Designing for Reflection: Utilizing slow technology to create tangible interactive designs for reducing technostress

Armaghan Behzad Behbahani

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Wallace Santos Lages, Chair
Aisling Kelliher
Thomas Tucker

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Abstract

Technostress is an emerging and significant psychological phenomenon associated with the use of technology. It impacts human behavior and distracts from living a healthy and meaningful life. As humans increasingly encounter computational technology on a daily basis, there is a need to understand and manage the anxieties and tensions that can result from these interactions. Using the lens of critical design, this thesis explores this concept of technology induced stress and promotes reflection, personal growth and awareness through three different design research methods. It further builds on the topic of slow technology which unfolds in the form of a design fiction, design probe and design artifacts, challenging our understanding of technostress while embracing constructive discussions and creative designs to speculate the human-technology relationship.
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General Abstract

Technostress is an emerging and significant psychological phenomenon associated with the use of technology which impacts human behavior and distracts from living a healthy and meaningful life. As humans increasingly encounter computational technology on a daily basis, there is a need to understand and manage the anxieties and tensions that can result from these interactions. By employing critical thinking, this thesis explores this concept of technology induced stress and promotes reflection, personal growth and awareness through three different design research methods. It further develops designs which challenge the current technological systems and invites people to interact with the designs to bring awareness to the matter of technostress and its relationship with people.

The designs presented in this thesis encourage slow interactions, meaning that they foster pause and reflection by taking the focus away from efficiency of performance or time which is commonly expected with any technological device or system. It further builds our understanding of technostress while embracing constructive discussions and creative designs to speculate the human-technology relationship.
Dedication

To my loving family and my dearest friend, Ahmadreza.
I would like to express my profound gratitude to:

My wonderful advisor, Wallace, for his patience, invaluable guidance, trust and for helping me pave my own path.

My inspiring mentor, Aisling, for her unbelievable support and for giving me the joy of growth in the field which has become my true passion.

My kind teacher, Thomas, for his support and for pushing me to achieve big goals and become the confident person I am today.

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Preface

I came to the Creative Technologies program with a background in architecture, although I was interested in working as a designer. During the first year, I had an anticipation to create interactive public installations, but I felt that the lack of intimacy was significant in my designs. Short after, I took a theory class which opened a new world to me. It introduced me to critical and cultural computing which challenged me to look beyond the status quo of technological designs and become more mindful of its impacts of humans. At that time, my mind was set in projects at an architectural scale, however, this class allowed me to explore designs at a smaller scale and not just think and design critically about technology but it also inspired me to be critical of my personal and professional design process and essentially rethink my role and contribution as a designer. Ultimately, I found the intimacy in small designs which as a result led to the topic of my masters thesis.
Designing for Reflection, is not just about speculation and critical designs which promote pause and self-reflection, it can also be considered as an autobiographical report on my reflective process as a designer. With this research and through building every single one of the design artifacts, I was challenged to learn many technical skills, familiarize myself with the right type of vocabulary to engage with experts outside my discipline, and further grow as a critical thinker. The making of the artifacts, putting them to test and understanding their capabilities through informal and expert feedback, encouraged me to go through a more slow process. In other words, the notion of slow technology not only inspired my design criteria, it also influenced me to go through a slow knowledge building process myself.

The designs I present in this research are also somewhat personal which means that I would personally want to engage with them and have them as part of my everyday setting. Lastly, as a quick HCI method, by giving these very personal objects to colleagues, friends and even experts at conferences my designs were simply informed by their reflections and experience.

My journey throughout these two years has not been a straight line, but my experiences and self-discoversies through my research process has pointed me to the direction I wish to continue in the future.
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Chapter 0
This research makes an effort to explore one of the rather new areas of HCI; Technostress and utilizes a research through design approach with the overall goal of designing for reflection. It further looks at the notion of Technostress through the lens of critical design, and embrace the principles of slow technology to inform the research and design direction. Three main design methods are presented which have led to prototypes, kits and interactive artifacts, to mitigate technostress and ultimately creating an opportunity for reflection.

**Chapter 1** is dedicated to a design fiction which critiques how digital possessions are shared through social media. This phase acts as an initial step in this research towards realizing and understanding technostress in relationship with people and their use of technology.

**Chapter 2** presents a design probe, exploring this concept of technology induced stress in a practical manner. The probe embraces multisensory experiences as a tool for individuals to reflect on their relationship with technology. This chapter is a segue towards the making of prototypes and artifacts which are presented in its following chapter.

**Chapter 3** introduces two artifacts as a means for pause and reflection in combating technostress and leveraging personal growth and awareness in an everyday setting. The objects are then given to participants to interact with and use as a form of evaluation.

**Chapter 4** concludes with reflecting on these three chapters and suggests trajectories for the future of this area of research.

The way this thesis is written is such that it takes the reader on a journey. It starts with grounding the work in the foundations of the research, being notion of technostress, slow technology and critical design. It then leads into an activity-based design, opening a space for participants to become part of the conversation and exploration in regards to technostress and slow interactions. By the end of this stage the reader would have a better understanding of how critical design and slow technology influences the relationship between technology and its users which could later offer new design ideas for dealing with aspects of technostress and reflection. To complete the learning, two tangible interactive artifacts are presented as the final stage, proposing potential future products for the purpose of designing for reflection. The hope is to have the reader slowly grasp the importance of designing for reflection as each chapter progresses while thinking critically about their own relationship with the technologies they use everyday.

The following pages present definitions and explaining the terminologies used in this research.

"Introduction"
Figure 1- Research Process- The process starts with technostress as the overarching problem. Through each design methodology- design fiction, design probe, and design artifacts- the research puts slowness into practice and completes the process with evaluations and reflections on findings.

*For the Purpose of Designing for Reflection

**Critical Design is a Methodology within Research through Design
Stress is the tension we experience when we feel there is a need for adaptation to significant change while maintaining our old equilibrium [6]. Technology has become a source for stress, which builds through the obligations surrounding the use and adaptation of technology in our everyday life. It is also known as an important fallout of the inevitable use of technology [41]. The strive to be “always on”, sometimes creates an endless loop of addictive behaviors, minimal human interaction, and leads to the increase of technostress. Tarafdar et. al describes technostress as the “dark side” of technology [12] which individuals experience as “a modern disease of adaptation caused by an inability to cope with new computer technologies in a healthy manner” [6-p.16]. This phenomenon seems to be a timely fit for today’s lifestyle, as technology has surpassed the boundaries of office and work places and digital tools have become an interwoven entity in our everyday lives.

Studies regarding technostress show that forty-three percent of smart phone users experience stress for constantly checking their messages, while sixty percent of the users tend to check their messages and emails at least once an hour. Also, before bedtime, in the middle of the night or right after waking up, fifty-four percent of users check their phones [12]. Furthermore, there is a common anxiety among people who constantly interact with technological machines or devices which literally end up controlling them. This fact and the condition of constant connectivity, not only suggest a great deal of attachment to technological devices and notifications but also the pressure for missing out, eliminates the conventional workday [37]. It has also caused a significant change in behavioral patterns and implies that technology has substantially invaded personal space and that users are never free of it [41]. In other words, instead of having technology act as an extension of the users, the users become an extension of technology [6].

Looking beyond usability and professional support tools, the HCI community has lately shown an interest in creating a space for research and discussions about technostress [11]. This research takes “technostress” as a socio-technical issue to further study its impacts and explore trajectories to reduce this negative psychological experience.
Research through Design

In recent years, the field of Human-Computer Interaction (HCI) has and continue to broaden in scope, creating a growing interest for design research. It brings different perspectives and disciplinary backgrounds together to pose a necessity for new ways of conducting scholarly research. With this demand, research through design presents a trajectory which leverages producing new knowledge through methods and processes of design practice [46]. The design process is considered a legitimate research activity which bridges design theory and practice to generate new knowledge [23]. Simply put, research through design embraces design artifacts as an appropriate conduit for research contribution to the interdisciplinary structure of HCI community [45]. Therefore, it is found appropriate to apply research through design as an approach for exploring new methods and designs to scale down the negative effects of technostress.
Critical Design

Critical design is a “research through design methodology that foregrounds the ethics of design practice, reveals potentially hidden agendas and values, and explores alternative design values” [2-p.3297]. It is also a “form of social research” [13-p.147] which challenges and refuses the status quo design possibilities. It further introduces a mindset, encouraging alternative solutions for “producing new knowledge to promote social, cultural, technical, or economical values” [14-p.58].

This notion also opens an interesting space for consumers to think more critically about how they unquestionably adopt social values, make assumptions and accept ideologies and behavioral norms [2].

Critical design has an interesting take on how designers can think and construct a creative process in a speculative fashion. The notion of challenging the norm and provoking social, cultural and even personal issues through the idea of designing a set of protocols, kits, exercises and prototypes, provides a good opportunity for designers to engage in critical thinking in a more practical and impactful manner.

Dunne and Raby argue that design is a tool to create not only things but also ideas for the purpose of speculating possible futures [15]; therefore it is important to be speculative and allow the speculations act as a catalyst for interesting conversations and debates.

Thus, this thesis embraces critical thinking and critical design to drive our research direction towards creating less conventional designs, and welcoming ideas to shape around speculation. In this realm, the research avoids proposing critical theory and rather expands the importance of acquiring critical thinking in practice, which could have a more direct impact on design and making things.
Slow Technology

Slow technology casts a speculative lens on HCI, design and technology to utilize slowness as an advocate for promoting “reflection and moments of mental rest rather than efficiency in performance” [22-p.201]. It nurtures a meaningful relationship between the user and the product by reducing the ubiquitous “always on-ness” associated with these products [22].

