

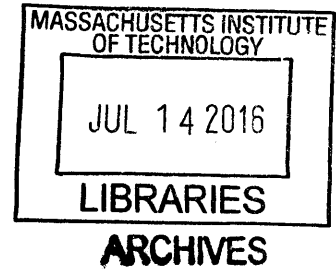
Digital Pregnancy Through Domestic Objects

Creation of debate around the topic of surrogacy
through creation of speculative domestic objects

Dan Chen

Submitted to the Program in
Media Arts and Sciences
School of Architecture and Planning

In partial fulfillment of the requirements for the degree of
Master of Science in Media Arts and Sciences
at the Massachusetts Institute of Technology
©2016 Massachusetts Institute of Technology.
All rights reserved.




Signature redacted

Signature of Author
Dan Chen
May 6, 2015


Signature redacted

Cerdfied by
Hiromi Ozaki
Professor of Media Arts and Sciences
Program in Media Arts and Sciences


Signature redacted

Accepted by
Pattie Maes
Academic Head
Program in Media Arts and Sciences

Digital Pregnancy Through Domestic Objects

Creation of debate around the topic of surrogacy through creation of speculative domestic objects

ABSTRACT

Pregnancy or career - that's a question many women face as they progress with their professional careers. In the high tech industry, driven female professionals often choose to pursue their careers in lieu of having children. For many of them, strategies of surrogacy or freezing eggs are popular options not only because of available technological advancements but also because of shifts in cultural perspective enabled by a new biotechnical regime. The dichotomy that forces an "either-or" divide between motherhood and careership can be seen as a modern form of regulatory control on women. The question of reproduction becomes a matter of our bio-techno-capitalist society as a confine of women's options, voices, and freedom.

Companies such as Facebook and Apple have recently offered to pay female employees to freeze their eggs so they can continue with their careers, without interrupting their dreams of having children. In addition, companies in India offer outsourced surrogacy services for U.S. couples who can afford to pay, services that are contingent upon the poverty class that needs additional income. The female employees who are now freezing their eggs in Silicon Valley may very well be choosing this surrogacy option fifteen years down the line. However, there still remains many ethical, social and political dilemmas which exist with surrogacy, questions that must be posed to the public. My thesis intends to inspire those discussions through critical speculative design. Women who choose to delay reproduction to stay in the American capitalistic workforce is an obvious economic advantage for the corporate machine, but are women - both the employees and surrogates - being unethically exploited in this capitalistic arrangement?

With careful form, motion, user experience studies, I will design a set of speculative services and products for women in the high-tech industry who choose to give birth to their children using surrogacy. This series of design objects will allow us to explore and discuss our internal and external struggles with the detached ownership of a child, gender and body politics, and the economic forces surrounding the surrogacy industry.

Thesis Supervisor

Hiromi Ozaki

Assistant Professor of Media Arts and Sciences

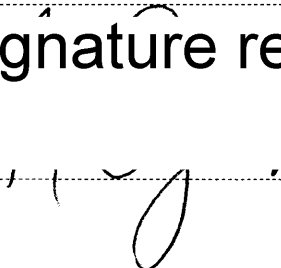
Digital Pregnancy Through Domestic Objects

Creation of debate around the topic of surrogacy
through creation of speculative domestic objects

Dan Chen

The following served as a reader for this thesis

Signature redacted



Hiromi Ozaki
Assistant Professor of Media Arts and Sciences
MIT Program in Media Arts and Sciences

DIGITAL PREGNANCY THROUGH DOMESTIC OBJECTS

Creation of debate around the topic of surrogacy
through creation of speculative domestic objects

Dan Chen

The following served as a reader for this thesis

Signature redacted

Kelly Dobson
Technical Program Lead
ATAP, Google

Digital Pregnancy Through Domestic Objects

Creation of debate around the topic of surrogacy
through creation of speculative domestic objects

Dan Chen

The following served as a reader for this thesis

Signature redacted

Pattie Maes

Professor of Media Arts and Sciences
MIT Program in Media Arts and Sciences

TABLE OF CONTENTS

Introduction	11
Approach	13
Speculative Design	14
Related Speculative Design Projects	15
Functional Products that are not Speculative Design	17
Background of Surrogacy	19
What is Surrogacy? The Current State of Surrogacy Ethics	19
Surrogacy in the US	20
Surrogacy in Europe	20
Surrogacy in India	21
Research and Interviews	23
Circle Surrogacy Agency: Largest Surrogacy Agency in the East Coast	23
Bonding with The Baby Through a Surrogate	25
User Experience Design	26
Goals for the Design - “Fictional but Functional”	26
Design Process	26
Final Design	37
Design for Demo and Trade off	39
Design to Spark Debate	39
Technical Experimentation and exploration	41
Wireless Communication	41
Baby Monitoring Sensors	41
Construction and Fabrication	43

User Testing and Insights	46
General Comments	48
Survey Results	49
Learnings from The User Testing	53
Future Work: Storytelling to Spark Debate	55
Conclusion and Future Work	56
Endnotes	57

Page 8: Photo of the finished sofa.

Page 9: Photo of the intended parent using the sofa to experience the baby's movement.

Page 10: Photo of the surrogate using the pillow to transmit baby's movement and heart beat.







INTRODUCTION

Assisted reproductive technologies include services such as surrogacy and egg freezing that help with delaying and/or outsourcing pregnancy. These technologies have shown potential to emancipate women of their biological burden, alleviating many women from the cultural pressure to have children in lieu of pursuing professional careers. Similar to outsourcing child care to kindergarten or baby sitters, the economic transaction often benefits all parties.

These services also provide the corporation the opportunity to retain gender equality in a working environment. The technologies allow female employees to stay at work longer, not having to take maternity leave, therefore boosting the productivity of the company. The surrogacy industry could provide those who can afford the services a chance to have a child and free up their time to pursue their passion or career. For the surrogate mothers, especially mothers living in developing countries, the transaction brings them a good source of income to feed their own family and have better standards of living.

However, there still remains many ethical, social and political dilemmas which exist with surrogacy, questions that must be posed to the public. Strategies of surrogacy or freezing eggs are popular options not only because of available technological advancements but also due to cultural shifts enabled by a new biotechnical regime. The dichotomy that forces an “either-or” divide between motherhood and careership can be seen as a modern form of regulatory control over women. The question of reproduction becomes a matter of our bio-techno-capitalist society as a confine of women’s options, voices, and freedom. Although biotechnology enables a privileged sect of women freedoms and choices through assisted reproductive technologies, it does so at the cost of reducing women’s bodies to biocommodities. Women who choose to delay reproduction to stay in the American capitalistic workforce -- this is an obvious economic advantage for the corporate machine. So, are women - both the career professionals and the surrogates - being unethically exploited in this capitalistic arrangement?

Surrogacy and assisted reproductive technologies have the potential to raise pertinent ethical issues around the topic of reproduction and the rights of “future children.” Mitsutoki Shigeta, a wealthy businessman, utilized the surrogacy industry as a “baby factory” to have 16 surrogate children³, raising questions surrounding the use of women’s bodies as an incubator for biological specimens, especially for those who can afford it. According to Shigeta, his motive was simply to have a large family and he had the means to support it. Is it ethical to deprive him from having as many children of his own? When does the ethical line get crossed?

