To Live Deliberately

A Critical Exploration of Robotic Technologies in the Home

Wesley Johnson
Jodi Forlizzi, advisor
Carnegie Mellon University
School of Design 2012

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ABSTRACT

Robotic technologies are increasingly entering our domestic environment. iRobot, manufacturer of the Roomba floor vacuuming robot, reports the sale of over six million home robots [19]. While domestic robots are often created solely to perform one specific task, their influence extends beyond their intended function. For example, the Roomba's primary function is to vacuum dirt and debris from the floor; however, the Roomba has been shown to have "substantial and lasting impact on people, activities, and the use of other cleaning products within an existing product ecology" [11].

This research addresses the need to explore the cultural, social, and aesthetic implications of robotic technologies in the home. This work takes a critical design approach, where design artifacts are situated in the context of use in order to challenge existing thoughts and provoke new ideas. Using this approach, we can question the role and behavior of home robotics beyond the practical functionality of current, commercial robots.

The realization of functioning design artifacts is central to this exploration. The development process grounds the design in reality and forces it to confront the details of physical experience in addition to enabling multisensory interaction. Ultimately, the design artifacts examine and extend the cultural, social, and aesthetic experience of domestic robots.

INTRODUCTION

In 1845, Henry David Thoreau built a small cabin in the woods outside Concord, Massachusetts. Thoreau subsequently lived in the simple, secluded cabin and its natural surroundings for over two years. Reflecting on his experience near Walden Pond, Thoreau stated, "I went to the woods because I wished to live deliberately, to front only the essential facts of life, and see if I could not learn what it had to teach, and not, when I came to die, discover that I had not lived" [37]. This great experiment was an exploration of living life and an examination of society's status quo. Thoreau's experience was the vehicle for his thinking and a provocative narrative for his readers. With the boldness, rigor, and openness of Thoreau's actions, this research seeks to create experiences that explore the essential facts of our interactions with robotic technologies in the home.

Robotic technologies are increasingly entering our domestic environment. In the January 2007 issue of Scientific American, Microsoft founder Bill Gates claimed, "I can envision a future in which robotic devices will become a nearly ubiquitous part of our day-to-day lives. I believe that technologies such as distributed computing, voice and visual recognition, and wireless broadband connectivity will open the door to a new generation of autonomous devices that enable computers to perform tasks in the physical world on our behalf" [14].

There might not be a robot in every home yet, but robots are becoming more prevalent in homes around the United States and the rest of the world. In fact, iRobot, manufacturer of the Roomba floor vacuuming robot, reports the sale of over six million home robots [19].

While domestic robots are often created solely to perform one specific task efficiently, their influence extends beyond their intended function. For example, the Roomba's primary function is to vacuum dirt and debris from the floor; however, Forlizzi found that the Roomba has "substantial and lasting impact on people, activities, and the use of other cleaning products within an existing product ecology" [11]. Additionally, Sung et al. concluded that people form intimate relationships with their Roombas. "Householders feel happiness toward Roombas for helping them become neater… People used life-like associations to engage with Roomba… People valued Roomba enough to promote to others and to change the home for better accommodation" [35].

This research addresses the need to explore the cultural, social, and aesthetic implications of robotic technologies in the home. This work takes a critical design approach, where design artifacts are situated in the context of use in order to challenge existing thoughts and provoke new ideas. Using this approach, we can question the role and behavior of home robotics beyond the practical functionality of current, commercial robots.

The realization of functioning design artifacts is central to this exploration. Much like Thoreau's physically living in the woods, this method grounds the design in reality. It forces the design to confront the details of physical experience in addition to enabling multisensory interaction. Ultimately, the design artifacts examine and extend our experience with domestic robots.

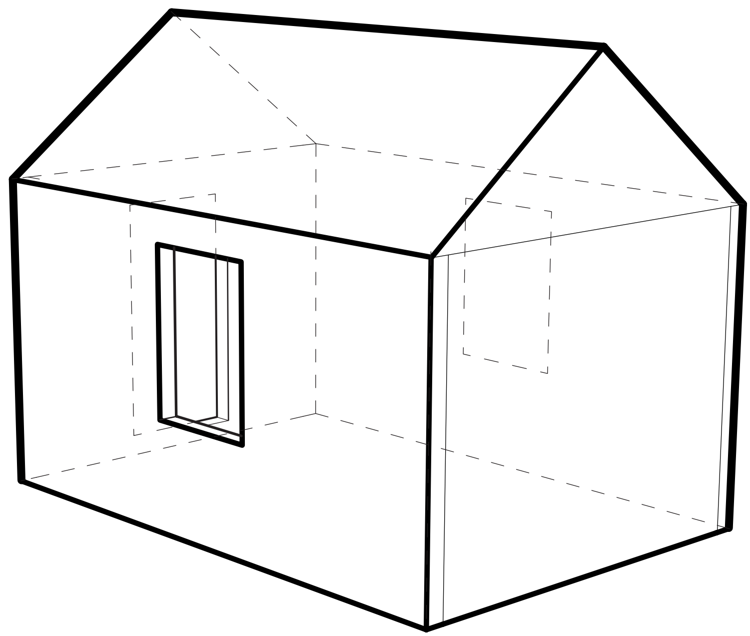

Figure 01: Thoreau's cabin on Walden Pond

RELATED WORKS

ROBOTICS

This research builds upon theoretical and practical work in the fields of robotics, critical design, and explorative domestic technology. Robots that are commercially available for consumers to purchase like cleaning robots [3, 21, 22, 25], telepresence robots [1, 36], and toy robots [33, 34] demonstrate the current characteristics and assumptions. Research investigating our current relationships with these robots in the home [11, 35] establishes a level of understanding and supports the rationale for this research. Other research presents important technical and non-technical threads in the field of robotics. Cynthia Breazeal has done extensive research into the creation of what she calls sociable robots. For example, one of her robots, Kismet, "is designed to be a robotic creature that can interact physically, affectively, and socially with humans in order to ultimately learn from them. Accordingly, our robot is designed to elicit interactions with the human that afford rich learning potential" [6]. More generally, Fong et al. provide many academic and commercial robots that deal with social interaction and possible impacts on humans in their "A Survey of Socially Interactive Robots" [10]. Similarly, Lichocki et al. provide an overview of central ethical issues in robotic research and commercialization [26]. Sherry Turkle, a researcher who has worked closely with Breazeal, provides a thoughtful voice regarding our interactions with sociable robots. "Relational artifacts [or a computational object explicitly designed to engage a user in a relationship] open up conversations about what is essential about aliveness, what is special about being a person, and the roles of thought and feeling, in defining human uniqueness. Interactions with robots are a powerful projective screen as well as a site for working through personal and social concerns" [38].

There are also related works exploring fictional robots. Valentino Braitenburg's Vehicles, Experiments in Synthetic Psychology, describes a series of simple imagined robots that sequentially increase in complexity. Through altering the connection and relationship of simple sensors and motors, the fictional robotic vehicles display characteristics like fear, aggression, and love. For example, a vehicle that turns away from light detected by a light sensor is read as being afraid of the light source. Alternatively, a vehicle that turns towards a light source as detected by a light sensor is read as showing aggression towards the light source. While these examples are oversimplifications of Braitenburg's vehicles, he also hypothesizes that people overestimate the sophistication or intelligence of simple robotic systems [5]. Additionally, there are many science fiction films and books that also explore imagined robots. Isaac Asimov notoriously explored ethical and social issues regarding robots in many short stories and novels. Popular films like the Star Wars series, Blade Runner, and WALL-E present a wide spectrum of possible robotic futures. These works have the ability to ignore real world constraints in order to provide suggestive and provocative ideas and images.

CRITICAL DESIGN

Another body of related work is critical design. Critical design enables reflection, discussion, and debate—it does not present straightforward answers or solution. Anthony Dunne states that critical design produces conceptual design products that explore and critique typical and assumed design trends. He states that critical design "rejects how things are now as being the only possibility, it provides a critique of the prevailing situation through designs that embody alternative social, cultural, technical or economic values" [8].

Anthony Dunne and Fiona Raby's Technological Dreams Series: No.1, Robots is a critical design project that explores formal elements of robots and attempts to question how people could relate to robots. The non-functional robots are brought to life in a suggestive film. The intent of the project is to question our current notion of robotics. "How will we interact with them? What new interdependencies and relationships might emerge in relation to different levels of robot intelligence and capability? These objects are meant to spark a discussion about how we'd like our robots to relate to us: subservient, intimate, dependent, equal?" [8]. Similarly, James Auger and Jimmy Loizeau's Carnivorous Domestic Entertainment Robots are another critical design project exploring the issue of robotic technologies. The project consists of a series of fictional robots that are powered by decomposing insects and animals that live in the home. This project questions the role and limits of robotics, specifically in the home. The project is designed to explore carefully crafted questions. "How comfortable would you feel having a machine kill and 'eat' animals in your house? Do you think it is unethical? Is it any worse that using conventional poisons or traps? If the robot did not consume enough 'food,' it would 'die.' Would you feel guilty? Would you go out of your way to feed it (much like keeping a Tamagotchi alive)? Are these objects really robots? How would you define a robot? [41]. Noam Toran's Accessories for Lonely Men also consists of a series of fictional electronic products. "The objects propose that most forms of human intimacy are crude enough in their physicality that they can be replicated with electronic objects and are meant to question what we think we miss in a relationship; the individual or the generic traces they leave behind" [32]. This provocative collection includes devices that curl one's chest hair, share a cigarette, breathe on the back of one's neck, and steal the bed sheets.