Recent studies propose design criteria of slow technology [22, 21,17] and designing for reflection [10, 38 16, 26] to support healthy relationship between technological tools and its users. By doing so, it is critically reflecting on technology itself with the purpose of creating a creative dialogue in design research and practices.

In this thesis, principles of slow technology is applied to address our ideas for reflection in support of reducing technostress through our design methods and prototypes. It explores the implementation of slow technology in designs as an incremental, implicit and on-going relationship with the users.
Designing for Reflection simply dwells on the notion of technostress as a negative experience while creating a dialogue with slow technology and slowness to inform design decisions. This research presents itself with a critical and speculative voice towards the interaction of people and technology, placing the emphasis on an explicit relationship through the proposed designs.

The connection between the problem, approach, applied principles and methodologies is depicted in figure 2. This research explores the mutual area, shown through various design decisions.
Figure 2- The relationship amongst different aspects of this research.

“Designing for Reflection”
Design fiction is a great source of inspiration and motivation for engineers and designers to push past creative boundaries. The ambiguity of science fiction is what makes a design a strong speculative and critical manifestation due to its imaginary nature [7] and acts as a way of guiding practices which choose to realize these sci-fi scenarios [40]. In other words, design fiction is not necessarily fiction; it is simply a possible design trajectory which speculates and critiques current and future technologies in either a utopian or distopian light. *Sharing is Caring* gravitates towards a more utopian design fiction.
"Sharing is Caring"
Sharing by definition is a positive social act. The ability to share information in a wide sense, was made possible with the rise of the Internet. In 1997 the birth of Social Media introduced a new perspective to sharing information. It created a platform for connecting with friends and others through sharing text and images. In the in 2005 Facebook [50] changed the way people record, share, view and save those distributed information. Although it was initially meant for family and friends to stay connected, it later became a global platform for communication. Ever since, we have become desensitized from sharing our personal information with the entire world through social media. This notion has further caused users to appear constantly online and active in social platforms in fear of missing out which has led to experiences such as anxiety, addiction and low self esteem.

Sharing is Caring is a design fiction which employs the principles of slow technology and speculates sharing through social media for the purpose of reducing the negative feelings and stress surrounding this action in a tangible medium.

**Alternate Scenario**

Let’s say we were to go through our day without having any online sharing platform. How would we then stay connected and share our images, videos and texts in a meaningful way? How would slow-sharing, become an alternative to instant sharing?
Design Concept

This design fiction, creates a tangible system which allows people to share information, in the form of images, videos and text, and with others who have previously exchanged phone numbers.

Having saved ones phone number typically suggests that both parties have met or know each other to some extent, although there maybe some exceptions. Utilizing phone numbers challenges the users to connect with people they already know or have met before, suggesting a more meaningful sharing experience.

The system has a sender and a receiver. A necklace is designed for the sender to record and share images, videos and text to individuals or a group of selected people using their phone number. All the recordings are kept within a lens inserted inside the necklace pendent. The recipient would view each person’s shared information one at a time through a receivers box, home to lenses assigned to an individual person sending information. The recipient would be able to view the information through a pair of glasses after inserting each pair of lens into the designed slots on the glasses. They could then place correlating color filters to view the received information depending on its medium. The concept is to make sharing a tangible act and to slow down both parties while recording or viewing the information.
Figure 2- A conceptual drawing of all the components for the design
Components

The design consists of the followings components:
1. Necklace (with a recording lens Pendant)
2. Cellphone (any cellphone which could access saved contact information)
3. Receiver collection box (containing individualized information lenses, RGB Filters)
4. Viewing Glass
5. Memory Book
The Package*

* The package also acts as the “Receiver Collection Box”
Necklace: Creating a Daily Fashion Statement

The necklace is designed to be used for recording and sharing media. It holds a recording lens pendant. There are 5 buttons on the pendent which are dotted in Red, Green, blue and two plain.

The buttons allow the following actions:

- Red button: record video
- Blue button: capture image
- Green button: record audio (which would be transcribed into text)
- Plane buttons: connecting the lens to a cell phone to access the phone book and choose the type of information (image, video, text)

The pendent displays a visual representation of the amount of information the owner has recorded. The lens would start to fill with Red, Blue or Green depending on the type of info the owner is recording. The lens could only hold a finite amount of information and would last only a day, whether or not it has been shared. This feature, challenges the user to be mindful of not only the amount of information they share, but also the type of media they choose.

Cell Phone: Reducing the Necessity of Having a Smart Phone

Once the owner decides to share the content of the lens, by pressing one of the plain buttons, the lens would access the owners cellphones’ phone book and by selecting individual or groups through the cell phone, the information would then be shared.
Figure 6- The necklace

Figure 7- The pendent includes a lens, and 5 buttons
Receiver Collection Box: Reserving carefully and selectively

The receiver’s box, consist of two sections. In one compartment there are rows of lens holders which have a barcode readers. Each pair of lens in placed in one of the slots with a name tag and a small LED. They are unique to a person as they have a special barcode on their rim. Once an information is shared, the barcode reader identifies the sender and the LED would light up. The lens would also show the amount and the type of media which has been shared, on the lens. Once the lens has been picked up, the LED would turn off. Also, if a lens has not been viewed by the recipient, the information which it consists would automatically erase.

The information lenses have two sets of memories; Short term memory and long term memory. The short term memory is valid only for a day and erases its content after 24 hours. This feature challenges the user to be mindful of whose information they view. The long term memory allows the receiver to choose and store a finite number of media shared from each person forever.

The other compartment contains slots for the lens to have its information saved to long term memory. This feature would compress the information and save it on the lens. Another slot in this compartment is for deleting a lens from its information and the third slot allows the receiver to engrave a new barcode on the rim of a lens, for a new person. Furthermore, each person could only have one pair of lens with their name tag and they would need to ask for a new pair from the sender.
Figure 8- Slots for deleting, assigning and compressing

Figure 10- Lens

Figure 11- Information stored on the lens

Figure 12- Barcode on the lens rim
Viewing Glasses:

The glasses allow the receiver to view the information. The recipient simply inserts the pair of lenses into the glasses. Since there are three types of color coded data displayed on the lens, color filters are available to be placed on the glasses. This would allow filtering the other two type of data and displaying only the type which correlates to the filter color.
Figure 13- Viewing glasses with inserted filters

Figure 14- Viewing glasses with inserted lenses

Figure 15- The viewing glasses components
Memory Book: Promoting the Notion of Reminiscing

Finally, once a person becomes no longer active in the cycle, the receiver may want to save the persons previous memories and store the lenses separately. The memory book serves the purpose for storing lenses which only have long term memories. The memory book is no longer connected to receiving any information.

Figure 16- The memory book

Figure 17- The memory book containing lenses with long term memories
Design fiction is a great method to critically rethink the relationship between people and technology. Sharing is Caring is a design which speculates the culture of online sharing and suggests an alternative way for this purpose in a slow, tangible and meaningful manner. This chapter unfolded the issue of technostress through a utopian design fiction, initiating a critical look into this topic. Not only does the design challenges the relationship between people and their use of technology, but it also questions the systems, behaviors and even the type of media which is used when sharing personal information. Current online sharing culture has created a temptation and obsession around wanting to always be up to date or not missing out on any social news or activity. With this design we hope to address these obsessive behaviors, encourage mindful interaction, and re-imagine the social engagement with one another through physical objects through a tangible sharing mechanism. Furthermore, the design has made an effort to alter the following experiences:

- Virtual into **Physical Artifact**
- Instant into **Slow**
- Unknown audience into **Known audience**
- Insensitive into **Intimate**

And most importantly, presenting the true spirit of sharing: **Sharing is caring!**
Chapter 2
Explore different Methods

2 Design Probes

Gaver’s widely influential cultural probes [19] and other concepts of empathetic probes [44], present an avenue for understanding people’s intentions, behaviors, thoughts and interactions that are less familiar to researchers and designers. Cultural probes were initiated as “part of a strategy of pursuing experimental design in a responsive way” [18-p.22]. In other words, they serve as tools for designers to understand potential users where studies may cause disruption in people’s private accommodation. In this approach, participants are usually given packages containing instructions and equipment such as notebooks, stickers, maps and cameras to complete assigned daily tasks [9,18, 44]. Due to the open-ended nature of probes [19], recent research has taken advantage of modifying and improving the tools used in probe studies. Although cultural probes primarily emphasize their inspirational intent [19], the notion of empathy and engagement embedded in design probes can also promote participatory design research [5] while also benefiting a larger audience. Simply put, participant engagement with probes may lead designers and researchers to discover unexpected ideas and introduce new research directions. Through a multisensory design probe, this chapter creates a space for engaging people to explore the notion of technostress while allowing discussions to inform future design and research possibilities.
Create new Designs

Probe Kit
We are constantly shuffled into expectations of learning and adapting with ever-evolving technological tools and gadgets, so much so that we can forget our personal essence and the genuine values we carry. Originating from this notion and informed by critical design, this chapter turns to concepts of design probes and slow technology to open up a space for conversations with design professionals and participants. This chapter introduces a design probe which challenges the aspects of current technologies encountered in our everyday life [1,15, 42] and builds around notions of reflection, expression, representation, and the materiality of time [35]. The purpose of the probe is to create a tangible experience in support of pause, contemplation, and reflection [32]. In addition, challenges regarding implementations of meaningful multisensory for interactive experiences have recently been raised in the field of HCI [30].