Corporations and wealthy individuals might have the good intentions to help women reproduce while advancing their careers, however as a society we need to raise awareness around the ethics of outsourcing pregnancy as an economic transaction and weigh the benefits of such service.

As part of my thesis, I have engineered a such a device to encourage public discussion around these ethics. The device includes a sofa and a pillow that contain a set of wireless transceivers that transmit the baby’s heartbeat and movements to the biological parent from the surrogate, so that the intended parents can bond with the baby growing distantly inside the surrogate’s womb. Through the strategy of speculative design, this “fictional but functional” prototype aims to spark discussions about the relationship between the surrogate, biological parents and the female body in the techno-capitalist world.

APPROACH

I aimed to design the object to facilitate human connections and provoke stimulating discussions about surrogacy in the public sphere. I wanted the object to straddle the line between comfort and discomfort - it should be a seemingly inviting installation but also a disruptive visceral experience. I decided that the format of the family sofa would be a good choice for this object, because the sofa is often seen as a symbolic place for family gatherings and discussions, and it is a domestic object that is ubiquitous in many households, from the rich to the poor.

I conducted several interviews with surrogates and workers at Circle Surrogacy(<http://circlesurrogacy.com>), a surrogacy agency based in Boston, who gave me very good insights on the culture of surrogacy and the ethical issues surrounding the industry. I believe in continuing to conduct more interviews with people in the related fields would provide me with even better insights for user experience design and storytelling for this project.

According to Emily Sonier, the Clinical Director at Circle Surrogacy, “Relationship-based surrogacy is a way to help intended parents bond with the child and also form an open relationship with the surrogate and the child”. However, the relationship between the intended parents and the surrogate mother could be viewed in many ways - as a job, a surveillance, or simply a happy way to help people start a family. I would like my objects to evoke complex emotions so they can invite people to reflect on the many dimensions of this relationship. Through my design I would like to illustrate the sense of monitoring someone else’s body at all times, but in a very domestic, seemingly positive set-up.

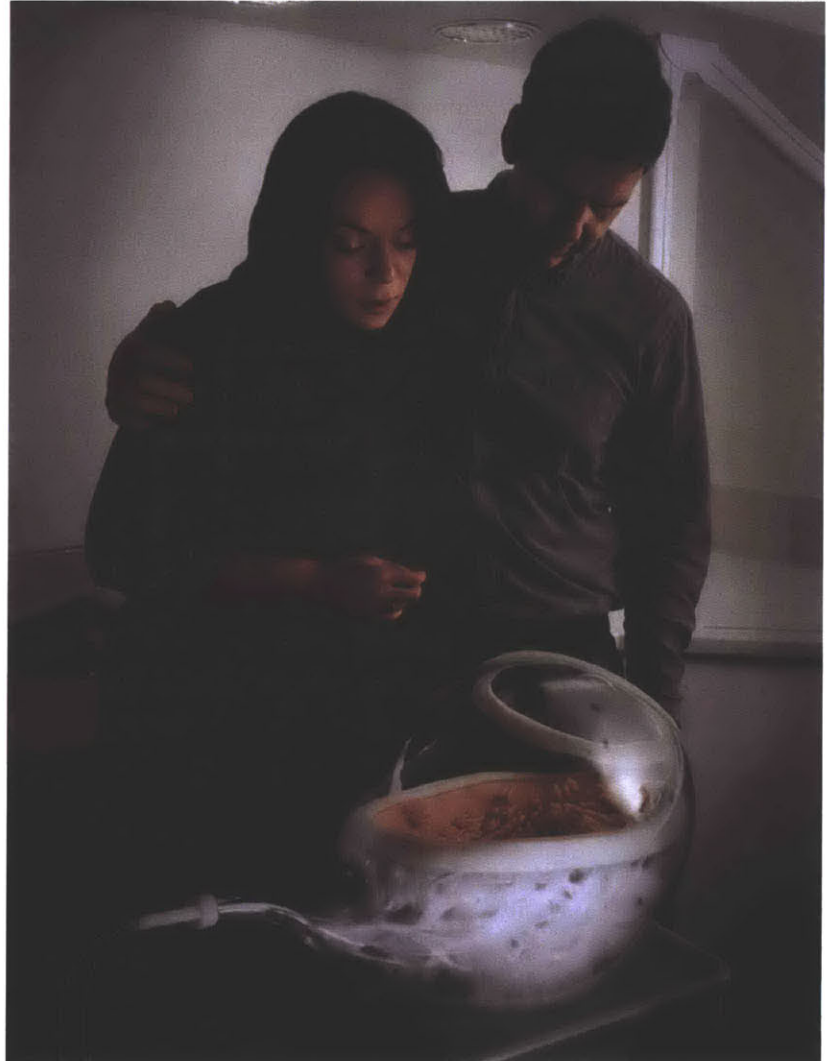
SPECULATIVE DESIGN

To raise issues around surrogacy I adopt the method of Speculative Design, popularized by designers Anthony Dunne and Fiona Raby. We don't use design methodologies merely to make consumable products, but to help people imagine possible alternative futures.

Speculative Design is important for “debating potential ethical, cultural, social, and political implications.”⁴ by creating fictions to reflect on the possible impact of emerging technologies. The sofa and pillow in my thesis project are functional devices that exist to question the way that we use technology to connect others or connect through others. It is used for social critique on the ecosystem of the surrogacy. As Dunne and Raby writes, “ It is not enough that it simply exists and can be used to experiment or entertain; we also want it to be useful, to have a sort of social usefulness, specifically, to question, critique, and challenge the way technologies enter our lives and the limitations they place on people through their narrow definition of what it means to be human” ⁵.

I created a work that tapped into parents' desire to have a child and bonding with them when using a surrogate. I created the “smart” sofa and pillow that could potentially be mass produced that served a social purpose for facilitating discussion. The discussion on how technology could remove the awkward barrier of having a surrogate to bond with their child to understand or reveal the implications on how the surrogates are made invisible. As Dunne and Raby said, “We need to question these ideas (and ideals) and explore their human consequences once applied on a mass scale to our daily lives. This is where design enters; we can take research happening in laboratories and fast- forward to explore possible applications driven by human desire rather than therapeutic need. By facilitating debate on the implications of advanced research in science, design can take on a practical, almost social purpose, and in doing so, play a role in the democratization of technological change by widening participation in debates about future technologies.”⁶