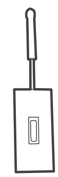

Figure 02: Chest Hair Curler

EXPLORATIVE DOMESTIC TECHNOLOGY

The final category of related works includes texts and experimental projects that explore domestic technologies. These works are less about provoking specific questions and more about pushing the boundaries of technology in the home. In "Making by Making Strange: Defamiliarization and the Design of Domestic Technologies," Bell et al. argue that designing unfamiliar technological artifacts can create new opportunities for designers and users. Using ethnographic techniques, Bell et al. discuss the wide variety of values within the home. The home is not simply a space where we desire to be efficient in completing our tasks; it is a space where we relax, play, work, learn, and love. The defamiliarization process can be used to explore assumptions and open the design space to new possibilities. "Making domestic life and technologies strange provides designers with the opportunity to actively reflect on, rather than passively propagate, the existing politics and culture of home life and to develop new alternatives for design" [4]. Additionally, "Designers have an opportunity to alter these built-in assumptions and thereby support different patterns of behavior. This strategy runs counter to user-centered design techniques because it proposes to design not for users' current needs and desires, but to shape alternative needs, desires, and behaviors through design" [4].

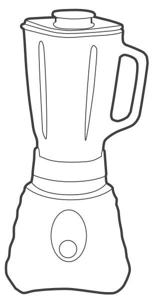

Figure 03: Blendie

There are a variety of works that operate within the space mapped out by Bell et al. Some projects are explicitly design projects and some projects are the creations of artists exploring the domestic space or working with domestic technologies. Kelly Dobson's Blendie creates a novel mode of human-machine interaction. A user must mimic the sound of an operating blender to activate and control Blendie. "The experience for the participant is to speak the language of the machine and thus to more deeply understand and connect with the machine... The participant empathizes with Blendie and in this new approach to domestic appliance, a conscious and personally meaningful relationship is facilitated" [23]. Blendie explores new relationships between people and domestic technology. Niklas Roy's My Little Piece of Privacy is a robotic curtain in the window of his workshop. As people on the street walk by the window, the robot curtain, which is much smaller than the width of the window, moves to block the view into the

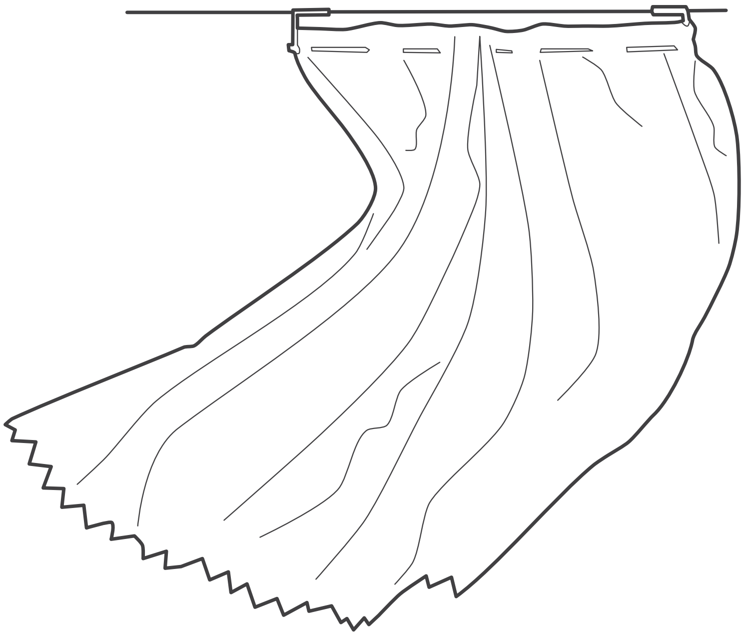

Figure 04: My Little Piece of Privacy

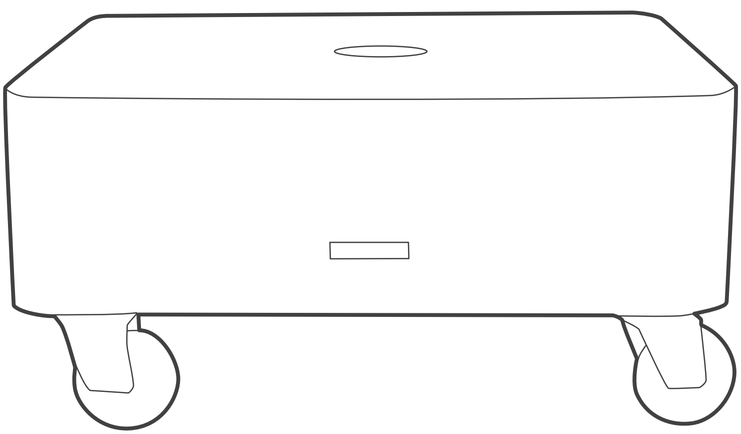

Figure 05: The Drift Table

workshop. "But in the end, it doesn't protect my privacy at all. It seems that the existence of my little curtain is leading itself ad absurdum, simply by doing its job very well. My moving curtain attracts the looks of people which usually would never care about my window. It is even the star of the street, now! My curtain is just engaged" [31].

William Gaver's The Drift Table is an "electronic coffee table that displays slowly moving aerial photography controlled by the distribution of weight on its surface. It was designed to investigate our ideas about how technologies for the home could support ludic activities—that is, activities motivated by curiosity, exploration, and reflection rather than externally defined tasks" [16]. Unlike critical design projects, the Drift Table doesn't question specific assumptions; rather, it explores technology's relationship to ludic activities in the domestic environment. Outside of the Drift Table project, Gaver points out the value of ambiguity in design explorations. "Ambiguity frees users to react to designs with skepticism or belief, appropriating systems into their own lives through their interpretations. In the process of reacting to the system either positively or negatively, however, users engage with issues that the designer suggests. Thus ambiguity is a powerful design tool for raising topics or asking questions, while renouncing the possibility of dictating answers. By virtue of this balance, ambiguity both offers an inspiring resource to designers and shows a deep respect for users" [15].

People's relationships with robotic objects and, more generally, their values in the home are complicated. To name just a few qualities, the home is a space for fun, work, love, mourning, relaxation, and reflection. Robot technologies take an active role in this environment. Building on the precedent works in the fields of robotics, critical design, and explorative domestic technologies, this research can explore this complicated interaction space in order to think critically and expand our relationship with robotic technologies in the home.

DESIGN METHOD

RESEARCH THROUGH DESIGN

While this research is rooted in a critical design approach, it also borrows from the design research method known as research through design. Described in Christopher Frayling's Research in Art and Design, research through design is a method of inquiry that uses techniques of design practice (e.g. materials research, development work, and action research) [13]. Forlizzi et al. advance the concept of research through design by providing a framework for the development and evaluation of interaction design research. Their model provides "a way for engaging with messy (or wicked) problems that are not easily addressed using traditional science and engineering methods" [12]. In the context of this research, the creation of functioning artifacts enables the exploration of the messy or wicked space that is the cultural, social, and aesthetic qualities of domestic robotic technologies.

CRAFTING EXPERIENCE

While other design and design research techniques were used throughout the design and development process, creating functioning artifacts is core to the approach of this research. As previously discussed, the practice of critical design can produce projects that are representations of concepts exclusively communicated through text, still images, and video—abstracted artifacts that cannot be physically experienced [7, 32]. The realization of functional artifacts grounds the research in reality and enables physical experience. This process forces design to deal with the details of experience. Unavoidable qualities of affordable robotic technologies like loud motors and imperfect sensors become real-world constraints and design opportunities. Physical experience is one of the aspects that make robotic technologies so powerful and interesting, so creating this experience empowers design to explore meaningful actions and interactions. Additionally, actualized artifacts can be situated in the context of use in order to directly challenge existing thoughts and provoke new ideas.

The concept of craft has been explored in the context of interaction design for various reasons and to varying effects [27, 40], but in this research, craft refers to the qualities surrounding physical articulation and the physical sensations produced and felt. This includes the construction and control of physical mechanism. Once a specific physical action is developed, it can then be physically experienced and, in turn, the construction or control can be altered to produce or explore other desired effects. The interrelationships of the system components are also considered throughout this process. For example, the relationship of the input from a certain sensor and the output of a certain actuator are closely linked.