The multisensory probe challenges the material aspect of time, help mitigate levels of stress, and promote meaningful reflection by allowing participants to engage in a series of calm activities. This phase of the research allows people to participate and become part of the discussion regarding technostress and self reflection.

The following sections present inspirational work, a description of the design probe, participant feedback and finally a reflection on this chapter.
Inspirational Work

Multisensory in HCI

Most of the technological devices we interact with today include platforms for audio-visual content. The ubiquity of interaction with such content may desensitize us. In other words, we may become desensitized to the constant notifications or the importance of certain content. In the field of HCI, audition and sight are primarily the main sensory targets [30]. While these two senses are constantly triggered, the remaining senses are significantly less involved.

For example, the SCHI research lab [28] has taken the initiative in exploring multisensory experiences which present compelling findings for the HCI community. In a recent study, the lab investigators draw attention to what psychologists believe are effective ways for reducing stressful strategies at the time of interruption. In line with this notion, their approach is to utilize the olfactory system as it is deeply connected to structures in our brain that relate to our emotions and memories. The team integrates olfactory notifications in messaging applications and show that it is possible to decode notifications’ meaning through smell. That is to say, the user is able to identify the sender and the urgency of the content without any visual interruptions. This has proven to reduce the stress associated with responding to notifications [27].

However, the main challenge regarding multisensory interaction still remains. Significant design methods and frameworks to assist in the digital or computational representation of the additional senses are yet to be determined [31].
Slow Technology in HCI

Prior research on designing for slowness includes explorations including Slow games [4], Photobox [33] and Future me [34]. These initiatives do not directly investigate designs and their relationship to stress reduction, but rather provide a significant body of work which ties together the importance of slowness and reflection.

Slow games are designed as physical video games with the intention of reducing the frequency of the players interaction. They are simply designed to allow only one move a day, and target patience, memory, and reflection [4]. The Photobox introduces a new approach as to how we understand the relationship between objects in an everyday environment. The artifact presents a monthly image selection from the participants image database and prints out the image in random intervals for the owner to view. The interesting aspect here is people’s reaction to a device which does not attract nor require the owner’s attention. The artifact also suggests opportunities for reflection and slowness [33]. FutureMe is another inspiring work which provides an online platform for people to send messages to their future self. Users can compose an email with a desired delay to receive in the future. It is intended to create the notion of re-experience, self-improvement, and challenge the obsession and anxiety for the future [34]. This suggests an experience of self-reflection in a timely manner and encourages a mindful and cautious approach towards the thoughts that a participant chooses to deliver to their future-selves.
Design Approach

Drawing from prior work, the design probe embraces notions of multisensory experience, slowness, and playful interaction. It emphasizes slowness by having participants switch from one sense to another in playful, step by step interactive activities. This series of activities suggests ways in which people could pause and reflect on stressful moments in their day. Building on this idea, the probe aims to reduce stress and tension by helping users to (even briefly) forget about the issue of time. Furthermore, the activities can be done individually, in pairs, or in groups.

As mentioned earlier, activities are composed to go beyond the typical audio-visual experience. Four possible ways are introduced to encourage people to develop personal agency in becoming less stressed and more mindful, thus potentially reaching a state of self-awareness and inner peace. The probe is developed as a kit to be given to participants to experience.

The probe investigates the 4 following areas which influence the activities:

Thoughts, as a way to promote control.
Aroma, as a way to trigger the imagination.
Comfort, as a way to imply timelessness.
Sculpting, as a way to foster creativity.

Each aspect is purposefully embedded in an activity which the kit contains.
Figure 18- Design Probe
The probe kit consists of 5 steps which are recommended to be completed in order. The orders are labeled on each activity and descriptions are provided for each step. The descriptions are hand written to reflect a “homier” and more welcoming feel for the participants. The following section explains the kit and the activities:

### The Kit Bag

Every design probe should have an inviting appearance for people to engage with. The aesthetic quality of our physical probe has to be considered since it would be carried and used multiple times and by a range of people. The crafted fabric bag holds an interactive pillow, two colored pieces of clay and two acrylic bases, a handcrafted felt notebook and a pencil, a metal box with 4 small perfume bottles and 4 colored square cards, a 3D printed artifact and 2 card strips. Before starting the tasks, participants are asked to write their name and age, and to describe their current stress level in the notebook. They are also asked to write about their stress levels after finishing an activity and further explain their experience.
Technostress is an emerging and significant psychological phenomenon associated with the use of technology. Using the lens of critical design and embracing slow technology and multisensory experiences, we created a design probe to explore this concept of technology induced stress.

Sculpting | Creativity | Thoughts | Control | Aroma | Imagination | Comfort | Timelessness

Figure 19- Design Probe kit bag and components
*Note Book | Color Clay | 3D Printed Artifact | Metal Box with Perfume Bottles | Interactive Pillow
Activity 1: The Beginning

Coloring books provide a fun medium for people to relax, be creative, and productive at the same time. Sculpting is adopted as an outlet for stress and disoriented thoughts, in the first and last stages of the probe. Furthermore, the sense of touch in these two stages have been employed.

The first activity is to create a sculpture using the colored clay. In the notebook, participants are asked to explain what their sculpture is and why they chose to make it. This activity is designed to learn about people’s self expressions and inner thoughts through form making, with the overall goal of facilitating creativity at a possible time of stress.
1 Create*

Start Here
Read the instructions on the activity

Open up the activity pack and find the beginning plate which you can use as a surface for creating your model

Using the colored clays sculpt what you wish

Describe your experience and what you have made and why

* Identify the first activity by looking at the attached number tags

Figure 20- Activity 1 & 5 cycle
Activity 2: The Thought Box

Journaling or keeping a diary is a common way for jotting down daily thoughts, events, and experiences. Another possible way for releasing stress might be through a similar experience one may have while talking to a psychotherapist. The Thought Box ties these two ideas together through a 3D printed artifact. It combines the concept of literal and verbal expressions in a low fidelity prototype with the purpose of articulating thoughts. The activity description explains that thoughts which participants wish to remember and forget should be respectively written on the “Hold On” and “Let Go” paper strips. The next step is to use the thought box artifact to speak in and say the thoughts they had just written. While saying the thoughts which they wish to forget, the “hold on” hole must be covered. A similar action must be done for the thought they would like to keep, but this time covering the “let go” hole.

The artifact is designed so that the “let go” hole is placed on the side and the “hold on” portion at the top. While covering the “hold on” void, the thought would pass through the ears from the side and would imply the sense of release. When the “let go” void is covered, the thought would transit vertically to be preserved in memory.

The Thought box is intended to help understand participants experience with audio and verbal journaling. Could a thought be slowly forgotten if it takes the form of a sound? Would speaking and hearing the thoughts reduce their severance? What are the connections between audio and literal expressions in helping stress-reduction?
2 Control

Start Here
This activity has two steps: Say and Write what you think.

* Identify the second activity by looking at the attached number tags

Figure 21- Activity 2 cycle
Activity 3: Aroma Box

The sense of smell carries a profound poetic property [30, 25]. Smell is integrated as a new material to enhance the interactive experience in the probe. Fragrances hold a certain space in our memories which may correlate with events, experiences, people or emotions.

Four small color-coded fragrance bottles are placed inside the Aroma Box. Participants are asked to smell each one and choose the color they find to be more peaceful and calming and stick the respective color sticker on the outline inside the box. The fragrances are chosen from a variety of everyday scents which include floral, vanilla, tobacco, and natural leather.

It is important to learn how smell can become an integral feature in stress reduction and the triggering of positive imagination. How might smell impact our experience of reflection and contemplation? Could aroma possibly become a new material to incorporate in interface design to enhance the quality of user experience?
3 Imagination*

* Identify the third activity by looking at the attached number tags

Figure 22- Activity 3 cycle

Start Here
Open the metal aroma box

Read the instructions on the box

Smell each fragrance separately

Describe your experience and whether the fragrances reminded you of any feeling or memory
Activity 4: Interactive Pillow

Yoga and meditation techniques are often accompanied by calming background music and melodies to help center the body and thoughts. The interactive pillow enables participants to either hold the artifact in their arms or simply place their head on it. Their connection to the pillow will trigger a five-minute piece of calming music. When the music is over, so is the activity. However, if they wish to spend more time on this stage, they could continue triggering the music. Activating the music through a seamless interaction can eliminate the possibility of technostress. It blends the foreign sense of technology into the design itself and provides a familiar experience. Is technology capable of resolving the issues which are associated with it? Could technology reduce technostress through thoughtful design decisions?

Activity 5: The Ending

Finally, the participants are asked to repeat the first step. This stage is intended to seek hints of closure through self-expression and form-making. It is worth mentioning that the probe does not only encourages pause for achieving meaningful experiences and overcoming stress, it also invites participants to find their own pace to get the experience they desire.