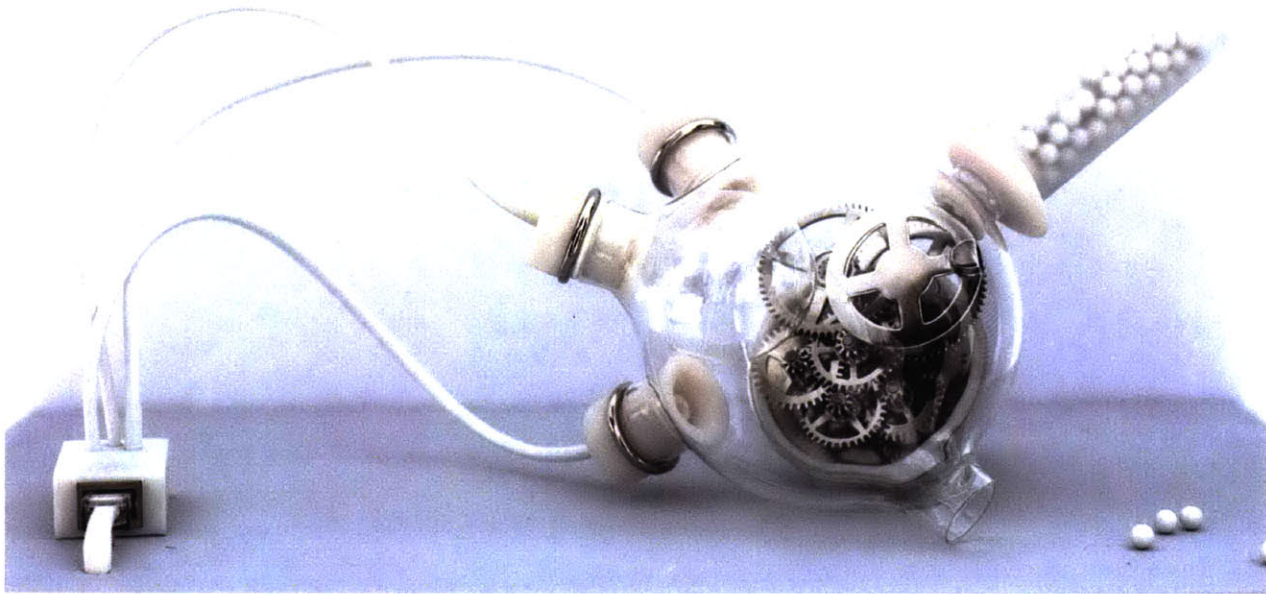
Related Speculative Design Projects



Survival Tissue. By Veronica Ranner. The parents visit their premature born child in the Survival Tissue section of the clinic.

Veronica Ranner's work *Survival Tissue*, "builds upon the potentiality of silken- based tissue engineering, taking it from the probable and preferable of *Organ Crafting*, into a possible, but unsettling and troubling realm of a future technological adaption."⁷ Similar to her work, but with the infant tactile communication technology, I am trying to create a fictional but functional object to reveal the troubling future of such technological adaption and gaining public acceptance of the artificial womb. I designed an object which seems uncanny and desirable at the same time.

Like her work, I aim to “put parenthood and the role of pregnancy into the sharp focus of public, medical and economical observation.”⁸



Revital Cohen, Artificial Biological Clock. 2008. Glass, resin, nickel-plated brass, electronics. 15 x 17 x 15 cm

In Revital Cohen’s work, *Artificial Biological Clock*, she created a device that compensates for the increasingly lost instinct for menstrual cycle due to “The use of artificial light and contraceptive hormones.”⁹ Such device could help women deal with the growing pressure to develop a career and at the same time remind them the temporary and fragile nature of fertility.

Functional Products that are not Speculative Design

Both Huggies' baby belt and BABYBE are existing functional devices that help the parent connect with the baby. Huggies' baby belt is designed for an advertisement to evoke father's emotion when they feel the baby kick. BABYBE is designed to give haptic information from the mother to the baby on real time, giving the mother an active role in the care of her preterm infant. Both objects are designed to serve and address a specific need, serve specific purposes but are not designed to spark public discussion. My approach is to use the domestic objects to inspire the possible future of mass adoption of such products, creating a sense of normalcy and to spark conversation around the surrogacy ecosystem. I am also aiming to design to investigate the comfort v.s. discomfort and uncanny v.s. Innate desire.



The mother using the BABYBE to transmit her sense of touch to the infant. <http://www.babybemedical.com/>



Huggies' baby belt.

<http://www.dailymail.co.uk/sciencetech/article-2340309/Fathers-feel-unborn-child-kicking-thanks-new-baby-belt-hooks-partner.html>

BACKGROUND OF SURROGACY

What is Surrogacy? The Current State of Surrogacy Ethics

Surrogacy is where a woman becomes pregnant with the intention of handing over the child to someone else (usually the biological parent) after giving birth. Generally, she carries the baby for a couple who cannot conceive a child themselves - they are known as “intended parents”.¹⁰ There are several ethical issues and benefits surrounding surrogacy. The regulations and the policies of the surrogacy industry are heavily influenced by economy, policy makers, and the intentions of the surrogacy agency, intended parents and surrogates. These regulations are constantly evolving worldwide as this thesis is being written¹¹ - reflecting how controversial the surrogacy practice is in this modern world. While surrogacy is one of the best ways to have your own biological child externally with the current technology, there are unfortunately some surrogacy agencies that see this as an opportunity for profits, abusing the system for their advantage.¹² Some organizations try to restrict surrogacy with regulation and policies, but the effort often creates a black market which allows surrogacy only for people who can afford it.¹³ Gianna Toboni, a reporter for VICE, traveled to India to report on the booming gestational-surrogacy industry. Toboni discovered many unethical practices in the surrogacy industry in India, such as a black market with babies on sale, doctors inserting more than two embryos into a surrogate mother, and a difference in pricing for babies with different race.¹⁴ Many surrogacy agencies in India see the technology as an opportunity for large profit, creating businesses around the surrogacy tourism. While many surrogates use this opportunity to earn the family extra money, people like Easwari, an Indian surrogate, lose their lives because the clinic was unprepared for complications. Some claim that surrogates in India are being benefited financially, but the agencies are often taking in a larger profit, attracting criticism that they are treating women as commodities.¹⁵ As mentioned earlier, Some corporations in Silicon Valley such as Apple and Facebook, are offering to pay for female workers' to freeze their eggs to increase the female work force.¹⁶ They argue that it is a tool for gender equality - but

why not change the corporate culture to encourage paternity leave or set up an environment that's easier for women to return to regular work after giving birth? These are the main biopolitical topics that need to enter the mainstream through culturally-digestible, speculative narratives.

Surrogacy in the US

In the United States, the surrogacy service generally costs around \$100,000, while in India it's around \$47,350. While it's cheaper to have babies in India or other developing countries such as Mexico (\$45,000), US has a reputation and a long history for safety with established frameworks in many states, particularly California.¹⁷ For this reason, the US has many intended parents coming from Europe.

The US represents a privileged country that is able to outsource its labor to developing countries where most of its population is below the poverty line. This project directly addresses the power and wealth dynamic of the capitalist consumerism that is prone to exploit the less-privileged for the benefit of the wealthy.

Surrogacy in Europe

Countries such as France, Germany, Italy, Spain, Portugal and Bulgaria prohibit all forms of surrogacy.¹⁸ For Circle Surrogacy Agency in Boston, Massachusetts, most of their client come from the Europe region, and about 50% of their client are same sex couple parent. Europe is represented as a Western power that is analogous to the US, and therefore parallels in the socioeconomic exploitation of the less privileged.