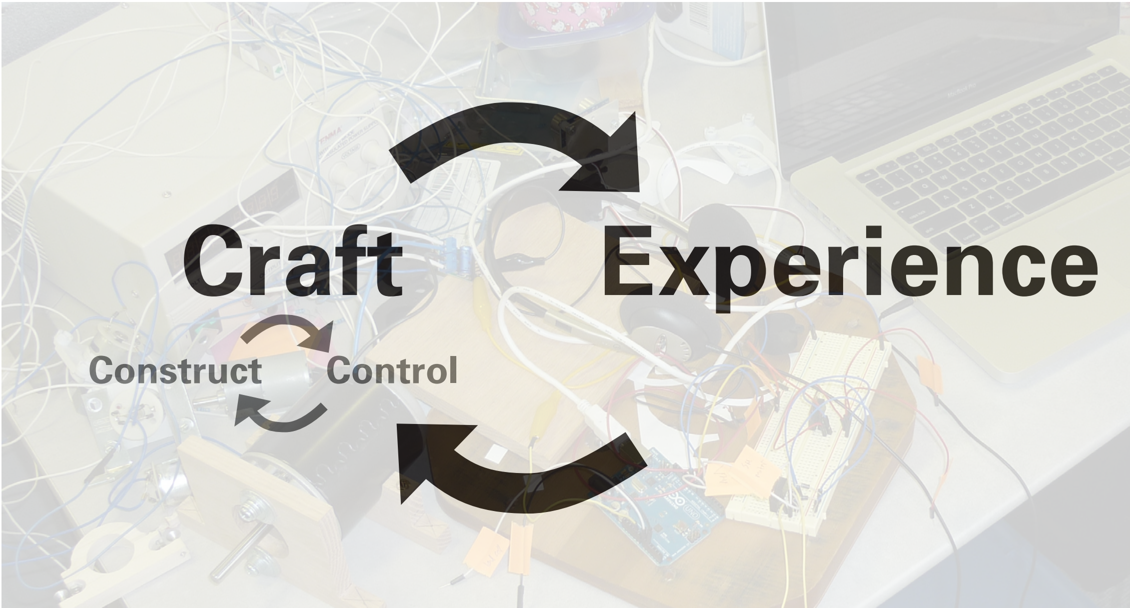

Figure 06: Design method diagram

Figure 07: Studio workspace

TECHNICAL RESOURCES

Technically and financially approachable electronic components and platforms enabled the realization of functioning design artifacts. The Arduino, an electronics prototyping platform, and iRobot Create, a mobile robot platform, allow non-engineers to quickly use and control electronic and robotic technologies. Each platform's website [2, 20] along with an ever-growing number of online technology development communities like those found at Instructables [18] and Make [28] provide easy access to technical resources and examples. Additionally, online retailers such as Digikey [9], Mouser [29], and Sparkfun Electronics [30] widely distribute electronic parts and components that may have otherwise been out of the reach of individuals working with these technologies. Utilizing these components and approach, a rich, multisensory experience can be explored and fine-tuned.

MACHINE FOR SITTING

MOTIVATION

In 1923, modernist architect Le Corbusier published a collection of essays called Toward An Architecture, in which he articulates his idea of modern architecture. Le Corbusier describes the role of architecture as supporting the lives of inhabitants. At one point, Le Corbusier claims that, "A house is a machine for living in" [24]. A house is not a decorative expression; it is there to serve its occupants. Le Corbusier compares this statement about architecture with the statement, "An armchair is a machine for sitting in" [24]. An armchair exists as an object that someone can sit in. This idea served as the catalyst for the first artifact that was created to explore the cultural, social, and aesthetic issues of domestic robotic technologies in the home.

Machine For Sitting was conceived as an autonomous electromechanical machine or robot that would sense and respond to elements in its environment. Machine For Sitting acts a vehicle to explore elements of interaction between people and robotic technologies. In turn, it is used to explore the cultural, social, and aesthetic implications of such interactions. Machine For Sitting leveraged the fact that chairs are ubiquitous objects in Western homes. Since chairs have no immediate or universal associations regarding autonomous behavior, it was an ideal form to raise or question ideas concerning autonomous domestic robots. Machine For Sitting could explore assumptions about the form, purpose, and personality of robotic technology in the home. Additionally, the chair has a rich history in the field of design. With technological advances in tooling and materials as well as conceptual explorations, designers, architects and craftspeople created a huge spectrum of chairs. Thus, it seemed appropriate for an interaction design research project exploring domestic technologies to continue this tradition. Is there value to a robot that does not always serve users? Can a robot that doesn't always serve users enable a richer, more complex relationship (like many relationships between people their pets)?

TECHNICAL DEVELOPMENT

As previously described, the design method was an iterative process involving the exploration of various technical and conceptual elements simultaneously. The construction of the physical system and the control software was also an iterative and explorative process.

Machine For Sitting's final technical system is pictured in Figure 08. This consists of a desk chair that has been augmented with an ultrasonic sensor, a load cell, and two motors. An external enclosure contains all of the electronic components. The ultrasonic sensor is mounted on the bottom of the seat of the chair and can sense the distance of nearby bodies and objects. It is mounted on a servomotor, so it can sense distances at various angles in relationship to the front of the chair despite having a relatively narrow field of vision. The load cell is mounted underneath the seat of the chair. Four rubber mounts allow the seat of the chair to move slightly and depress the load cell when an object or body is on chair. Because of its specific position, it can sense force that is applied to the seat or the back of the chair. Machine For Sitting

