project responds to the current state of Internet-of-Things systems designed for domestic life. Using an autobiographical design methodology, I designed two bespoke IoT systems to help my family rediscover ludic communication in a new home.

In the process, I came to know my motivations and values as a designer by practicing reflection, an essential element of a rich design process. At the same time, I drew closer to my family. The Thought Projectors and the Inter(net)coms became spaces for them to explore and express their individuality.

This research is not meant to suggest what people's relationships to technology at home should or will be in a preferred or even probable future. Rather, it is intended to act as a prompt for imagining life within a computing environment more broadly.

The current state of IoT in the home offers a limited perspective on the role of computing in everyday life, but the narrative is not yet fully articulated. The future of computing at home is still open to design. By creating more personal, authentic and diverse visions of how people might live with computers, designers can sketch diverse paths forward.

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