To assess the probe, three levels of evaluation was considered through informal evaluation, TEI’19 professional feedback, and with a two-week participant.
4 Timelessness*

Start Here
Read the instructions on the pillow

Describe your experience and whether the your hugged or slept on the pillow and if you closed your eyes while doing this activity

Place your head on the pillow or hug it to activate the embedded music

A speaker, battery and a microcontroller is embedded in the pillow

Figure 23- Activity 4 cycle

* Identify the third activity by looking at the attached number tags
The probe kit given to 6 people, including our colleagues for an initial informal feedback and evaluation. Figure 23 shows examples from the informal evaluation where participants were asked to engage with each activity in the indicated order. For each participant an average of an hour was allocated to interacting with the probe.

While all participants responded positively to the approach, they mentioned that the activities had helped them lower their stress level. Furthermore, thought-provoking questions were generated during the testing process. For example, how might the probe context affect the participant’s experience? Also matters regarding the scope of the participant user base, including wondering how a child might utilize the activities differently compared to an adult? Would the activities and artifacts indicate a certain playfulness which was not initially anticipated? Would one sensory experience, accent another if the activities occur in different orders? Some of these questions were further explored in different settings and time frames, however, future research could address some of these questions more in depth.

Reflect on Findings

Informal Evaluation
Figure 23 - Informal evaluation results from three different participants

* The results from three of the total six participants are presented here.
The design probe was presented at the *Tangible, Embedded, and Embodied Interaction 2019* conference in Arizona [51,3]. This opportunity provided a great space for collecting informal feedback from professionals in the field. The probe was presented so that the activities were placed next to each other on the table. After a brief explanation about each activity, the viewer was asked to do the following:

1. Place a smiley sticker next to the activity you found most interesting.
2. If you were to choose an order when using the probe, what order would you choose?

Below presents favorable activity in order from the most favorite to the least:
Thought Box | Interactive Pillow | Aroma Box | Sculpting

The viewers also suggested the order of activities they would do, 1 being the activity to start and 4 the activity to end with.

<table>
<thead>
<tr>
<th>Sculpting</th>
<th>Thought Box</th>
<th>Aroma Box</th>
<th>Interactive Pillow</th>
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<tbody>
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The feedback suggests a scattered order for each activity, meaning that the order could be a subjective matter. Thus for the next step, the participants asked to choose the order which they feel comfortable with. The attendees also expressed that the thought box appeared more interesting as it was a new idea with the potential to explore further.
TEI’19 Setup*

Figure 24- The activity layout

Figure 25- Probe favorable activity -The number of smiley stickers represent the amount of favorability.

* The presentation at TEI’19 also included a poster and an extended abstract which can be found in the ACM library.
In addition to play-testing and feedbacks from TEI, the probe was given to a participant to be used for the duration of two weeks. The participant had the freedom to engage with the activities in any order and as frequently as they pleased. She was allowed to use all, one or a combination of activities when using the kit each time. She was also asked to document the space and environment in which she stores and engages with the probe. Below are the findings from the “two-week” participant:

The participant reported that in her first few times of using the kit her stress levels were quite high. She had also taken all the activities out of the kit bag and preferred to store them in a cloth container where all the artifacts could be visible with easy and quick accessibility.

“I mostly used it in the night. I kept it alongside my bed, and if I was at home and getting anxious/ frustrated about something, I used it. I preferred to use the probe when I was alone. Sometimes during the day when I was at home, I found myself thinking about it, reaching out one of the things, depending upon the situation. I remember one time thinking about the pillow, and another time about one of the scents.”

At the beginning of the study, the definition of technostress was explained to the participant so that she could reflect on this notion during and after her experience with the activities. In this regard she commented:

“I wouldn’t know myself the cause of the stress, maybe it was techno related, maybe not. I wasn’t thinking about the reason particularly, but the probe helped me relax/ get the stress level down.”

She also shared how and in what order she interacted with the activities:

“I did not stick to the order of the activities. Most of the times it wasn’t all of them that I ended up using. Just depending upon the mood or stress level. Writing is the one I did the most maybe. I find it personally more relaxing to write down things (feelings/ unsaid things/ notes/ analysis). I didn’t end up using pillow, although I thought about it. Maybe because it was too personal/ or one really needs to be alone. Also the sound, I couldn’t do it if another person is at home, just not to disturb them.”

Reflect on Findings

“Two-Week Participant
She further added:

“I ended up using the probe 3-4 times the first week, and 2-3 times the second week. There were a few days in between when I didn’t think about it. I was not stressed or anything, so didn’t end up using it. I would have ended up using it more, if it was more handy. On my study desk, or in work space. Like I could have kept the clay in my bag or something.”

The importance of allowing the user to interact with the activities in any order and combination pushes the kit’s potential, providing each individual to tailor the tasks to their own level of stress and surrounding environment. Thus, customization can be considered in further developments. Furthermore, while the activities may reduce participants inner tensions, they could also be designed for portability and suited for environments besides the home. For example, there are certain expectations in regards to any work place and office culture which may or may not impact the number and quality of interaction with the activities in these spaces.
Interestingly, the study shows that some of the activities could also be used in other situations where the person is not experiencing any technostress or anxiety at all:

“One of the days I remember, I was very calm and then I thought of smelling one of the scents. So I think the scents work for a positive mood / in a positive environment as well.”

The initial intention of the first activity was to encourage the participant to think creatively and translate their thoughts into 3D models and sculptures. The participant utilized the color clay different than was expected:

“For the play dough, I didn’t try to make sculptures. I was just playing with it (not particularly thinking about it maybe, but just thinking about something else or doing some other activity like writing), and I had clay between my fingers, mixing them, sometimes keeping the two colors separate, one of the times mixing them together (that also happened unintentionally). Just like a spinning fidget or other squishy things.

With the dried up clay, although I wasn’t intending to dry it up, thinking about it later I would want to keep it with me, as a collection, and just want to hold it later or look at it, think about the time when I did it. I don’t remember the ‘why’ of it now, but later on if I end up creating something like it again, I may have it as an artifact that could remind me of something in particular.”

The mixture of the two colors can also indicate how different people interpret objects or display their creativity which was not experienced during the play-test or at TEI. The participant interacted with the color clay similar to a silly puddy, however, the clay had the potential to form and cure over time, allowing a different experience to shape around this particular activity and compared to when using a puddy. The fact that the participant was able to produce her own unique artifact suggests a satisfactory and pleasant experience. The created artifact could act as a token for when later the user sees it on their desk or feels it in their pocket!

In regards to the Thought Box, the participant also interacted unexpectedly:

“In the thought box, one time I wanted to scream, and at the same time wanted to keep myself composed, so I screamed three [times] (at the situation- some
The participant’s reactions to releasing her negative thoughts compared to the ones she wanted to keep, have been distinguished through her tone and voice expression when using the Thought Box. Once again, this would be an aspect to consider when designing these type of artifacts to use in spaces besides the home environment.

Lastly, part of this study was to understand how well these type of activities could become part of an everyday setting and whether or not they would be intrusive to ones daily life. The participant was asked to take pictures using her cell phone to document the activities as she was doing them. Here is was she said regarding this request:

“I didn’t click pictures of it after the first time, because I didn’t view it as a study, but rather part of the environment, and used it whenever I felt like.”

The fact that the participant felt as the kit was part of her everyday routine, supports the design intention for each activity which was to create tasks to be easily understood, interacted with and further blend into the users environment.

Another interesting finding, helpful to guide further developments and designs, was how impactful the multisensory aspect of the probe has been in reducing technostress:

“I think being multi-sensory helped, since it promoted accessibility. Depending on the situation, the time of the day, the place I am at, or the people I am surrounded with, I may or may not be able to use all the elements of the probe. Sometimes, writing was much easier than listening, and sometimes just smelling helped me lower my stress. Depending on my mood as well I went for one thing or the other. Also, one might get bored if it were to engage just one sense like sound (talking). The texture of the clay versus the pillow, although engaged touch, had very different feel to them.”

The multisensory feature of the probe is certainly a uniques aspect which promotes accessibility, flexibility and adjustability according to the environment in which it will be used. Furthermore the participant also points out texture as a significant characteristic, as it has impacted her experience in a positive light. Lastly, the participant’s relationship with the probe cultivated slowness at the time of use, leveraging the initial notion of slow technology embedded in the design of the probe:

“I did slow down, and whenever I was interacting with any element of the kit, I was engaged fully. Time-wise I took as much long as I was comfortable with. I didn’t purposefully spent more time on any activity and wasn’t thinking about how much time I was spending on each one. Just however long I wanted to spend. I feel the activities are designed such that you are automatically slowed down, and can’t do them otherwise, or at least I couldn’t.”
Part of critical design is to ask questions about ways in which people interact with technological devices on a daily basis, which may impact their well-being and performance. Through a multisensory probe, this chapter aimed to provide a space for discussion revolving technostress and understanding peoples relationship with activities and objects which support notions of slow technology, pause and reflection.

From the play-testing and discussions at TEI, it can be learned that engaging with multisensory activities would be most beneficial when tailored to each individuals stress level. The “two-week” participant also supports this idea, given feed back on the activities being new and appropriate for various situations, environments and stress levels. Even the thought of using the activities helped her lower her stress levels. The probe aims to inform future experiences of slowness and encourage users to interact with technologies as a time productive rather than a time consuming entity. The “two-week” participant’s experience validates the slow attitude intended while engaging with the activities. Additionally, the study suggests that perhaps future interactive artifacts purposed to reduce technostress, should meet some minimum potentials and user expectations such as portability, size and lightness.