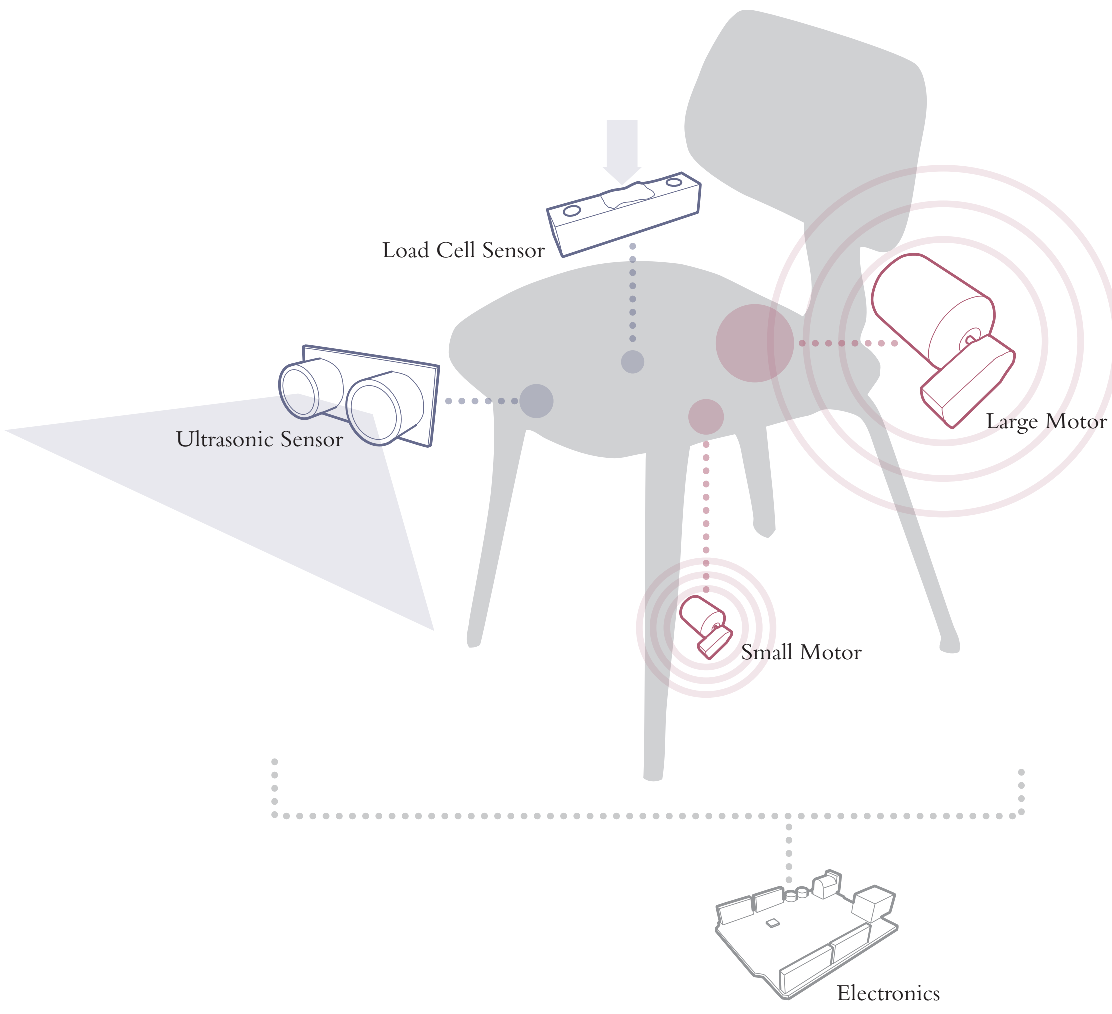

Figure 08: Machine For Sitting system diagram

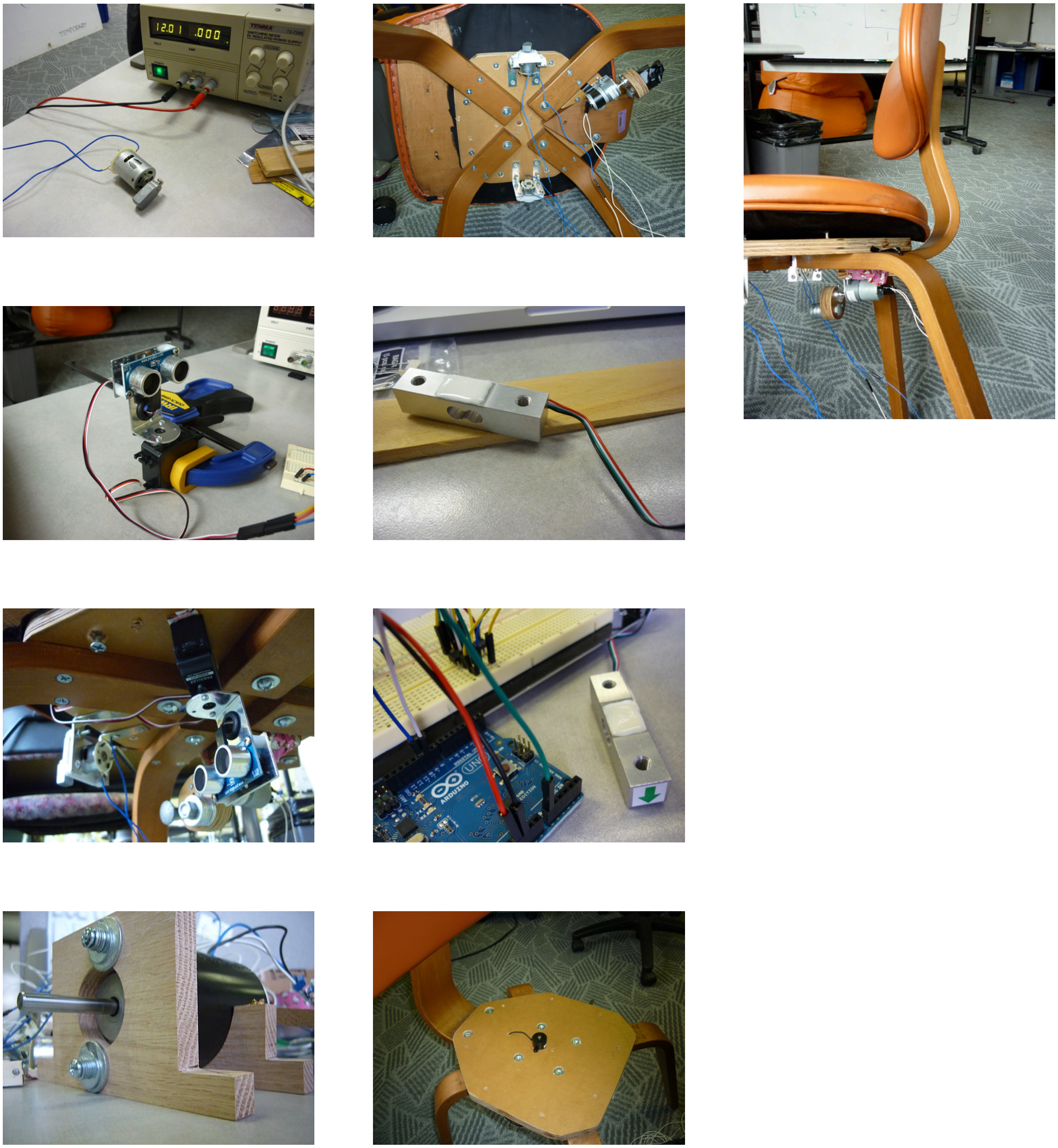

Figure 09: Machine For Sitting sensor and actuator development

also includes a large motor and a small motor that are mounted underneath the seat. Both motors turn an offset weight. Because of the variation of the offset weights, the motors can produce a variety of vibrations resulting in unique haptic, auditory, and visual sensations. The Arduino microcontroller reads the values of the sensors and controls the motors. A motor controller handles the power distribution to the large motor, and a Darlington transistor handles the power distribution to the small motor. Finally, a power supply provides power for the sensors, motors, and microcontroller.

While many different ideas were explored, Machine For Sitting's technical system was arrived at because of its simplicity. The sensors could sense forces from bodies or objects sitting or pushing on the back and seat and the distance of nearby bodies or object. The specific sensors were chosen because of their ease of use and consistent readings. The language of vibration was chosen as the output because it was a simple expression that could produce tactile, visual, and auditory sensation. The specific motor and weight combinations were chosen because of the rich spectrum of multisensory expression.