Surrogacy in India

The process of surrogacy in India is often quite simple - the intended parents drop off the embryo then pick up the baby on delivery day. The entire process could feel chaotic, due to the poor communication and dealing with the newborn in a foreign country. The intended parent, Steve said, "After having been there and seeing it, now you understand why everything's so curt and it feels cold," "They're so busy, and it's just so chaotic."¹⁹

The intended parents do not have time to bond with the baby when the baby is still in the womb. They often only get to see the surrogate in person around their delivery date.

Before the ban on surrogacy for non-Indian passport holders at the end of November 2015, India had its own surrogacy tourism culture, with hospital, fertility clinic and accommodation all in one campus. The industry generated some \$2.3 billion a year.²⁰

The surrogates would get around \$10,000 for carrying foreign babies and less money if they were carrying a child for an Indian couple, making the overseas clients to be more preferred. Some argue that India's recent announcement on banning surrogate services for foreign couples might create an even larger black market and also cause many surrogates to lose their jobs and income. ²¹ Aasima, a 26 year old surrogate said in an interview "What are we going to do if they stop this? It's better to do this than immoral things," she says, implying prostitution. "So I can eat my bread with dignity." ²²

For some surrogates it is a women's right issue, on how they should be able to decide how they use their body. Devi Parmar, a surrogate mother in India said, "What the government is doing is wrong. Are they going to come to our homes to ask us about our problems and feed us if we're starving?"²³ Who should be in control of their body, and should they be exploited for financial gain?

“In India, the intended parents are seen as the legal parents,” whereas under UK law, the surrogate mother is recognized as the legal mother.”²⁴ If the intended parent decided not to go through with the surrogacy, this baby could end up being the “extra” baby in the black market. In the documentary, *Outsourcing Embryos* by VICE, the correspondent Gianna Toboni was surprised by how easily they were able to find the “extra” baby.

A lot of surrogacy agencies in India exploits women with low income, taking advantage of their situation and advertising for a win-win situation for both sides. These “women are routinely recruited from slums, made to sign contracts they can’t read, before spending a year living in a facility. Once the baby is born — via cesarean section so that doctors can maximize births per day — the surrogate is sent home, often without the full compensation she was promised.”²⁵

RESEARCH AND INTERVIEWS

Before designing the interaction and user experience for the project, we conducted several interviews with the surrogates, intended parents and people who are experts within the surrogacy industry. We also researched the current surrogacy situation in India, government policies, and black markets for surrogates before and after the restriction was put in place.

Circle Surrogacy Agency: Largest Surrogacy Agency in the East Coast

We interviewed several staff members at Circle Surrogacy Agency, which is the largest Surrogacy Agency in North America region. The agency is based in downtown Boston, with clients around the world. Many of their clients come from countries such as France, Finland, Hungary, Iceland, Italy, and Pakistan²⁶, where surrogacy is illegal.

According to my interview with Brian Manning, Circle Surrogacy's Director of Marketing, the agency is "a relationship-based surrogacy agency". This means that they mandate regular checks between the intended parent and the surrogate. About half of their clients are same-sex couples, and most of them are from Europe due to the government's tight regulation on surrogacy.

According to Emily Sonier, the Clinical Director of Circle Surrogacy, there are certain requirements for both the surrogate and intended parents that need to be met before they can be in the matching pool. On the surrogate side, they need to be healthy and have already experienced the process of having a child. They also need to understand the biological risks and are willing to share the pregnancy experience with the intended parents. On the intended parents side, they must interact with the surrogate at least once a week and go through all the screening. There are other surrogacy agencies that do not require communication between the intended parent and the surrogate, however according to John Weltman, the President and Founder of Circle Surrogacy, it is important to build a healthy and open relationship between the child, intended parents and the surrogate. Even

after the birth of the child, they encourage the honest relationship between the parents, the surrogate and the child.

People often wonder the motivation behind becoming a surrogate. According to Amanda Baker, the Surrogate Outreach Coordinator of Circle Surrogacy, who is a surrogate mother herself, she mentioned that the financial gains are often not the driver for the decision. According to her, the main driver is often the ability to help others to form a complete family - allowing others to experience life fully with a child of their own is extremely gratifying for surrogate mothers.

There is a good reason for agencies such as Circle Surrogacy to have screening, matching and interview process for their program, because they want to maintain certain ethical standards. Emily Sonier, Clinical Director of Circle Surrogacy, said that “pregnancy carries a certain risk for the surrogate”, the surrogate could lose their lives from complications, which is why they carefully select their clients to avoid unwanted risks. The intended parents must have some form of biological issue that makes them unable to have a child - such as sexuality, having biological defects or aging. For instance, a supermodel, with the capability to have a child but does not want to have to go through the body transformation of having a child would not be approved by Circle Surrogacy’s program. When asked about the Facebook and Apple’s new benefit program, where the employees can freeze their eggs for later use in reproduction, she said it is a suitable case for their program. Sonier says “aging could cause higher risk in pregnancy or the ability to get pregnant, therefore we are not putting the surrogate at a unwanted risk.”

BONDING WITH THE BABY THROUGH A SURROGATE

In my interview with staff at Circle Surrogacy, I noticed how strongly they recommend that the intended parents bond with the child while it is growing inside the surrogate. According to the staff, many people would find the interaction awkward at first, interacting with a child with a surrogacy that was assigned to you. The agency encourages both the intended parent and the surrogate to establish a relationship by a regular check in to mitigate this awkwardness. All the surrogates at Circle have been through the motherhood experience and they understand to give the intended parents the time and the space to see and watch the baby grow. According to Emily Sonier, bonding with the child at that early stage is critical to the baby and intended parent. Sonier says: “They need to form relationship at early stage. We don’t want the intended parent to simply pick up the baby after it is out of the womb.”

I learned from the interviews that building a strong relationship between the surrogate, intended parents and the child is crucial to building a successful relationship in surrogacy.

I realized that my “fictional but functional” project could function as a working product to enhance this relationship that these surrogacy agencies are seeking - but also work as a controversial narrative to stimulate discussions about possible uncanny futures where this device becomes an everyday product.