Although for the participant, activities were used at home, it is important to consider various environments such as the work place when designing activities to fit the needs of various users. Implementing the probe in contexts other than the home environment may not only require certain adjustments, but also would create a space for re-imagining office cultures and work spaces. In addition, due to the multisensory aspect, all activities had their own unique impact on the participant, However, the most interesting finding would be the unintentional creation of a symbol/object of serenity through the use of the clays. Her play with color and effortless exploration with form further suggests a more self guided activity which extends the probe’s potentials.

As an expansion on the probe, research products and prototypes were also imagined as conceptual ideas for multisensory artifacts which could be placed as non-intrusive products in various environments seeking richer inspirations for complex HCI questions embodying matters of technology, stress, time, and multisensory experience and interaction. These designs could be deployed in future research.
Conceptual Ideas*

* These ideas have been explored in the next chapter.

Figure 28: Conceptual Sketches | Interactive Multisensory Artifacts
In recent years, the field of Human-Computer Interaction (HCI) has and continues to broaden in scope, creating a growing interest for design research. It brings different perspectives and disciplinary backgrounds together to pose a necessity for new ways of conducting scholarly research. With this demand, research through design presents a trajectory which leverages producing new knowledge through methods and processes of design practice [46]. Furthermore, making research artifacts suggest new ways of tackling wicked problems [8] and evaluating its relationship with people, current and possible future technologies [47].

This chapter presents two artifacts, designed as non-intrusive objects for the purpose of self reflection and slow interaction. Since technostress impacts behavior, the two designs present themselves as products or objects which have the capability to influence positive behavioral change. Grow Slow targets this matter by encouraging personal growth and positive behavioral change requiring a purposeful attention while The Wandering Cube challenges memory and meaningful engagement, without the need for users attention.
I. Grow Slow
Self-awareness and well-being is usually taken for granted and its importance is rarely realized in this fast pace era. The majority of the time, we are either occupied with technological devices and gadgets or relentlessly busy focusing on our performance in our jobs, maintaining good standing status as students and keeping up with friends and family. We constantly find ourselves wishing if only I had a bit more time to devote on thinking about our day, actions, and mental well-being. It seems there is never time to allocate to bring attention to ourselves. This project contributes to sustainable happiness of personal growth through an interactive device which allows moments of pause to shape in the form of a daily ritual.
Design Concept

The concept of an interactive hourglass challenges time as an unstoppable entity and draws attention to the notion of mental pause through a controllable system promoting self-awareness and self-growth. The design is so that it builds its own temporal configuration of time which builds on the idea of slow technology. It demonstrates personal growth in a slow interactive experience which embraces users mental pace rather than actual time itself.

Unlike the regular hourglass which only allows the sand to flow continuously, this design has an additional section to allow pause and reflection. The three compartments are associated with their own temporal configuration which builds on the idea of slow technology.
Design Concept*

Set a goal for changing unwanted behavior/attitude/habit

Grow-Slow Hourglass

A bead is dropped at the time of the behavior occurrence

Improving self-awareness over a year

Typical Hourglass

- Occurrence
- Reflection | Pause
- Remainder

Take one out once you have improved

Beads which are left unimproved

Figure 29- The hourglass design concept

* The design concept was initially inspired by the traditional hourglass.
Inspirational Work

The Everyday Calendar

The Every Day Calendar is simply a physical interactive annual calendar which helps users make commitments to a desired goal. Although the goals are set based on each individual, the calendar works the same for any type of goal. The user sets a daily goal and after plugging in the calendar, they manually turn on a light on the calendar by pushing one of the respected daily buttons, keeping themselves on track. This notion is like giving yourself a gold star sticker every time to achieve your anticipated goal. Besides its purposeful functionality, the everyday calendar can also be expressed as an aesthetically pleasing calendar or wall hanging [20].

Figure 28- The Everyday Calendar [39]
Worry Dolls and Worry Beads

Originated from Guatemala, Worry Dolls are small, hand-made dolls common among young Guatemalan children. The worry dolls, also known as trouble dolls, act as an object for children to release their worries, stress and troubling thoughts into. The way they function is that the children would tell the dolls their worries and then place them under their pillow before going to bed at night. In the morning the dolls would gift the children with the wisdom to eliminate and forget their sorrows [36]. In modern child psychiatry, the dolls are known to play the role of “the listener” and further become a mediator for the child and adult [48]. For adults, this notion presents itself in the form of worry beads. Worry beads or kombolói is a set of strung beads used in Greek or Cypriot culture. They are used in various ways for various purposes depending on how they are handled. While interacting with the beads, they would create a quiet or load sound depending on their arrangement and the way the user holds and interacts with the thread. This interaction impacts the user in ways for relaxation, enjoyment, as a guard against bad luck and even preventing from bad habits [29].

Figure 28- Worry Dolls [36]
The Package

Artifact Box

The box consists of an hourglass, three color beads, a lamp unit and a base. This package was initially designed for the first prototype and has later been modified for the interactive version.

Artifact Logo

The logo was designed so that it reflects a simplified shape of the hourglass. It consists of two similar squares, one on the top and one at the bottom with a central square is slightly larger and is an outline of a square which emphasizes the importance of pause which is not seen in a typical hourglass form.
The Package*

Figure 30- Inside the Package

Figure 31- Artifact Box | Design Logo

* This package was designed specially for the third iteration.
Design Setup

Setting up the initial hourglass prototype is fairly simple. The hourglass does not require any connections to the base board or any power source. Of course this is later modifies for the final interactive version. The base should lay flat with the bead holders inserted in the correlating colors attached to the base. Color beads (chocolate, caramel and beige) are then placed in one of the bead stands. The lamp unit, sits on the center on the base, and is designed for a night time reflection, meaning when the day is over, the hourglass could rest on the unit and activate the light. This illumination, not only acts as a night lamp but more so, allows the user to perceive their days’ accomplishments or setbacks in a calming manner.
Hourglass Setup*

*This setup was designed for the third and last iteration.

Figure 32- The Set up | Hourglass | Night stand | Bead holders with beads
Hour Glass Components

The three compartments are associated with their own temporal configuration which builds on the idea of slow technology.

**The top:** a short term (one day) compartment for things like goals, activities, habits, behaviors, etc.

**The center:** a longer temporal compartment (one week/month) allowing moments for reflection to consciously shape around the specific goals, activities, habits, behaviors, etc.

**The bottom:** the long term compartment (a year) for the ambition of self improvement.

The beads are components which help categorize different goals. The associated colors shows a personal concern (attitude/behavior/habit) or a goal.
The Bead
Categorizing different entities

Daily Component
Each day beads drop down

Monthly Component
Each Month beads drop down

Annual Component
End of the year flip over the hourglass

* The design of the hourglass is similar throughout all four iterations.
How it Works

The way that this interactive system functions is that each time the user’s action lines up with one of the concerns, a bead must be placed in the top compartment. After the day of occurrence, the bead would drop into the central section and stay there for a week/month. If by the end of that time the user has done something positive or made improvements towards the concern, they could take the bead out, otherwise it would drop into the bottom compartment and stay there until the next time the hourglass is turned.

Similar to the worry dolls, the user places their goals, fears, behaviors, etc. into a bead and lets it inhabit inside the hourglass until its removed. The interpretations around this interaction, is later put to test with a week-long participant.

All transitions from one compartment to another, is designed through a dynamic plate. The plates are placed in between each compartment and would open and close in a timely manner. For example, the plate located between the top and central compartment, would open and shut every 24 hours. The action happens within a few seconds, giving just enough time for the beads to drop down in the central compartment. Similarly, the plate in between the central and bottom compartment, opens and shuts in the same pace, but rather than every 24 hours, the plate moves each week/month. In the low fidelity prototypes, the dynamic plates are designed to move manually, whereas in the interactive prototypes, the plates are controlled by micro controllers and motors.
Interaction*

Place a bead

Day 2 onwards

During the month

Improvement

Figure 34- Interacting with the hourglass

Figure 35- The base becomes a lamp unit when the hourglass is rested on it for a night time reflection

* In this stage (third iteration) the interaction was limited to opening and closing the compartments manually.
**Storyboard**

**Intro:** Laura and Sara are friends and they work in the same office. Laura has a bad habit of overreacting and getting angry over small things on a daily basis.

**Scene 1:** One day, Laura and Sara were having a friendly conversation when Laura snapped and got angry at Sara’s opinion about the weather! Not long after, Laura realized her unreasonable reaction and genuinely was upset that she never has the time to work on her personal wellbeing and social behavior.

**Scene 2:** Later that day, Sara introduced a new product to Laura called the “Grow Slow”! She explained to her how it works and how it has helped develop her personal goals. She further expressed that it has encouraged her to devote some time for her self to reflect on her actions, and that Laura should give it a try! Laura accepted the gift with an open mind and set it up in her home on the same day. She placed one bead in the first compartment and was optimistic that she would try and improve her behavior.

**Scene 3:** The following day, while she noticed that the bead had moved to the middle compartment, she remained optimistic that she would manage to improve. While driving back from work, Laura was stuck behind a car which was too slow to pass the traffic lights before turning red. All of a sudden she started yelling and acting out, but shortly realized she has done it again. She placed another bead in the top compartment and hoped she would improve the next day.

**Scene 4:** The next day Laura was out n about enjoying nature and the singing of the birds when a pink robin decided to make a number 2 on her! For a split second Laura’s rage was about to come out when she quickly realized that she should control her anger. When she reached home, pleased and excited from her improvement, she took out one of the beads from the middle compartment. Before going to bed she set the artifact on its night stand and gazed at the illuminated hourglass, reflecting on her successful accomplishment.