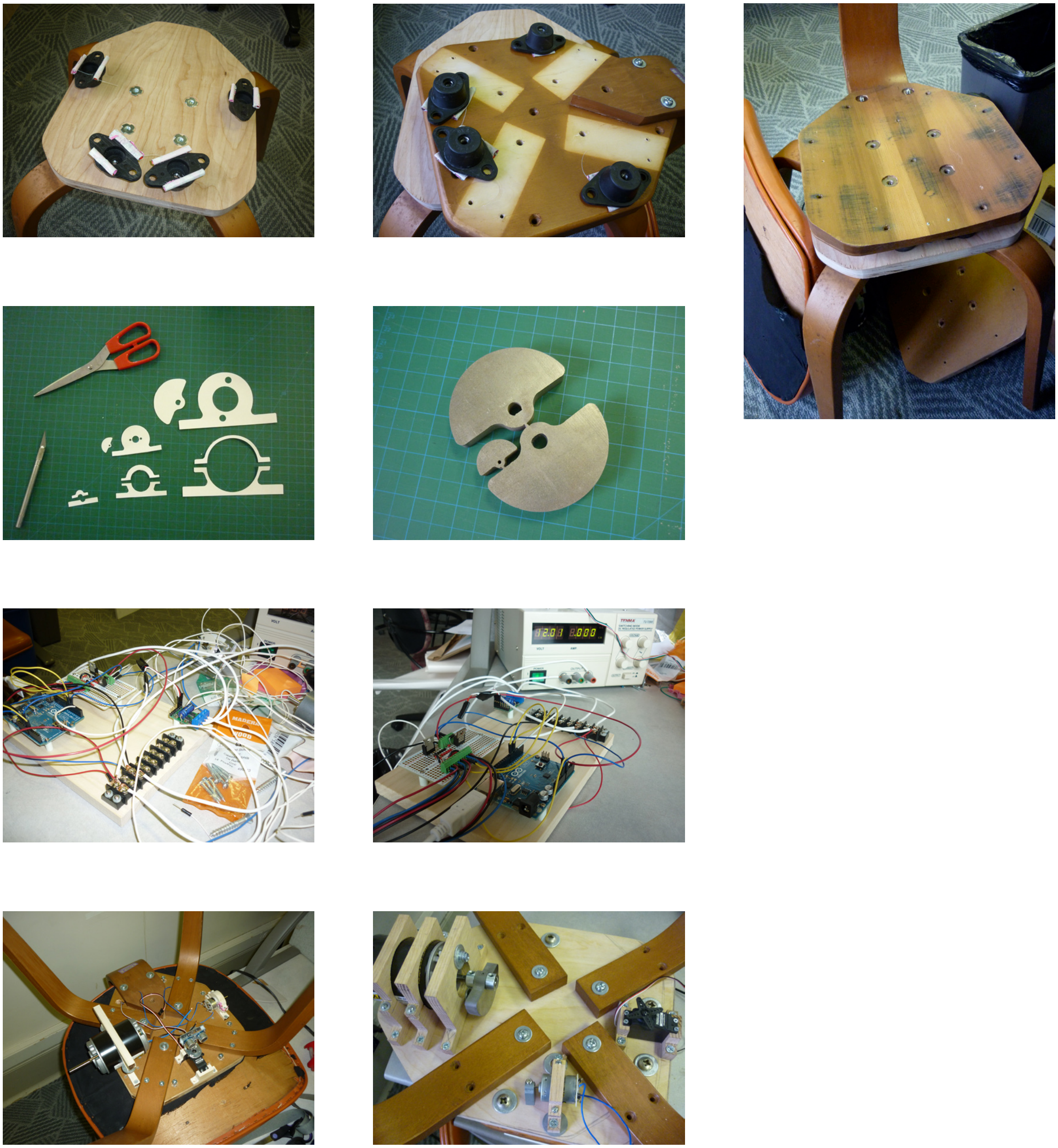

Figure 10: Machine For Sitting physical and electronic development

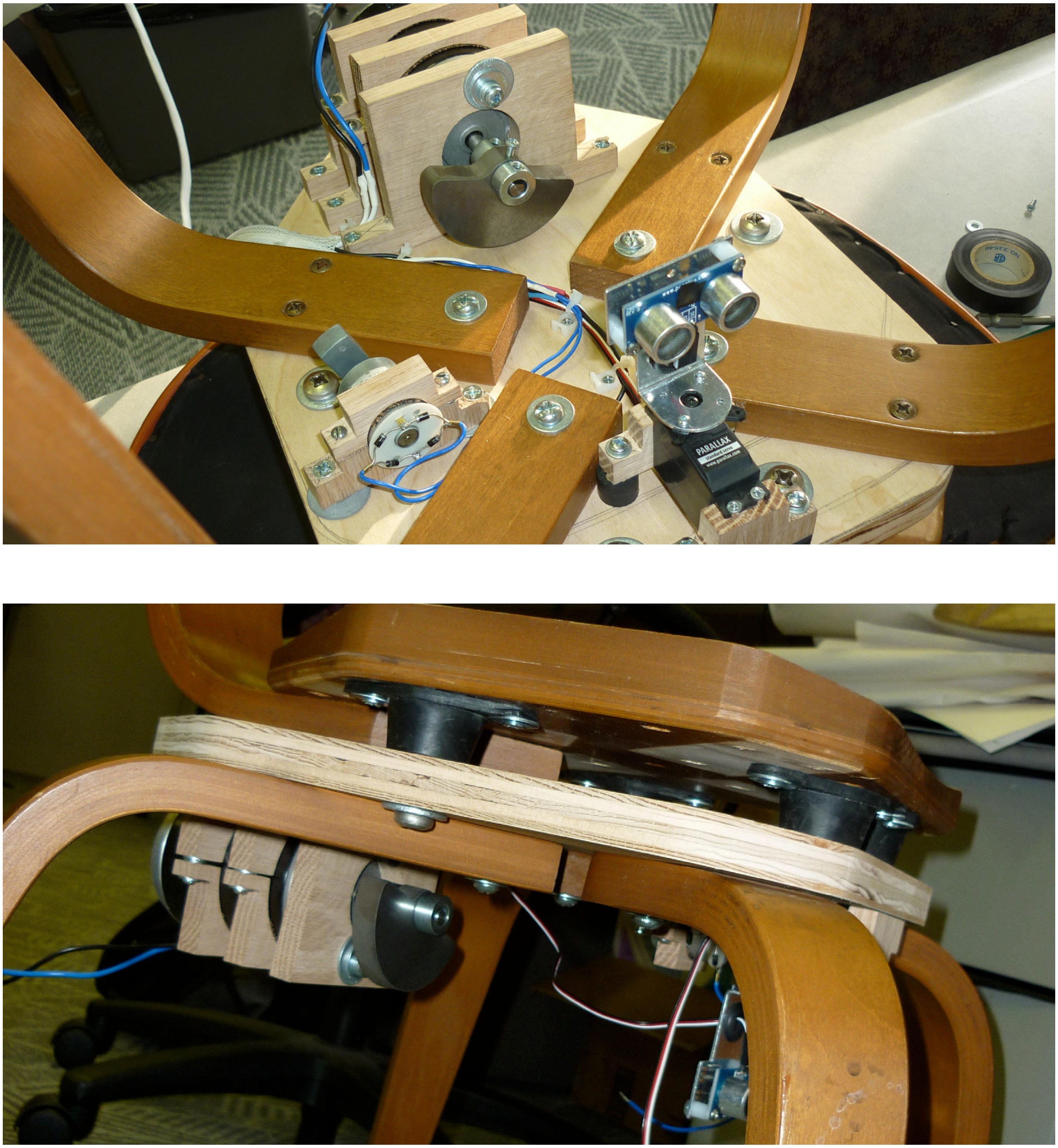

Figure 11: Machine For Sitting final electromechanical components

CONCEPTUAL DEVELOPMENT

Concurrent to the development of the physical system, the idea of a "machine for sitting in" was explored. How could such a machine behave in our domestic environment? What would it like? What would it dislike? Figures 12-14 illustrate several representative behavioral scenarios. Figure 12 shows Machine For Sitting trying to reach its desired state—having a person sit on it. Machine For Sitting attempts to get the attention of a person walking nearby. It produces large levels of vibration to produce a very public action that could be felt, heard, or seen by anyone nearby. Contrasting this public display, Figure 13 depicts Machine For Sitting producing subtle vibrations. This expression of satisfaction may occur when someone sits on Machine For Sitting and its desired state is achieved. Figure 14 shows Machine For Sitting produces large levels of vibration in order to displace a shirt or coat that was placed on its back. After all, it is a machine for sitting, not a machine for holding articles of clothing.

SOFTWARE DEVELOPMENT

The control software was developed with these scenarios in mind. For example, when the ultrasonic sensor value changes because of the presence of an object or body after long period of time, the large motor might turn quickly. This cursory description suggests the programming that might describe the scenario above where Machine For Sitting gets the attention of a person walking past by vibrating loudly. In reality, the sensors, actuators, and control software don't always work in ways that the previous scenarios suggest. Machine For Sitting