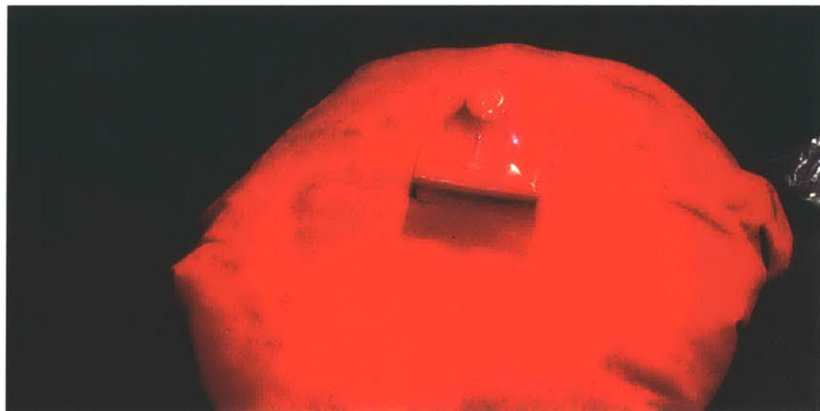
USER EXPERIENCE DESIGN

Goals for the Design - “Fictional but Functional”

An interesting aspect of this project is that it could be both speculative and functional. Even though the product is (still) fictional, the technologies are available today to make it a real, widely-available product at any moment. However, my main goal is to propose a product to inspire imagination about possible futures of surrogacy and the new cultures of reproduction, and it is NOT to invent a new product for the market. However, I wanted to also make it fully functional because the fact that this product could be realized any day makes the issue more pressing for people to think about. This is different from the time-range of many speculative design projects which are usually much longer, but I believe such “Fictional but Functional” designs are important because there are so many complex issues and ethical dilemmas arising from technological developments happening today.

Design Process

The earlier version of the sofa and pillow were not designed to match as a set. I was designing the pillow based on the shape of a pregnant woman’s belly. However the design lost the quality of a domestic object and did not have the design elements from the sofa. The newer design echoes the shape and detailing of the sofa.

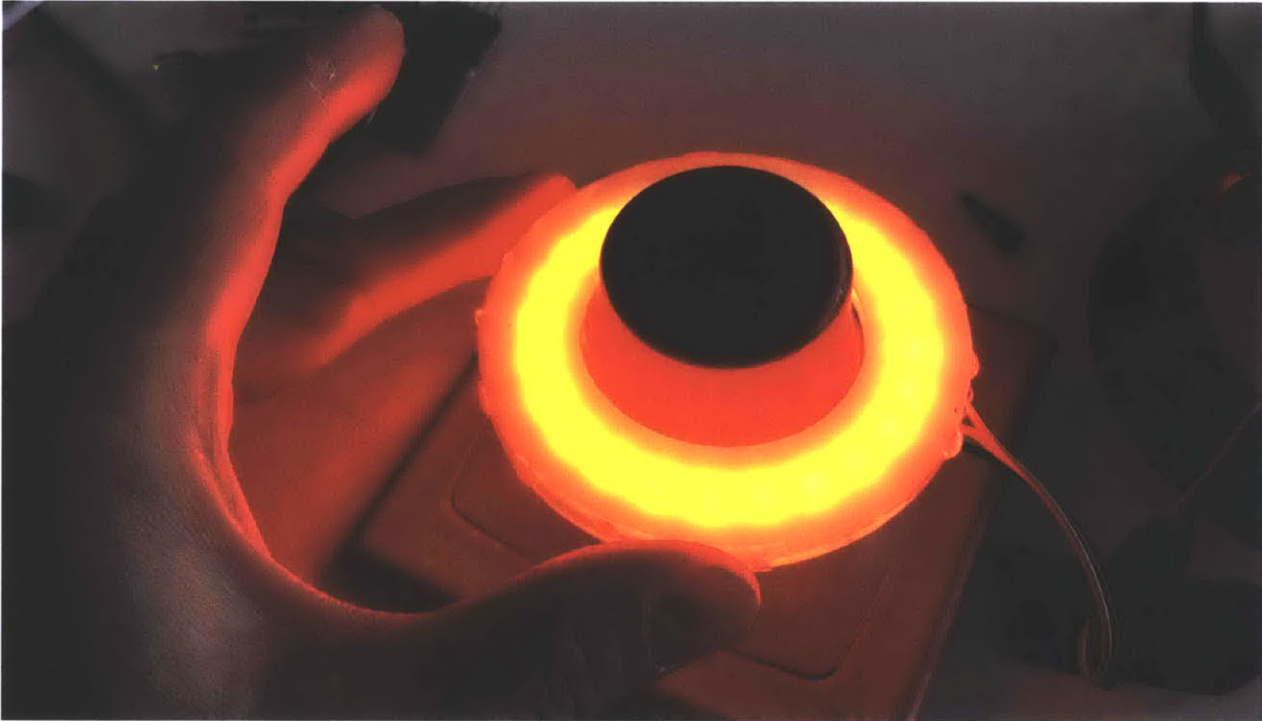


The initial prototype of the pillow.

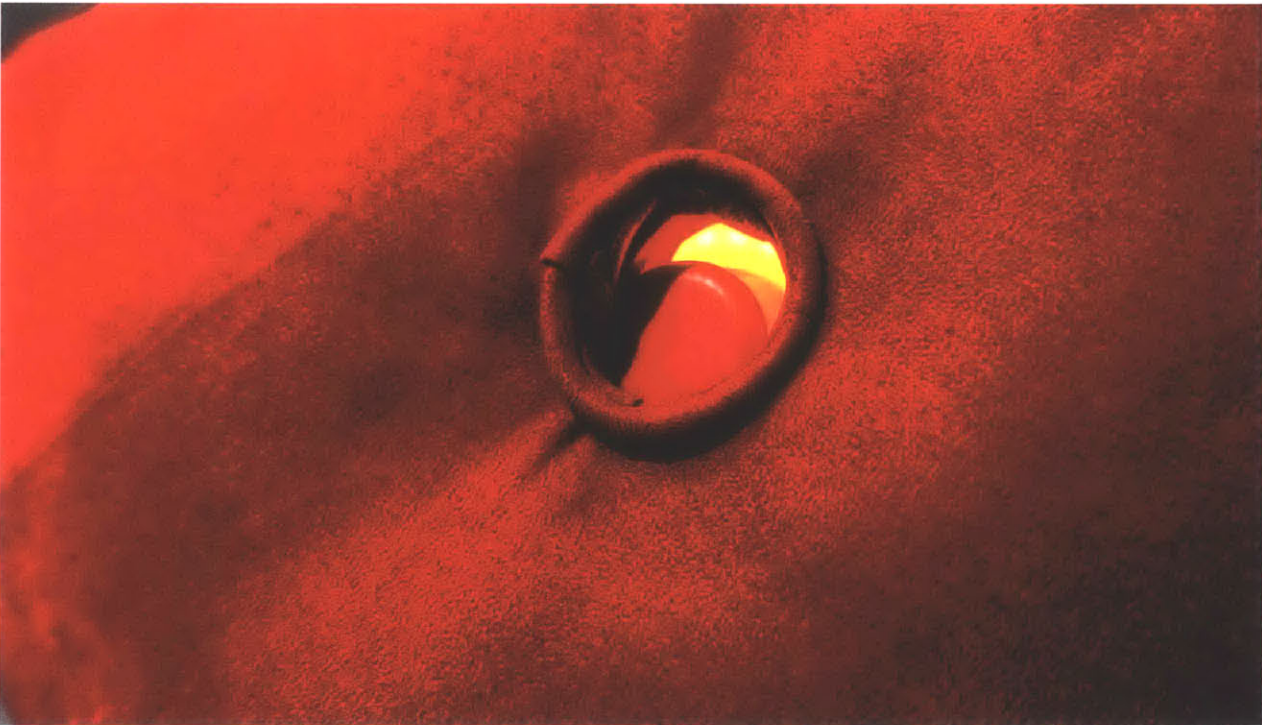


The latest version of the pillow. Designed to match the sofa as a set.