**Final Scene:** As the months went by and the remaining beads made their way down to the bottom, Laura had managed to make significant improvements regarding her reactions. After a whole year, only a few beads remained in the bottom compartment and she was satisfied with how well the hourglass had helped her grow and allocate time to her well being. She is now ready to turn the hourglass and start a new cycle.
The Scenes*

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Figure 36- A storyboard of how the artifact can be used
Design Iterations

The initial idea for the hourglass was explored using simple materials such as paper and foam. Cut up color plastic straws were also used to represent beads. In the second iteration, both the form and dynamic components were refined. In this iteration, the frame and structure was created with wood, using a laser-cutting machine to fabricate the pieces. Acrylic was then laser-cut and used to cover each side of the cubical components. Plastic beads were also replaced with wooden ones. Electronic and mechanical components were explored in the third and forth iteration. The dynamic plates were connected to servo motors and micro controllers for their timely activation.
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Figure 37 - The design iteration cycle

* Only the last iteration was given to a participant for further studies.
Design Refinement

The final interactive prototype is a refinement of the previous versions. Wood was used for the overall structure. Each piece has been carefully laser-cut, shaped, formed and put together. Edges have been sanded and filleted for aesthetic purposes and for more pleasant use and feel. Small acrylic squares were laser-cut and placed along each face of the cubes to allow transparency and visual access to the beads.
Figure 38- Hourglass wooden pieces

Figure 39- Construction process of a single compartment | Sanded for a smooth finish

Figure 40- Compartment pieces to make a single cube | Each piece individually sanded and glued
Design Improvements

The overall silhouette has also been extended, with a detachable piece covering the electronic components. This piece was designed especially designed for maintenance, and ease of access to the motors in case of any malfunction. Velcro was used as a temporary adhesive for the detachable component. Small paper strips were designed to be placed at both top and bottom of the hourglass for jotting down behaviors, goals, or feelings. Additionally, four movable acrylic plates were designed to be placed between the compartments allowing the beads to navigate through the hourglass.

The top and bottom plates should be moved manually and only at the time when the user wants to place a bead inside the hourglass. The bottom one, simply acts similar to the top one and is used once the hourglass is flipped after a year. The movement of the remaining two are controlled by servo motors and micro controllers.

Electronics

The hourglass operates every 24 hours and once a month. In order to do so, the top and middle compartments must have plates which automatically allow the beads to drop down in the appropriate timely fashion. For this purpose, a servo motor was attached to each of the plates and later connected to an Arduino Nano [49], programmed so that the top motor would rotate 90 degrees and back to its original position after 24 hours. The second motor was programmed to rotate its attached plate once every 30 days. It is worth mentioning that since the artifact was given to a participant for a week to interact with, the motors were adjusted to move in a smaller increment of time compared to its original settings.
Figure 41- A breakdown of the final hourglass design

Figure 42- A breakdown of the final hourglass electronic components
The Views
The Final Look*

Figure 43- Depiction of the hourglass, its extension box logical design.

* The final design does not include a night stand.
The hourglass was taken to the participants home and set up by the researcher. After a brief explanation on how it works, the participant agreed to work with it for a week. Below are the findings from the “week-long” participant:

The participant expressed how the hourglass helped her find the right scale and scope for the goals she wanted to set for herself which ultimately resulted in finding a balance between her expectations, goals, and the positive feelings she experienced:

“Initially when I started working with it, I wrote my goals on the paper strips. The first two or three days, I realized the two different goals I had set, I was not doing it and I had to put beads everyday. And that made me realize that, okay my goals are too big and if I am not able to do them, that means I need to tone my goals down and take baby steps. After day three I changed my goals and started over.”

The participant shared her insight in regards to the interaction with the artifact on various occasions. It was interesting to learn that the participant felt the need to interact with the artifact long after there were no beads left in the hourglass to take out or simply there were no reason for a bead to be placed in. While continuing her goal and doing something positive without having a bead in the hourglass, she still wanted to interact and engage with it in some way which suggests a developing a balance between inherent need to engage with the artifact, and the unnecessarily interactions.

“If I was following one of my goals and I didn’t do anything about it the first day but did something about it the next day. Then I would take the bead out. However, if I continued towards that same goal, the followings days for like two three days, then there was no bead for me to take out! There was no interactivity with this artifact, like I’m not engaging with it! I’m doing something right, but now there are no beads to put in and nothing to take out! I thought maybe the reverse of this action would be helpful, like I am adding more beads so it’s getting fuller and it makes me feel like I’m doing great. But then again, I don’t know if that would work well, because difficult to keep track of how good or bad you’re doing something that gets enlarge numbers.”
Although the participant implied that a positive feedback system would be motivating, nonetheless, it also appears that the absence of such assessment, for example not having to place a bead when a goal has been accomplished, may actually impact the overall experience in a positive light. According to the participant, not having the beads affiliate with any positive attribution, seemed to benefit the quality of the set goals rather than challenging the user to judge their performance by the number of times the goal was met. In other words, if the beads had positive attributions it may have influenced not only the goals, but also the quality and standards of which the goals met.

Additionally, setting strict goals also enhanced the quality of the users actions and helped with her performance. Through the participants experience, the artifact had seamlessly encouraged the user to set goals, take control, and carefully pursue them:

“Having no beads left to take out, instead of getting lenient with my goals, I was getting more strict with myself. Sometimes you give yourself some leeway, but I told myself that if I didn’t do it then I have to put a bead in. For example, initially I started with a goal related to my health, like not eat any sweets or exercise daily. But nothing was working. So I reduced it to a smaller goal like having my dinner before 8pm. If I was eating before 8pm that was fine, but if 8 became 8:30 or 9, then I would put a bead in otherwise I would have given my self permission to eat at any time after 8 and not really care. In general, you tend to give yourself some leeway but maybe just to make improvements, I was keeping track of those small margins.”

This statement suggests a development of an interesting relationship between the artifact and the user. That is, in order for the user to interact with the artifact she would need to update her goals once previous goals have been met. The participant was also encouraged to be more serious and mindful of her goals.
This realization process, shows how the participant was able to take control of her goal priority, based on her own lifestyle, engage with the artifact as often as she hoped and improve the quality of her actions leading up to accomplishing her set goals over time. It is evident that the hourglass took the user through a reflection phase in a ineffectual manner that led to a self discovery and a meaningful interaction. This informative finding accents the aspect of slowness and highlights its importance in creating an impactful artifact for self-growth and reflection.

Furthermore, the participant had not experienced any sense of stress while engaging with the hourglass, although she mentioned that at the beginning when her goals were set high and the beads were building up, she felt a bit stressed but the stress was actually a constructive feeling since it gave her the understanding that the goals were set too high and she had to lower her expectations and find a balance. Additionally, having the beads sit in the hourglass acted as a reminder for her to do better tomorrow.

The sensation of the beads falling into the bottom compartment, reflects another important aspect of the human-artifact relationship. The study shows the different levels of control which the two entities had on one another. As technostress occurs when technology takes over control of the user, it was clear from the findings that the hourglass promoted a balanced influence between the user and the artifact without repressing one or the other.

“It’s far better than apps for sure! Apps make you stressful or they cause you anxiety, even the notifications are stressful. For example if you want to learn a new language and you get a notification but you don’t have time you would get, just irritates you. But the Grow Slow hourglass was not like that. If I’m not able to do something, [whether correcting my behavior or what ever goal I have], that thing [hourglass] is not annoying me or making me anxious or stressed. I know I didn’t do it, it’s okay, I’ll do it tomorrow and I did. I took the bead out the next day. It was a friendly relationship rather than a forceful one. It wasn’t like you have to put a bead in or you have to take one out.”
Although, when the beads fell into the lowest compartment, the participant felt less in control and even though a slight sense of anxiety was experienced, it seems that she managed to focus on the interactions which were in her own control.

“With the first two compartments I feel they were in my control but the last compartment was not because it [the bead] was just gone! While the beads were in the bottom, I was thinking how am I going to get it out and would it matter if I work on it or not! It’s just there now! But when there were beads in the middle compartment and also beads in the bottom compartment, I would just focus on the beads in the middle compartment. Having the beads in the bottom compartment would also act as a reminder that those goals are there!”

Not only the bottom beads had no significant negative impact on the user’s motivation and interaction with the artifact, they encouraged the user to recognize some important aspects of their behavior. For example, identifying the goals which require more time, practice and even constant reminders suggest an exercise for patience and mindfulness.

“After a while I realized that if I can’t rectify something or get better at it in one week or one month, then it means I would need more time and that “more time” is defined one year. In this case the artifact is controlling that time I need to get better at it! “

Another finding from this study was the artifact engaged the user through multiple senses. For example, visually the participant felt the hourglass was aesthetically beautiful. Besides the visual appearance, the beads texture felt pleasing and the sound they made while dropping down was nice. It was interesting to learn that for the participant the sound resembled a positive feeling that she has set this goal and she is pursuing it, rather than thinking that the goal has not yet been met.

“When the day ended and the beads dropped, the sound of the beads dropping was actually nice. The sound was in the background and acted as a reminder and was a nice feeling that I am pursuing a goal. It reminded me of my goals in a positive and encouraging manner. I didn’t feel any stress like when a typical hourglass is just running.”

The participant’s roommate also found the artifact intriguing, and when noticing the sound of the beads drop, he found it playful!