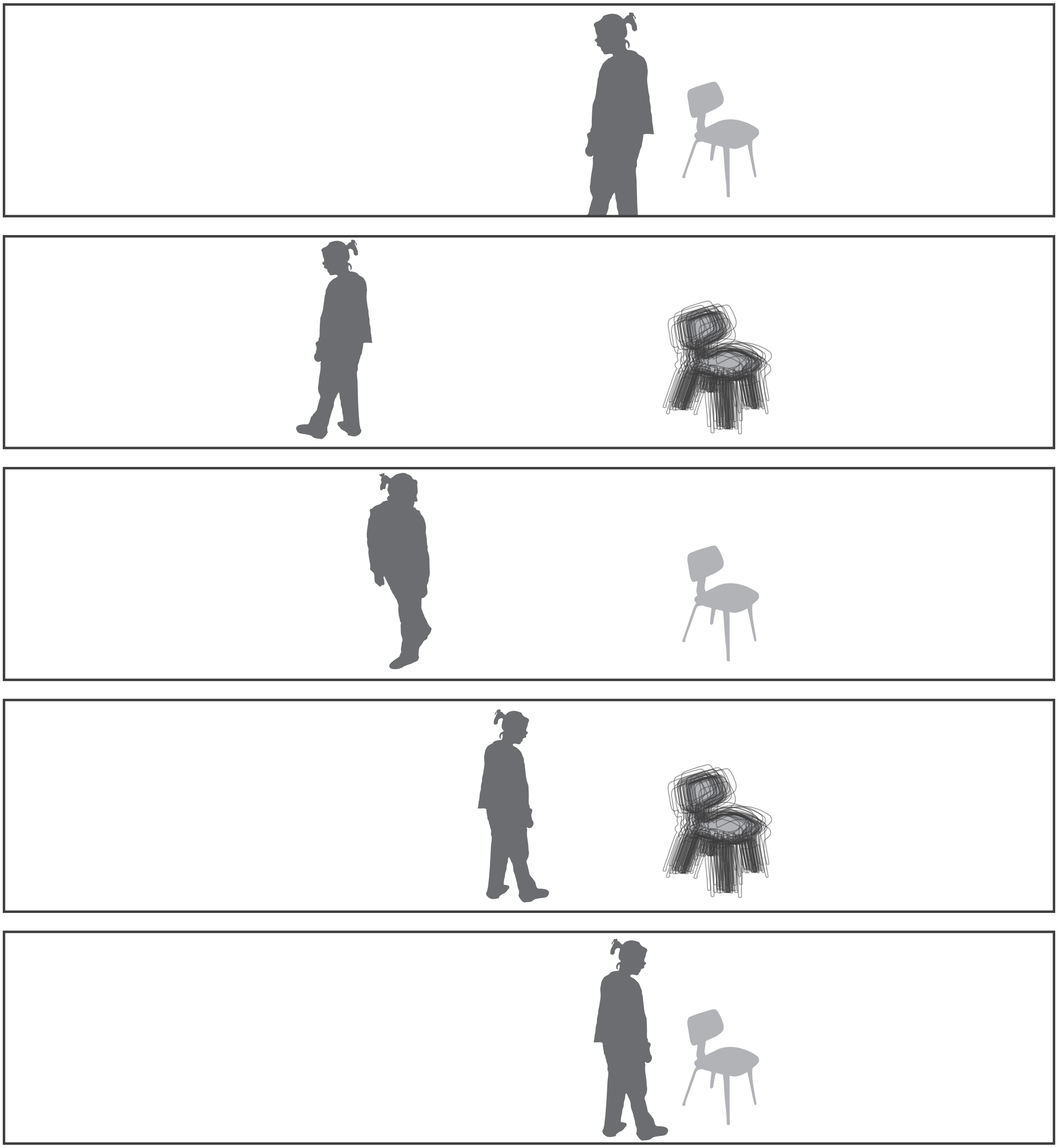

Figure 12: Machine For Sitting behavior illustration, attraction

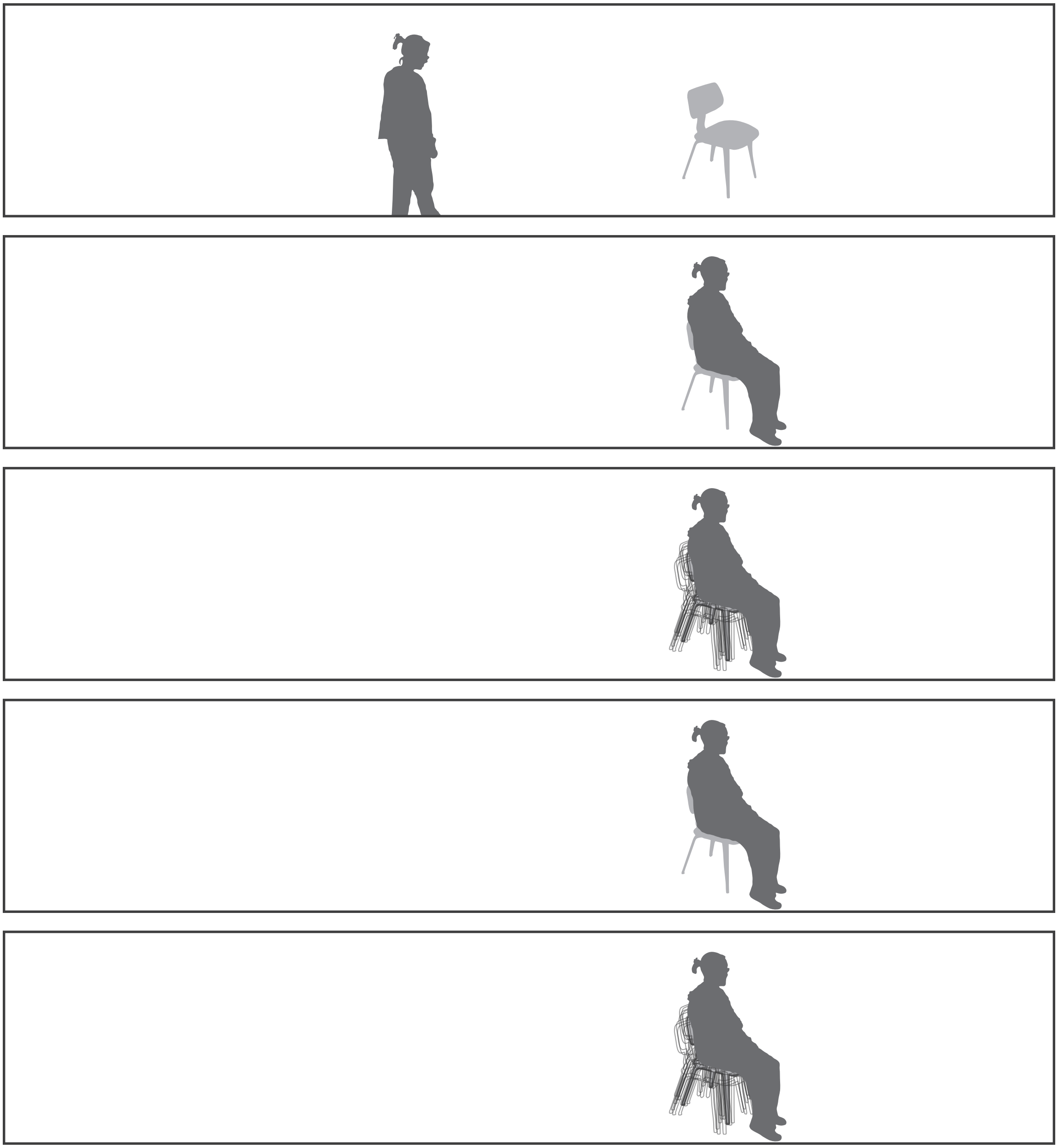

Figure 13: Machine For Sitting behavior illustration, satisfaction

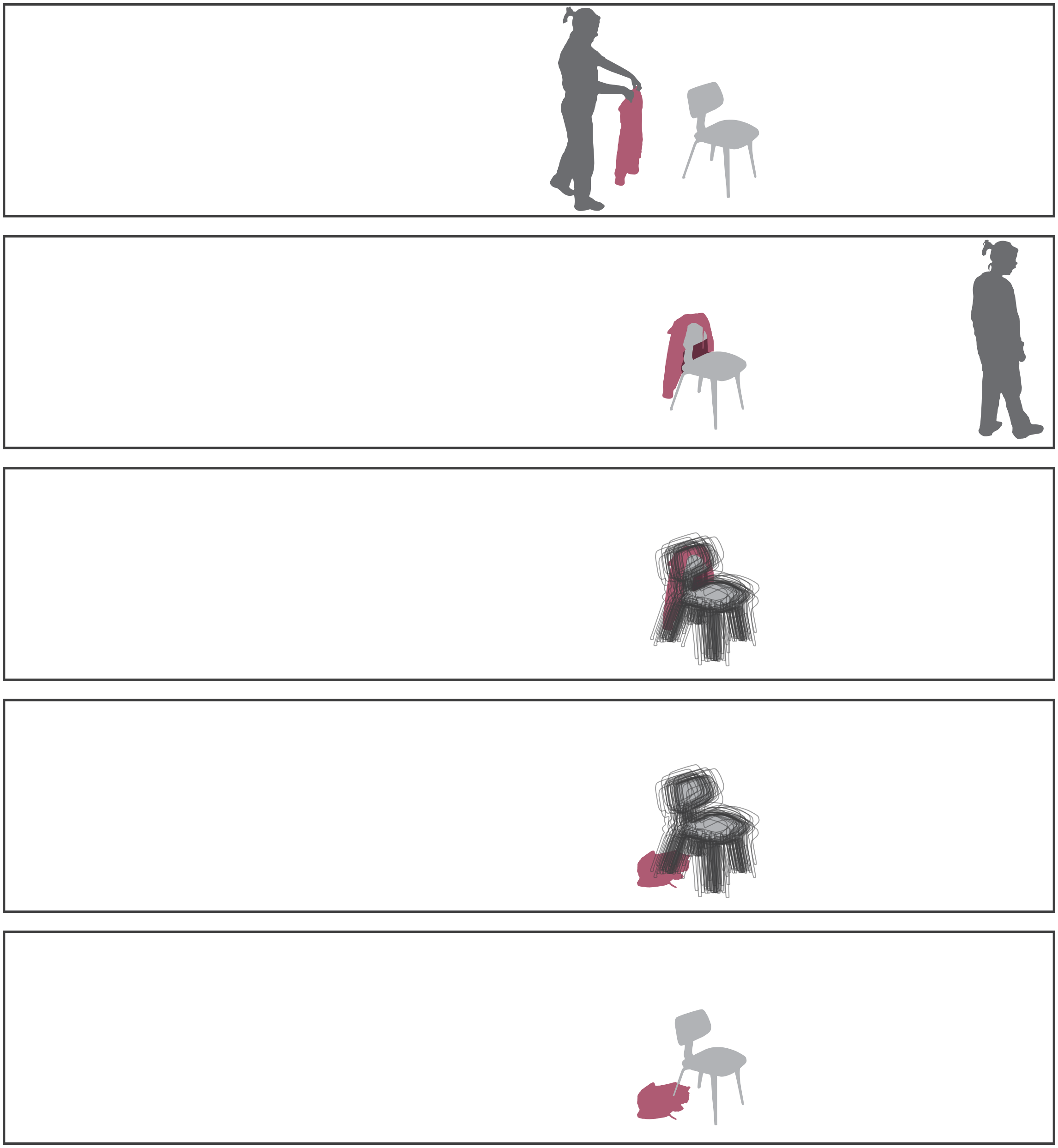

Figure 14: Machine For Sitting behavior illustration, annoyance

Figure 15: Machine For Sitting home installation

cannot distinguish a person from a 150 pound block of concrete that's placed on the seat. Regardless, the system is consistent and suggestive. It may be just as provocative that Machine For Sitting produces a purr-like vibration when a block of concrete is placed on it. Additionally, random variables were used throughout the development of the software in order to give the behavior a dynamic or exciting feel.

USER INTERACTION

The intended user interactions are based on established interactions that people have with desk chairs. Machine For Sitting may respond to users' approaching, passing, sitting or placing objects on or in front of it. Users' relationship with and understanding of Machine For Sitting develops over time through these natural actions.

USER EVALUATION

Machine For Sitting was tested with users in two ways. Both sets of tests were completed in the spirit of other critical or explorative design works [8, 16]. The goal was not to complete a rigorous, scientific study. The informal user tests sought to observe user interactions with Machine For Sitting and illuminate anecdotal experience of unfamiliar users.

In the first set of tests, participants were exposed to Machine For Sitting in a lab-like setting. A variety of programmed motor behaviors were "played" for the participants, who were then asked to consider how they felt. While even this simple lab test provoked a great deal of questioning and discussion, one major trend

Figure 16: Machine For Sitting home installation

emerged. Actuations that were regular and repeated (e.g. motor on for .2 second, off for .8 seconds, etc.) felt very artificial. One participant stated, "It's very mechanical, less personality. It didn't feel like there was a message. It's not really communicating anything to me. It felt very much like a mechanical thing happening." Another participant claimed, "It reminds me of an alarm or maybe a distress call." Actuations that were irregular (e.g. motor on for .1 second, off for .6 seconds, on for .5 seconds, off for .2 seconds, on for .5 seconds) felt more organic. A participant stated, "It was more emotional. The tone was changing. It wasn't playful; it was sort of sad in a way. It sort of trails off. Maybe like help me or I'm annoyed." Another participant said, "It feels kind of sneaky for some reason. It's a little quiet. It's doing something, but it not overtly trying to talk to you. Like it's talking to you in kind of a whisper tone. A little more intimate. But not warm or trusting, so sneaky."

The second set of tests placed Machine For Sitting in actual home environments. Participants spent several hours simply spending time in their home with Machine For Sitting present. Reflecting on their experience, users emphasized how difficult it is to articulate Machine For Sitting's actions and behaviors. As one participant stated, "It's something that people would wonder, 'What the hell is it? Why do you have it? What does it do?' Which were all the questions I asked when I first saw it. And I still don't know any of the real answers to that. But you can still sit on it." Participants also tended to ascribe much more intelligence to Machine For Sitting. "It seemed as though it was figuring out where things were positioned

Figure 17: Machine For Sitting home installation

in the room, and as new things moved in or moved around, it would do more. But it got its initial layout of the land." Machine For Sitting simply gets a value from its ultrasonic sensor to establish its "initial layout of the land." It is an occurrence that lasts a fraction of a second. Finally, participants ascribed some sort of embodiment to Machine For Sitting. A participant stated, "It was very much as if [it was] an animal... It felt real. It felt alive because of that gentle, almost like a breathing... Or almost like a peaceful, relaxed sound and that vibration that goes along with it. It felt good. I don't know how you put that into words."

In both test cases, participants were reacting to initial impressions of Machine For Sitting. The experience would certainly be different over the course of long-term interaction. The cultural, social, and aesthetic space of the home is something that is established and developed over long stretches of time. The user testing provides some valuable insights, but the limited time-frame provides a serious limitation to these tests.

A SELFLESS ACT

MOTIVATION

In many ways, A Selfless Act was conceived as a direct response to the design and development of Machine For Sitting. Machine For Sitting explored ideas surrounding the voice, personality, and embodiment of the machine. The crafted experience of Machine For Sitting suggests the chair has specific likes and dislikes. Throughout the design and development process of Machine For Sitting, many questions surfaced in relation to this idea of embodiment. Is it ethical to deliberately build illusions of personality or embodiment in inanimate objects? Is it ethical to suggest qualities like desire within a machine? Where should the designer or creator enter this picture? A Selfless Act attempts to diminish the appearance of embodiment or agency within the robot and make a machine that is explicitly an extension of the designer. Additionally, A Selfless Act raises questions surrounding the presence and effects of a domestic robot.

CONCEPTUAL DEVELOPMENT

A Selfless Act is a performance featuring iRobot's Create robot. Rather than vacuuming the floor, the Roomba-like machine continuously travels along a path in the form of the designer's handwritten word. Over time, the movements of the robot will slowly scrape the handwritten 'selfless' into the surface on which it travels. There have been many writing machines before including Pierre Jaquet-Droz's eighteenth century automatons. Jaquet-Droz's machine was created to dazzle viewers at its simulation of life [39]. The context and qualities of A Selfless Act, however, create a performance that questions our current technological situation.