The older version of the pillow also lacked cues for the surrogate - there were no indicators for the surrogate to pick up the pillow and start using the device. To solve this, I added the glowing red lights as an indicator. This is to inform the surrogate that the intended parents are requesting the baby's movement and heart beat. This request is triggered when the intended parent sits on the sofa.

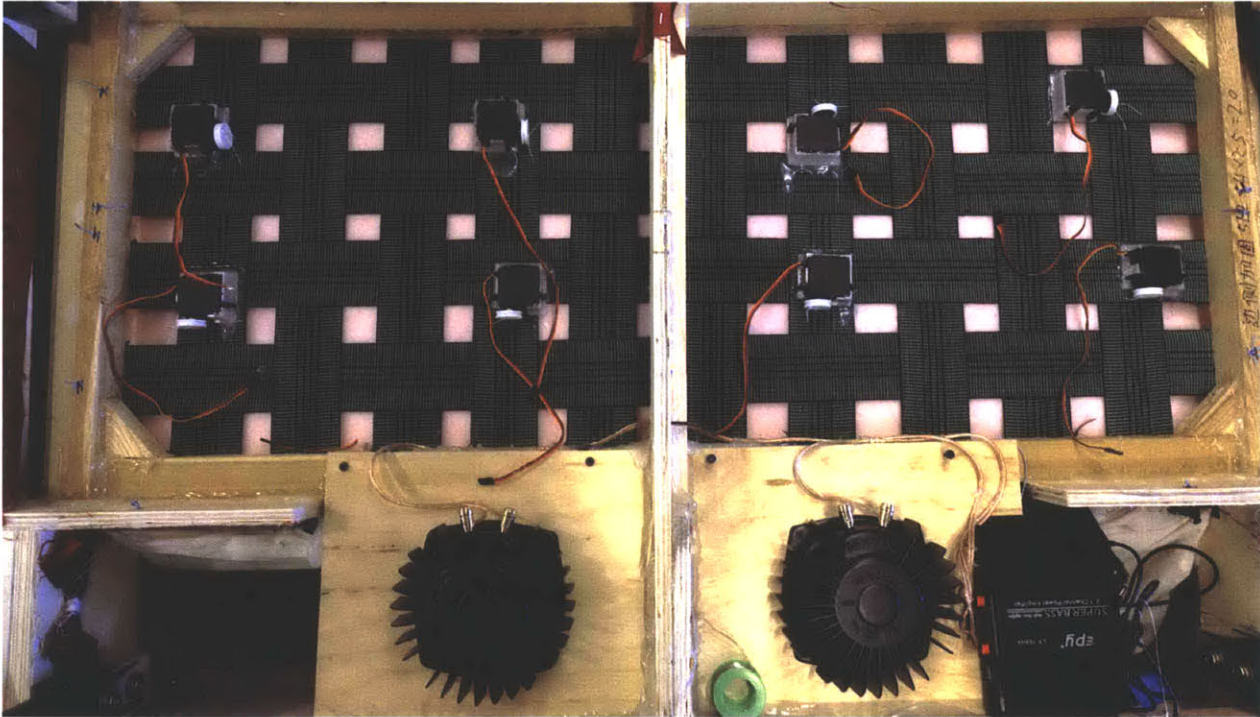


Glowing red LED ring as indicator

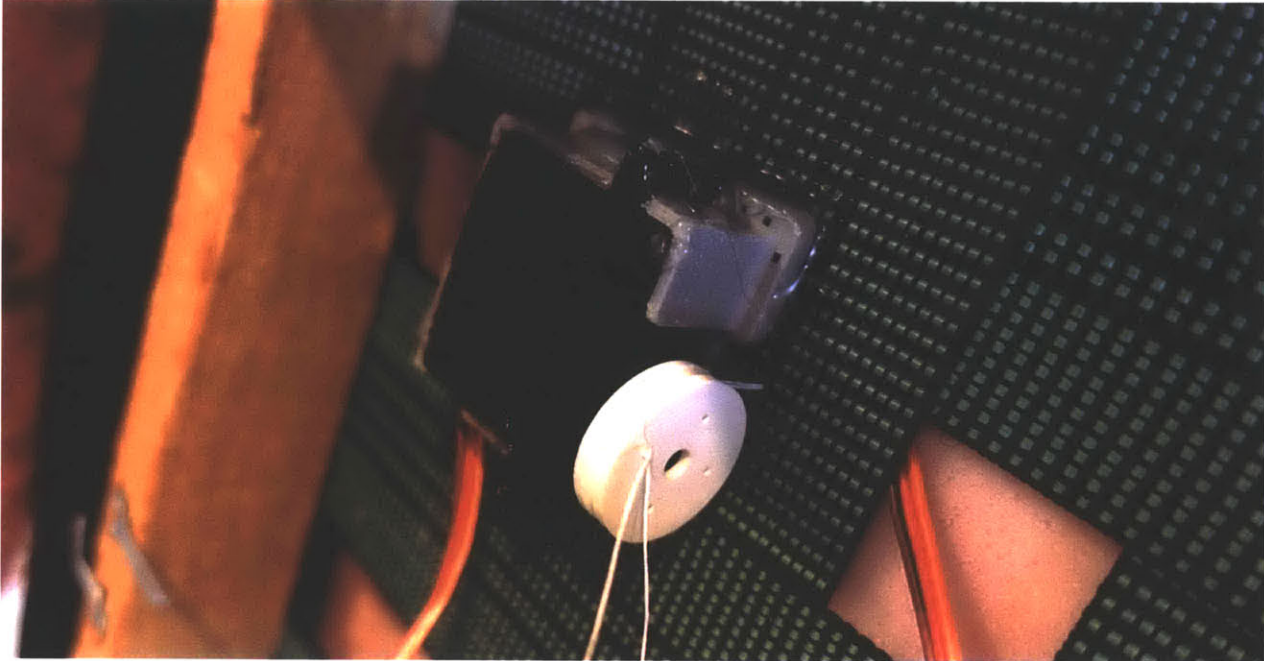


The red ring embedded in the sofa.

For the first version of the sofa, it only relied on the vibration as the main source of the feedback. It was lacking the sense of uncanniness, aliveness and cues for inviting the users to sit down and experience. I added eight sets of servo pulley mechanisms and FSR sensors to create a more animated appearance.



This is the bottom of the sofa. I used two transducers and one amplifier to generate the vibrations.



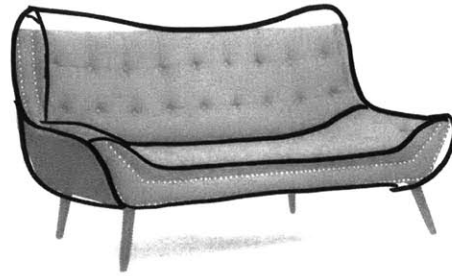
Custom servo holder and pulley were installed under the sofa to pull and release the buttons from the surface of the sofa from the other side.