What sometimes experienced through our interaction with technology, is the feeling that we are an extension of the technological devices or tools which we use [6]. With the hourglass however, the participant felt it was an extension of her rather than the other way around.
“I felt it was a part of me, because I was putting in the beads and taking them out. I felt I was controlling my behavior through the use of this artifact and I felt the artifact was an extension of me. The experience was more like you writing in your journal every day and the journal becomes part of you.”

Lastly, physical tangibility played an important role in the participants overall experience:

“It is an interesting artifact to have. It has a playfulness, which you want to interact with. It challenges you to find a balance and I think I found that balance by first lowering my goals and then setting a strict margin.”

Figure 44- The participants use of the paper strips and the hourglass
Although the Grow Slow hourglass was primarily designed to promote personal growth, the studies suggested far more potential than expected.

Slowness played an important role in the design, interaction and overall experience of the participant. The slow characteristic of the hourglass cultivated a thoughtful process for the participant, promoting self-discovery by encouraging her to realize how realistic her expectations were and how might she set and achieve her goals or improve on her behavior according to her own capability, lifestyle and pace in a non stressful manner. It also helped the participant to improve and reflect on not only herself but also her relationship with a technological object, realizing the type of control and freedom one offered to the other without being too demanding or forceful over time. As a result the hourglass had further impacted the participant’s performance quality.

This design challenged the user to find a balance between the genuine need to engage with the artifact, and unnecessary interactions. Through successful act of reflection and self growth, the artifact became less full of beads and over time the emptiness may take a positive meaning. Furthermore, engaging various senses through a tangible interactive artifact also improved the relationship and overall experience for the participant.

Additionally, there are improvements to make for future studies. For example, the number and variety of the beads may vary and may need to be altered to better distinguish goals and behaviors. For future studies, the hourglass could be given to participants for a longer period to gather in-depth insight and produce stronger knowledge about the impact of the hourglass and its relationship with its users over time.
II. Wandering Cube
The wandering cube was inspired and conceptualized during the multisensory design probe studies. Although it was originally designed as a multisensory cube, the design was altered to create a self-rotating cube in a slow manner which could then be placed in an everyday setting. Much like critical and speculative designs such as the table-non-table [24], and the tilting bowl [43], the wandering cube manifests an approach that promotes a creative and nuance interactions with artifacts in an everyday setting while shaping and co-constructing our everyday life.

This object has a behavior of its own, meaning it would start in one location in the house and maybe found in another room a month later without any disturbance, or need of interaction with the owner. Another aspect is understanding the notion of attachment as a key factor in human-technology relations. Even though the Wandering Cube is designed to be non-intrusive, the aim is to challenge the relationship between the artifact, the owner and its environment.

The wandering cube follows the principles of slow technology and leverages matters of awareness and memory.
Design Iterations

For the early iterations of the Wandering Cube simple materials such as foam were used. In the following stages, parts were 3D printed and later refined. The third iteration combined the electronics with the physical components and additional parts were developed to hold the motors and legs. All the embedded electronic and mechanical components were covered with light weight wood and acrylic in the final iteration.
Figure 45- The design iteration cycle

* Only the last iteration was given to a participant for further studies.
Inspirational Work

The Tilting Bowl

The tilting bowl is simply a ceramic bowl that tilts. The main concern of this design is to explore a set of relations between us and the world mitigated through technology. The concept is strongly rooted in a particular aspect of philosophy of technology which views the relationships between humans and technological artifacts as mutually shaping each other. The tilting bowl manifests as a familiar object accentuating its presents to be not in the foreground but rather becoming an unnoticeable part of our everyday setting in the background. The research expresses the human-artifact interaction as having a dialogue with an other, being that the other is a system or a machine.

In addition, the tilting bowl is a counterfactual artifact, meaning that its performance is against what is typically expected from existing design norms for a bowl. The artifact was given to participants to live with and later reflect on their experience while co-existing with the bowl. The discussions and debates which shaped around this artifact created an on-going and active reflection on the object. According to this research, what may have caught a significant amount of attention at the beginning, later ended up blending in the background. The participants grew a relationship with the bowl in different ways, with one expressing the bowl to have an “active present” while another experienced both “normalcy” and “anxiety” [43].

Overall, the research was inspirational in the sense that it challenged background relations which we do not actively think about such as human values, desire and anxiety, through a meaningful interaction with the other which in this case was the tilting bowl.
The Table-non-Table

The table non-table is a light interactive structure that inquires into a non-utilitarian aspect of human-technology relations and is designed to move beyond the purely functional understanding of design. This artifact consists of one thousand stacked up paper positioned very low to the ground. When plugged into an electric outlet, it would slowly move once or twice per day for less than 10 seconds in random patterns. Similar to the tilting bowl, this design centers on the crafting of a counterfactual artifact and challenges the expected norms which revolve around the mutual relations of people and technology. It proposes an alteration of user-centric ideas of technology and design. While the table-non- table roams in its environment which is considered a functionality, it is simply not in the service of human use. By deploying the artifact in domestic settings this research studies the table-non-table’s relationship with other co-existing objects and people and even pets. The participants engaged with the artifact is various ways, for example taking one of the sheets of paper and creating a paper snowflake. For another, a pet cat found the table a comfortable place for sleeping. Some participants struggled with making sense out of the artifact and not long after they deciding not to engage with it anymore and rejected the table [24].

What is different in this design compared to the tilting bowl, is that the relationship we have with objects may not necessarily be centered around use but rather the moment the artifact has become part of a home, regardless of the degree of engagement or usefulness, new meaning for peoples existence and experience is shaped.
How it Works

The wandering cube is simply a cubical object which is controlled by six embedded legs. The legs slowly grow out from each face, allowing the cube to tilt at a leisurely pace. The cube starts at a resting position and attends a single moving pattern by tilting and ultimately falling on one of its other faces. The faces were designed to look identical, challenging the user’s memory to recall its previous resting position and location. The legs sweep out in slow yet forceful manner while taking an entire week to fully tilt and fall over on a new face.

A rack and pinion gear mechanism was used for designing the legs to convert rotation into linear motion. Each leg was in contact with the pinion gears attached allowing the leg to move at an extensive and desired length in addition to back and forth. The motors were then connected to an Arduino Nano and programmed such that each leg slowly pushes out and reaches a complete stop once the cube had tilted and dropped on another face. This pattern would occur for the rest of the legs in an orderly fashion. The cube is powered by two 3.6V batteries and activates only when the on/off switch is turned to on.
Figure 48: Wandering Cube's components and assembly

- Velcro glued to the bottom of legs to avoid slipping on various surfaces
- Hallow space for placing the arduino and batteries
- Cube connection hubs
- Mounted Servo motor on bracket with wires connecting to the arduino
- Racks which act as legs
- Cube frame pieces
- Pinion gear
- Wires connecting to the arduino
- Motor brackets glued to the frame piece
Movement*

Cube starts tilting by pushing out leg

Leg starts moving in reverse

Figure 49- A step by step depiction of the cube's movement

* The cube tilts and rotates on a new face each time ultimately navigating through its positions environment.
Cube fully falls on new face

New resting position
Prototype Process

The cube itself was created using detachable components. It consists of eight connector hubs and 12 individual frame pieces which have been 3D printed. Each frame piece also has an indent creating a space for the legs to sit and further move back and forth in. In this design, the racks, pinion gears which were attached to 360 servo motors, were 3D printed. In addition, brackets were designed to position and hold both the motors and racks inside the cube and were glued to the frames. This process was done for all six motors and legs, and on each face of the cube. Three faces were covered with light balsa wood sheets and the other three with white acrylic where a power switch was also positioned on one of the faces.

The prototype phase also had its challenges. Due to the specific movement pattern which was designed for the cube to achieve, the legs had to be individually programmed in order to move in an incremental pace over time. This slowness impacted the force required to tilt the cube as it reached the maximum length of each leg, thus the prototype process took longer than anticipated. The challenge was further expanded when matters of friction, torque and weight came into play which stretched the completion time. The Wandering Cube is in fact a product of many trial and errors, and technical and design adjustments.
The Wandering Cube was given to three participants (P1, P2, P3) for evaluation and playful interaction. The study lasted for an hour. For the purpose of the studies, the cube was programmed such that the legs took less longer to extrude. The artifact was placed in the same space as the participant and the participant was asked to engage in a daily task, whether it be working on their computer, reading a book or writing in their notebook. The artifact was visually accessible however it was placed out of the participants reach. Participants were also given the freedom to move around in the space, leave the room and/or get close and interact with the artifact.

Below are some of the findings from the study:

Three types of interaction were found during the studies:

The first and more apparent one was visual interaction. In this case the cube was left to wander without being picked up or touched and just noticed visually. As expressed by the participants, this type of interaction would show the passage of time based on its new position or change of location.

The second type of interaction is when the participants engaged with the artifact by picking it up, touching it and drawing on it. In this case, the drawings would act as a reminder of specific events or feelings the user had every time they notice the cube fall of one of its sides.

And finally, it was interesting to see that one participant used it as an instrument like the Cajon! Since the cube was made from two different materials, the created sounds were also different, making it an playful object to interact with and a creative way to release any tension.

Another interesting find was when participants noticed the sounds coming from the cube while a leg was in motion. At first the sound, which was caused due to the embedded motors, seemed as the cube is calling for attention, however, as time passed the sound blended into the background and just like the tick tock of a clock became another ambient noise.