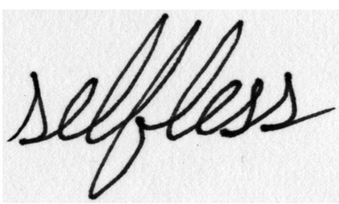

Figure 18: A Selfless Act selfless

Figure 19: A Selfless Act initial concept visualization

Figure 20: A Selfless Act initial concept digital simulation

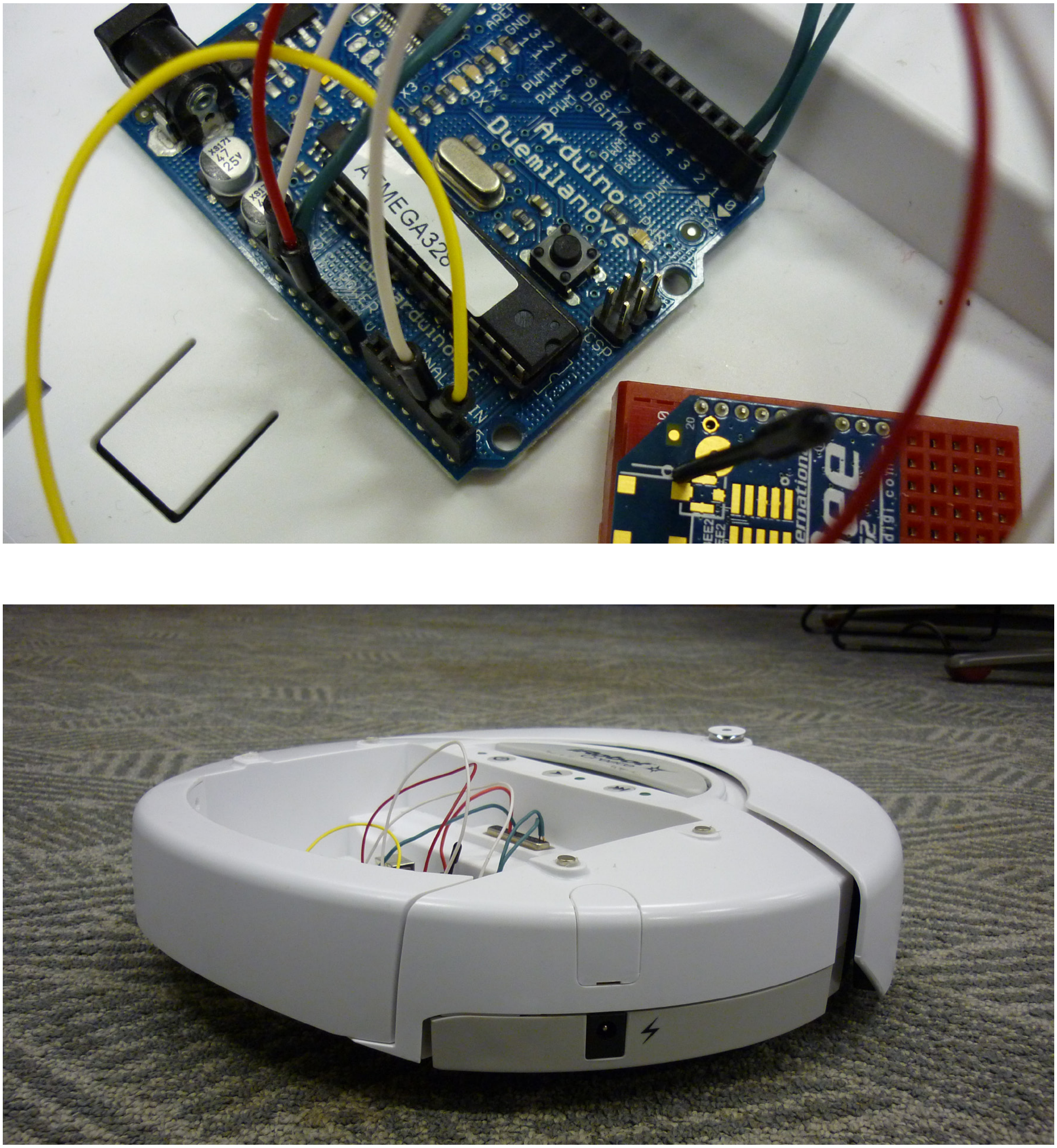

Figure 21: A Selfless Act design process

TECHNICAL DEVELOPMENT

Technically, A Selfless Act simply consists of an iRobot Create, an Arduino microcontroller, and a scraping mechanism. The Create is a mobile robot platform that is similar to iRobot's Roomba without the vacuum functionality. The microcontroller contains the code that guides the robot on its 'selfless' path. The scraping mechanism enables the robot to slowly wear its path into the surface on which it travels.

The development process iteratively crafted the quality of the robot's movement. The robot moves slowly, smoothly, and deliberately. It feels methodical and inanimate. As seen in Figures 22 and 23, a series of arcs and tangential lines were created to produce the smooth movement. The laborious process of path planning by hand seemed appropriate for a performance that suggests the robot is simply an extension of a designer's hand.

USER INTERACTION

Despite facilitating no direct interaction with people, A Selfless Act is a provocative statement about the role and presence of domestic robots. The actions and byproduct of the robot are meant to facilitate thoughts and discussion. The physical experience enables users to see, hear, and feel the presence of the robot rather than simply imagine it.

At the time of writing, A Selfless Act has not been situated publicly. While it is difficult to evaluate, the approach to A Selfless Act provides a framework for interaction design to question and explore in a tangible way. It is a reflection and response to this research and the current state of domestic robotics.