Before we designed the shape of the sofa, I wanted to make sure that the pillow and the sofa sculpturally matched together like a set. This is so that when the pillow is away from the sofa, the user could automatically associate it with the baby that is growing away from the family, communicating the sense that the biological family is not entirely whole. I took several design cues from the sofa and translated them into the pillow, things such as the piping around the edges, rounded corners, textures and the color, and most importantly the sense of comfort and discomfort from the alteration of the domestic object.

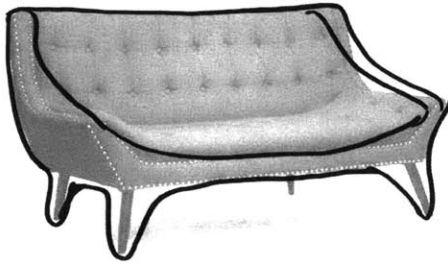
①



②



③

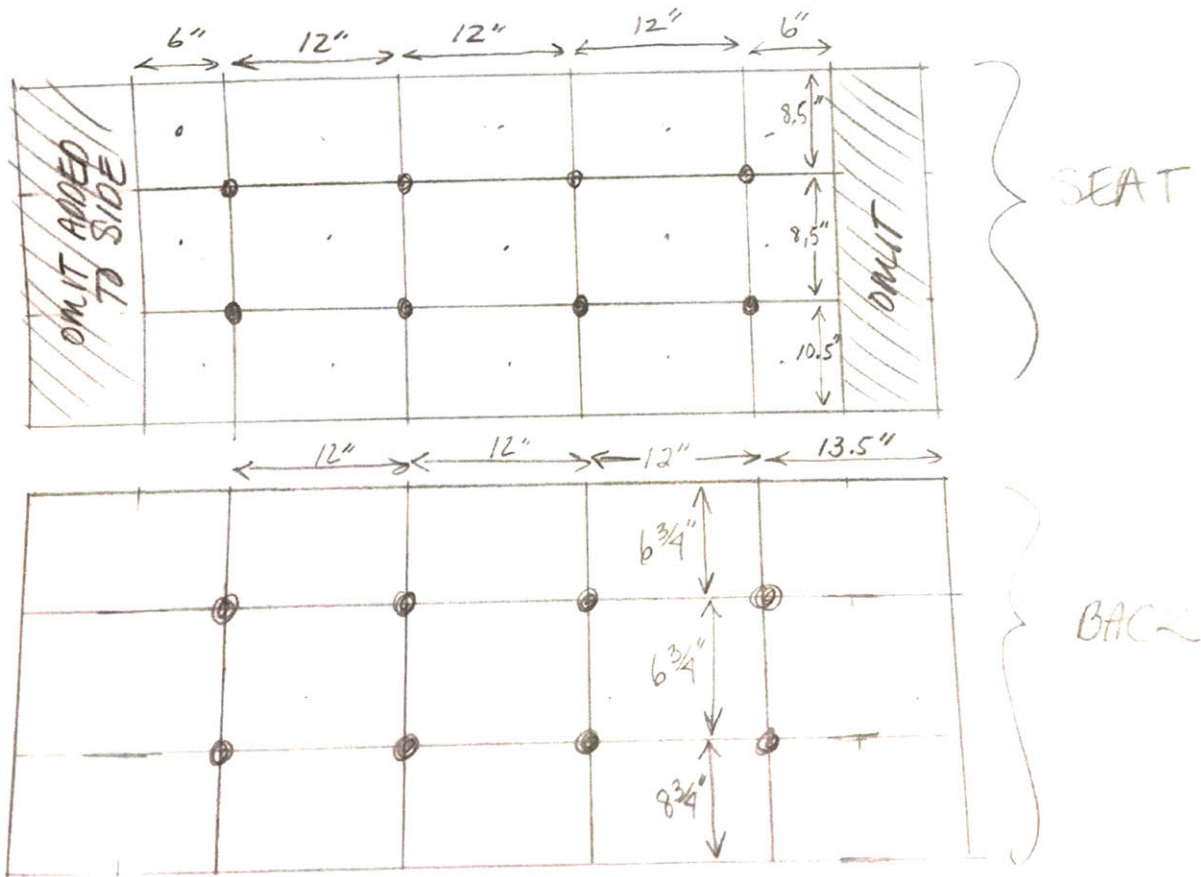


④



Design exploration of the shape of sofa

The original placement of the sofa and the pillow was apart from each other in a separate space to convey the distance between the baby and the intended parents. This is probably how the product would be used in a functional setting, but in an art installation setting, having the pillow in a different space made it difficult to conduct the viewers' conversation. By placing both the pillow and the sofa in the same room created a natural tension and a stage for conversation.



Sketch of the new button location that were used for moving the surface of the sofa.

I had a general idea of what a sofa would look like to represent the womb. I purchased a readymade sofa that I could best modify based on it's original shape. I made the armrest lower with smooth and rounded edges to create a more inviting form, rather than a higher armrest. I also simplified the seams where every piece of fabric meets to create a slicker look.



Comparing and selecting fabric sample from real leather, synthetic leather to synthetic fur.