Participants Interaction

Reflect on Findings
For P3, the sound portrayed a calming sensation and the slow movement of the legs helped him with managing the anxiety he was feeling from his daily life at that time:

P3: “These days I have many concerns going on in my life and I am experiencing too much stress. To me looking at the cube gives me tranquility. It moves slowly which helps me feel separated from my stressful environment and makes my thoughts move in the same speed as the cube. I find it a good source for meditation practice.”

This finding suggests that the user may overtime learn to sync their thoughts with the pace and movement of the Wandering Cube.

Furthermore, certain feelings are associated with the realization of the passage of time:

P2: “If I would have had this for a long time in my house I feel more reflecting, like how things have changed or what have changed with me or my surroundings.”

Since parts of the cube was covered with white acrylic, for both participants, it resembled a surface like a blank canvas. This feature encouraged the participants to write inspirational phrases or draw on the faces using dry-erase markers. One participant also suggested that she would probably use it as a daily reminder or memo.

P2: “I want to draw symbols on the white faces so when I’m coming back to it or just looking at it than I’m actually thinking about the last time when I interacted with it. For example, if I draw something on it when I’m happy, then the next time I’m noticing it I would be reminded of that time. Or perhaps by drawing on it I am trying to find a relationship with it or give it more meaning rather than leaving it to wander around.”

P1: “I like to write inspirational phrases so when ever I see it would be like an encouragement thing. I sometime need to be remind my elf that I am doing good or I need to be more patient so I think by writing those on the white faces I could reflect on myself next time I notice the cube.”

There were times when the artifact transitioned from the background to the foreground. This tend to happen when P1 left the room to answer a call. She returned to see the legs have extruded and the position of the cube had changed. This led to wonder about what the cube’s position was before leaving the room.

P1: “I’m trying to remember the last time I looked at the cube before leaving the room. How long was I out there?!”
Lastly, P1 felt that by leaving the cube to wander on its own, over time she might actually develop a certain feeling of empathy with the artifact.

P1: “The Wandering cube has an interesting personality. For example, if it was placed in my home, I would feel like it wants to slowly and quietly explore its new environment and surroundings without interrupting me. If I see the cube on its self wondering about, I would feel that it might need my attention or perhaps it might need help to move around and not bump into things at times.”

P2 also found the Wandering Cube to impact the way she would interpret time:

P2: “It would remind me of how long the time has passed by. If I were to have it for a long time it would make me think if it has made any significant change or the last time I saw it, it was summer and the memories of those days might come to mind and when I see it now it would remind me the passage of time and how since the last time I have been doing.”
The wandering cube embodies questions such as how does a non-intrusive object change the way people perceive themselves and the environment around them? How do people have an impact of the object and how does the object impact people’s behavior over time? How do the two define each other? What type of interactions may shape around this counterfactual artifact? What are other unforeseen implications of the Wandering Cube and how does it foster reflection over time?

The wandering artifact mirrored some of the aspects of the tilting bowl or the table-non-table, but overall displayed a different attitude when given to participants. The participants displayed three types of interaction with this counterfactual artifact suggesting that the cube is capable of having multiple applications. The user may engage with the object visually, physically, and mentally. It challenged the participant to position themselves in a dialogue with the artifact and find a relation with it. Feelings of tranquility, pause, meditation, and empathy were expressed during the study which supports the Wandering Cube’s potential for influencing the user to slow down and reflect. The participants tried to give the artifact meaning by making it an extension of themselves, meaning they would write or draw something on it.

In addition, the study shows that the Wandering Cube may in fact disappear and be forgotten like the other things in the environment over time. However, since it is dynamic and has movement, when noticed, it would bring the passage of time to the owners attention. This notion opens a space for the owner to reflect on the last time they recall noticing or interacting with the cube and allow them to pause. Challenging the memory to recall the last time the artifact was picked up, relocated or even played could further be explored in future studies by conducting the study for a longer duration. Furthermore, having to co-exist with something like this cube, that does not require any attention to function, may develop certain feelings worthy of consideration in later studies.

Interestingly, the findings support the initial idea of a multisensory cube, which were conceptualized after the design probe studies. The participants engaged with the cube by drawing, tapping to create sound and syncing their mental state with the slowness of its movement and pace. Future studies can deploy other senses and even different type of movements.
Chapter 4
Designing for reflection is a research through design project which explores various design possibilities for mitigating technostress through utilizing slow technology. It highlights the importance of looking under the hood of the correlation of theory, interactive artifacts and people by examining the interplay of theory and practice. In this research the artifacts and activities were simply created as a critical design speculation on the current technologies which are found in our everyday environment.

The design fiction, an unrealistic take on the action of sharing, was in fact a crucial step towards understanding the fundamental correlations of technostress, slow technology and critical design. It was learned through the process of making the Sharing is Caring system, how principles of slow technology require a clear underlaying logic in which each component could fully function as part of a larger system. Perhaps if the designer had worn the necklace as part of her everyday appearance or had given it to a participant, interesting conversations would have shaped around this design. This could be explored in the future and as part of a longer term design research trajectory and to expand the body of knowledge.

The design probe, presented a democratic space for design professionals, participants and even the researcher to explore various interactions with multisensory artifacts through a set of activities. Within this space, it was understood how it is important to design for customization and flexibility when dealing with matters of technostress as this notion is experienced differently among people. Even though the initial evaluation of the probe was informally conducted, it led to small alterations which later was shared with professionals. This co-design process ultimately impacted the refinement of the activities and their protocol, and essentially enhanced the “two-week participant’s” experience with the probe. In addition, the fact that one could use a material such as air-dry clay to imagine and create their personal symbol of serenity, was one of the most interesting findings in this design approach. The proposed conceptual designs inspired by the probe suggests the possible trajectories for future research which this thesis did not proceed with.
The design artifacts were perhaps the most technically challenging section of this research. Both artifacts went through an excessive amount of iteration and reflection, before they came to be what they are as design products. The Grow Slow hourglass was challenging in the sense that it needed to be programmed to work for a long period of time in an incremental manner. The programming went through a trial and error phase to later be given to the participant without any malfunction. The design of the physical object also had to be altered to the extent that the embedded motors had to be covered and the night lamp was then eliminated from the package. Perhaps in future works the physical design could also be further explored to have the night lamp as part of the final package and enhance the quality of the user’s experience.

Another interesting aspect of the Grow Slow hourglass was that while a typical hourglass is normally designed to show the passage of time, the Grow Slow hourglass suggests otherwise. It challenges and engages the participant in many levels, from their intuitive use of the beads to their cognitive expression when hearing a bead drop into the lower compartment (similar to when interacting with the worry beads). Dispatching worries, goals, etc. from the mind and placing them into each bead suggests a sense of relief with positive connotation, just like the worry dolls or similar to the Thought Box from the design probe. Every time there is an opportunity to take a bead out, a sense of accomplishment compliments the experience and further motivates the user to engage with the artifact to fulfill more goals with a personalized pace and quality.

The dichotomy of the positive and negative attributions with the goals and the beads sparks an interesting dialogue between the users and the artifact which ends up encouraging the user to find a balance for their goals and expectations through a slow and thoughtful realization process. Moreover the hourglass presents itself as an extension of the user and by allowing the user to take control, matters like technostress may actually mitigate and personal growth would appear over time. To expand this design, further research can be done with more participants in other settings outside the home environment. Perhaps, the characteristics and the cognitive effects of the beads could also be explored through using different materials or colors other than wood.

Although the initial idea for the Wandering Cube presented itself in the early staged of this...
research, it was the last design to be completed and evaluated. The human-technology relationship shaping around artifacts such as the Wandering Cube, promote questions which relate to the centered-ness of technology. The Wandering Cube sparked interesting interactions and applications as the participants engaged with the artifact. Different levels of engagement such as visual, physical and mental, was also seen during the studies which can further be explored in future research.

The Wandering Cube shows that interactive slow counterfactual artifacts may potentially mitigate technostress while criticizing their own existence. With this type of research, there are certain aesthetic or practical attention users may give to the artifact which is irregardless of its usefulness. However, if the user does not find the artifact as functional this does not mean that the design was unsuccessful. It simply means that there is a new avenue to explore the impacts which technological artifacts have on humans. This research shows that for some people meaning-making is an important part of their relationship with the cube. Through these type of interactions some human emotions, reactions or behavior may alter over time and people may find a broader meaning to their existence in relation to the world around them.

Overall, the design artifacts are products which have impacted levels of technostress either by stealing attention or challenging the users memory. Ultimately, they help the user learn more about their impact on technological objects and examine how technology may influence their existence.

The main takeaway here is that while each design is nested in its own methodology and has a unique characteristic, they all embrace the importance of self-reflection and bring awareness to the matter of technostress. Each design develops a significant critical conversation while placing emphasis on principles of slow technology. The combination of the implemented design methods and applied principles led to four very different yet creative designs. All four designs address the negative impacts of technology, namely technostress, by stretching human-technology relationships beyond familiar interactions. Many people interact with technology and are overwhelmed by the demeaning relationship they develop over time, however in this thesis critical design decisions were made to not only explore but further pave new possibilities for creating meaningful and mindful interactions in the long run.

Whether this research encourage people to share in a more meaningful manner, help them become more aware and mindful of their hidden intentions, or simply discover novel interactions with counterfactual objects, it is hoped that its contribution would go far beyond a thesis and benefit a broader audience.