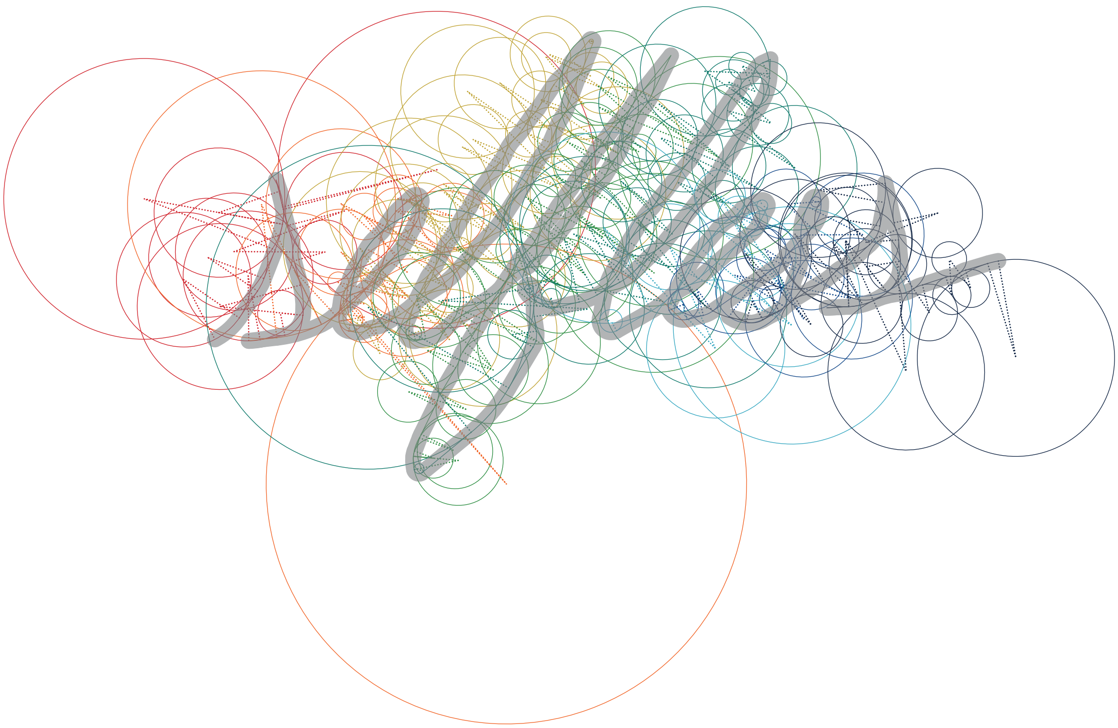

Figure 22: A Selfless Act path planning diagram

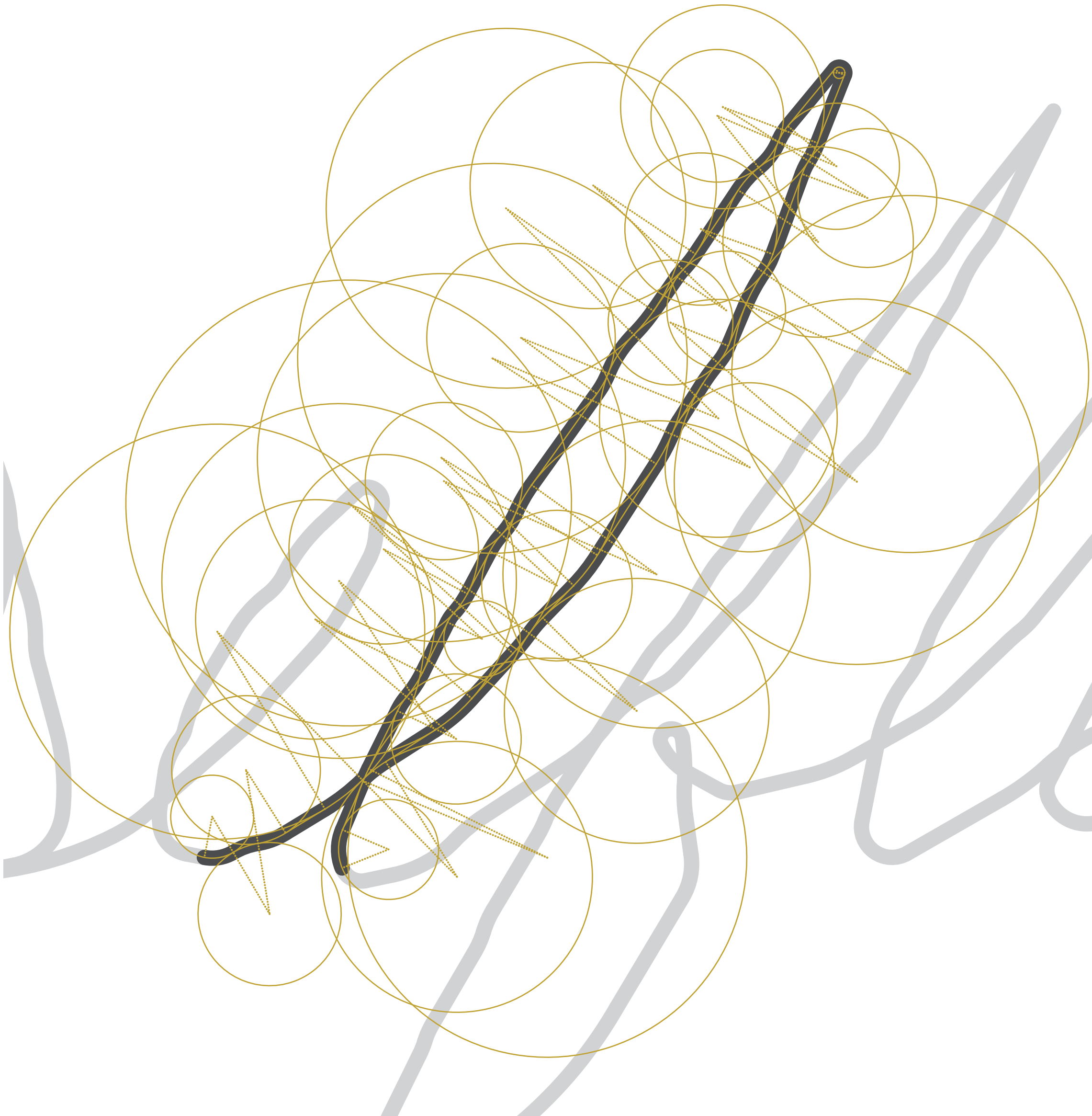

Figure 23: A Selfless Act path planning diagram, close

CONCLUSION

This research sought to question and expand the user experience of domestic robotic technologies in the complex space of the home. The realized design artifacts move beyond the practical functionality of current domestic robots.

ART AND DESIGN

This research was conducted in partial fulfillment of a Master of Design degree in interaction design. One common criticism of this type of work is that it is art not design. While the classification of this research is not paramount, it is important to understand how this is situated in the context of design. In the aforementioned Drift Table project, Gaver et al. state, "The Drift Table is not an artwork. Nor is it a toy or a tool. It is not designed to provide information, entertainment, or communication. But the temptation to interpret the Drift Table in any or all of these ways is key to its understanding. Perhaps it is best thought of as a pre-genre artifact, designed to be easy to use, but difficult to interpret" [16]. The artifacts developed in this body of research share a similar space. They are difficult to interpret, but firmly rooted in the questioning and expanding of interactions with domestic technologies. The technologies and larger context explored in this research are and will continue to be used in our daily lives.

In his Scope of Total Architecture, Walter Gropius described the overarching goal of the Bauhaus. "Our ambition was to rouse the creative artist from his other-worldliness and to reintegrate him into the workaday world of realities and, at the same time, to broaden

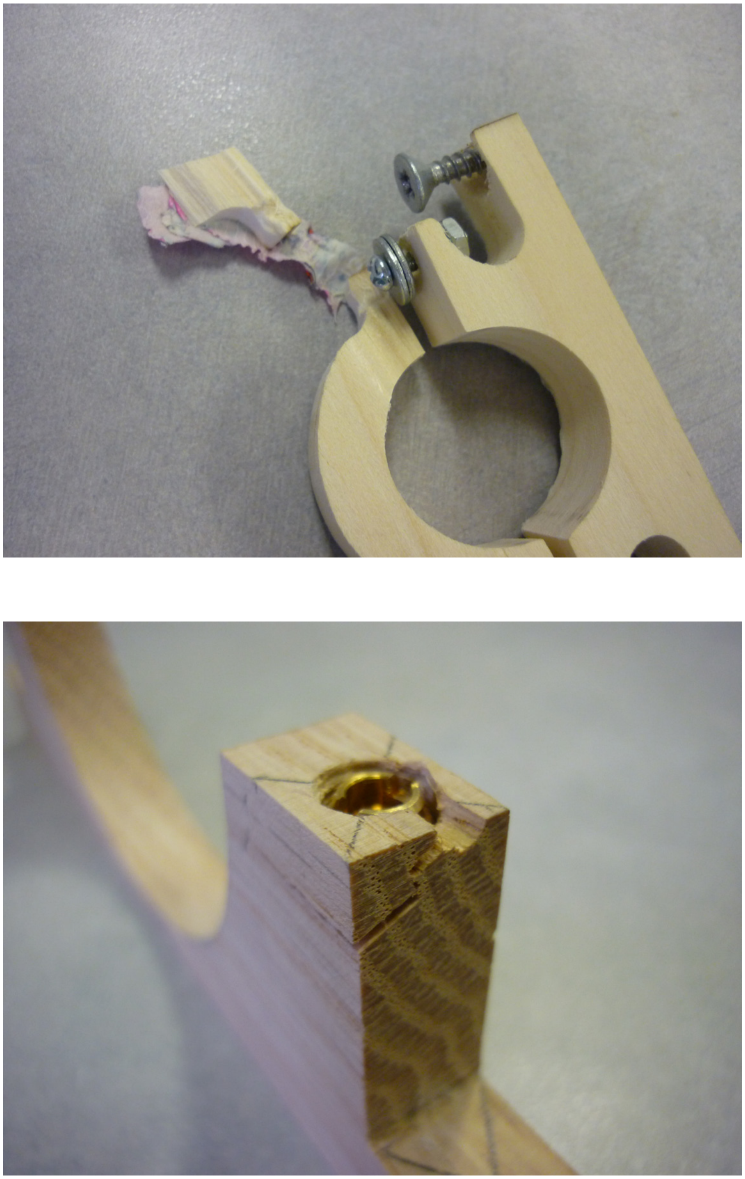

Figure 24: Machine For Sitting motor mount failures

and humanize the rigid, almost exclusively material mind of the businessman" [17]. Similarly, this research seeks to expand the qualities and experience of robotic technologies in the home. The home environment is not exclusively a factory or laboratory—the birthplace for many robotic technologies. Efficiency is not the driving value in the home environment. The home is a place with a rich and dynamic set of values, and other interactions with technology in the home should be reflective of this. An artful approach can help push the boundaries of our experience with robotic technology in the home.

A CAUTION

The mode of research can lead to a costly process in terms of both money and time. Electronic and physical fabrication requires a fairly large amount of support equipment and technical knowledge. As mentioned previously in the method section, easy-to-use electronic and robotic platforms like the Arduino and iRobot Create can greatly cut development time. In addition to being relatively expensive, these platforms also run the risk of leading to standardized technical solutions. Certain well-documented or easily implemented circuits or programming techniques can limit the possibility of expression. It is important to be willing to experiment technically as well as conceptually.

Additionally, this research required a great amount of time making and remaking physical components like motor mounts and offset weights. While these elements seem fairly inconsequential, they enable reliable physical experience. Outsourcing certain development and manufacturing can save time and delivery higher quality components, but it is also important for designers to be able to work physically as it informs how one approaches design.

FUTURE WORK

Due to time constraints, one of the limitations of this research was that the design artifacts were not optimally installed in their desired context. As previously mentioned, Machine For Sitting was installed in several homes but only for limited amounts of time. Ideally, participants would have the opportunity to live with the artifact for months or years rather than hours. After initial impressions of wonder and confusion, a more complex relationship between people and the chair could develop overtime. The subtle ideas and qualities of the chair would support an evolving relationship. Similarly, A Selfless Act has yet to be installed. Ideally, it would be installed in a location that would enable a long-term performance where it could be experienced by a variety of viewers. The performance and its resulting effects could lead to thoughts and discussion for anyone involved in the design and production of domestic technologies and consumers alike.

The intent and method of this research serves as a fertile landscape. While these projects explore cultural, social, and aesthetic qualities of domestic technologies, this territory is vast. As Dunne and Raby point out, design could be as rich and diverse as mediums like film or literature with their broad ranges of purpose, expression, and genre [8]. In a short film called Design Q&A, designer Charles Eames was asked, "Does design imply the idea of products that are necessarily useful?" He replied, "Yes, even though the use might be very subtle." Following this question, he was asked, "Is it able to cooperate in the creation of works reserved solely for pleasure?" Eames responded, "Who would say that pleasure is not useful?" While the purpose of the critical exploration of this research may seem subtle or even insignificant, it has real implications to the future practice of interaction design and domestic products using robotic technologies.

Revisiting Thoreau, he stated, "I went to the woods because I wished to live deliberately, to front only the essential facts of life, and see if I could not learn what it had to teach, and not, when I came to die, discover that I had not lived" [37]. This research sought to front the essential facts of our interactions with domestic robotic technologies. This research enables interaction design to confront how we will live and interact with technology. It questions and expands our experience and complex relationships with robotic technologies in the home. As robot technologies continue to find a place in our homes, we need to question and explore how we want to live with them.

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