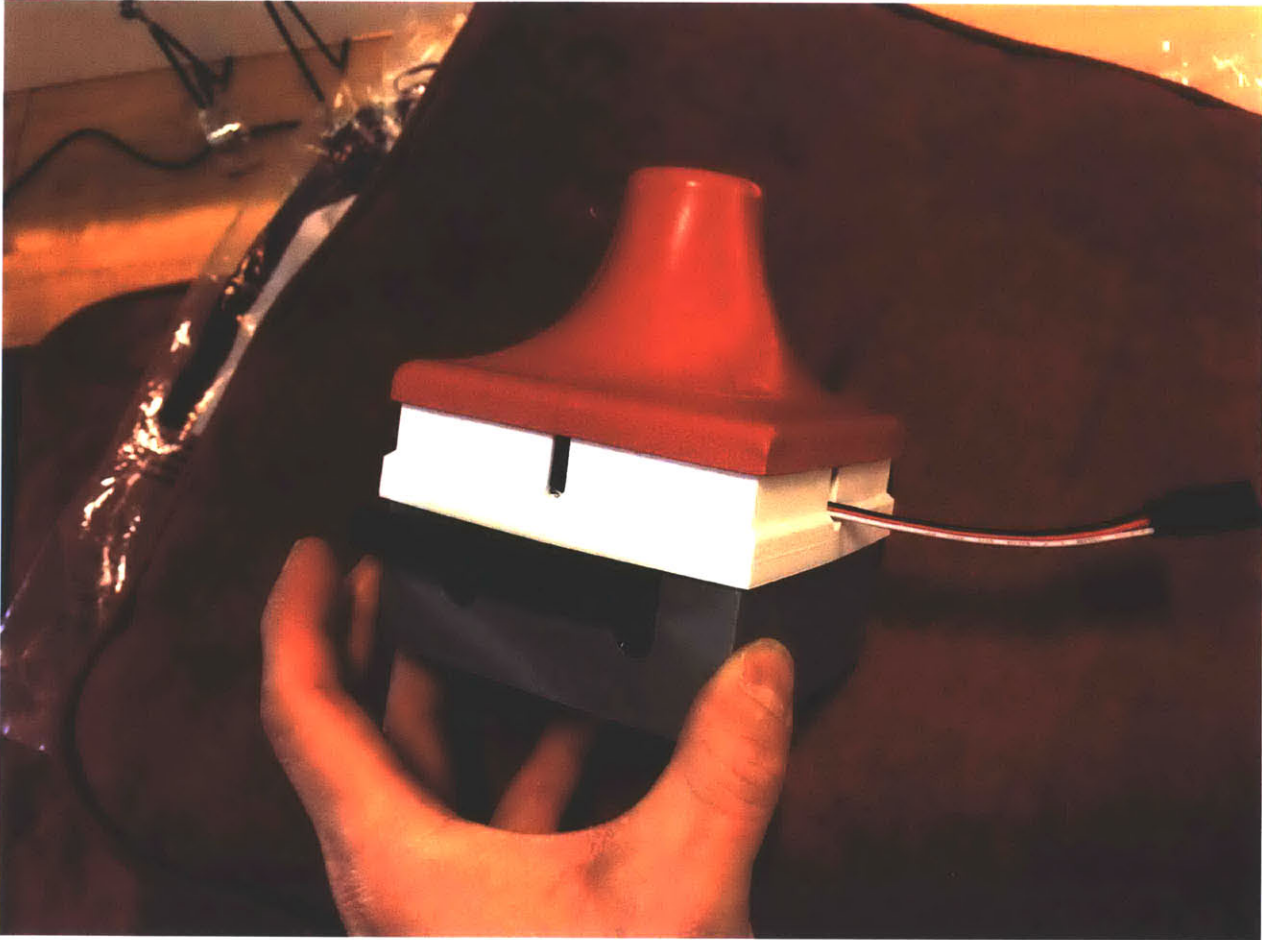
For the exterior of the sofa, I picked from a selection of fabric from fur to real leather. I ended up deciding to go with the fake leather due to its uncanniness and comfort. The red artificial leather creates this warm and biological feel to it, similar to a womb.

The most important part of the pillow is the sensor. Due to the shape of the sensor the tip has to be somewhat flat and that was the only mechanical design requirement in designing the pillow. I made the structure of the sensor shape like breasts to give it a feminine quality to the shape, to echo the connection with the intend mother. The opening of the pillow where the

sensor sticks out was designed to resemble a belly button. This is where the sensor tip would stick out, where the hard plastic meets the fabric. This design consideration was to indicate where the sensor would go on the surrogate mother, which is her belly button.



The pillow surface is designed in a way that allows the sensor to expose on the outside.



This is the sensor package with the antenna coming off from the side. The cable on the right links to the FSR sensor.



The housing contains battery pack, RF transceiver, amplifier and a microcontroller.

Final Design

The final installation consists of two sofas and one pillow. The sofas were arranged across each other to represent the tension between the surrogate and the intended parents, this is also to facilitate the discussion around the topic of surrogacy. The pillow is on the gray sofa to represent the separation between the intended parents and the baby.

When the installation is inactive, the surface of the sofa will slowly contract and expand as an indicator that the sofa is in standby mode. When the user sits down on the sofa, the movement of the sofa stops. Meanwhile, the request for baby's heartbeat and movement is sent to the surrogate. The red glowing light on the pillow indicates the pending request from the intended parents. When the surrogate picks up the pillow and points the sensor towards her belly area, the red light stops, and the device starts to transmit baby's heartbeat and movement to the sofa. Based on the sensor data from the pillow, the sofa would translate the signal to vibration and movement through eight servos and two transducers.

There are two main reasons for choosing the sofa as the domestic object. Sofa symbolizes the central place for family gathering. Also, I designed the product to look like a banal, readymade sofa to reveal how we as a society purchase products to solve our needs without often considering its implication.

I wanted to make the device inviting but at the same time somewhat uncanny to create the edge of comfort and discomfort to spark the debate around the topic of surrogacy. I used a combination of movements, textures, lights, forms, colors, sound and vibration to achieve this. The subtle movement of the sofa surface was designed to create an uncanny and off-putting experience, while the movement also conveys a sense of welcoming.

To replicate the sensation of the baby's existence in the womb, I chose vibration to best emulate the visceral experience. The vibration pattern is based on the baby's heartbeat, to create a sensation of bonding between the baby and the intended parents. The combination of sudden vibration with the quick pull back of the servo mechanism creates a similar sensation to the baby's kicking movement in the womb. In some aspect the sofa fails to capture the true experience - it does not have the high fidelity

sensors to capture every single movement of the child very precisely - but the main goal of this object is to illustrate a narrative to inspire debate, not to build a precisely operating functional product.

The glowing red indicator light on the pillow creates a sense of urgency, similar to many digital devices that we use today, which require our constant attention. I designed this interaction to reveal the power dynamic between the client and the employee. The privacy issue is raised through the constant tracking of the baby's movement and heart beat.

One of the advantage of using a pillow as the interface is that people have the natural tendency to squeeze and hug the pillow. The interaction would be both intuitive and seemly natural.



Two sofas arranged right across each other.

Design for Demo and Trade off

I conducted a test user study for my project. Not all of my test study users are pregnant or seeking for surrogates. The user study demo will be designed to spark the debate, therefore both the interaction and the narrative need to be accessible for general audience. The goal is to make the audience aware of the the ecosystem of surrogacy and help them think about possible futures of surrogacy and reproduction.

I created two modes of interaction, the demo mode and the functional mode. The demo mode would allow the general audience to squeeze the pillow and send prerecorded baby heartbeat back to the sofa. While in the “functional” mode, it allows the surrogate to send the real baby’s heartbeat via a set of transceiver, which requires skin-to-sensor contact. This “Fictional but Functional” design - a design for storytelling but also a completely functional product.

Design to Spark Debate

In order to spark debate around surrogacy, as the designer I need to present different aspects of surrogacy without revealing a strong opinion towards one view. To do so, I designed the experience in a way that conveys both comfort and discomfort. The domestic object is a entry point to access the work as an everyday object. The subtlety of the form, movements and sound are elements that makes a seemingly normal object seemed slightly out of the place to create an unfamiliarity and uncomfortable sensation.

On the intended mother side, we are trying to express the idea of long distance communication, communication through a third person, communicating without language, bounding experience with the baby through a digital device and the limitation of such digital device. I also want to reveal the awkwardness of such interaction, on power dynamics with the surrogate, the cost of the pleasurable experience with the sofa, the complex relationship with the baby and the ownership of the baby between the surrogate and the intended parents. In the installation, where I had the intended parent sitting across the surrogate on a regular sofa, creates a strong tension that sparks that complex relationship.

On the surrogate mother side, we are trying to convey the magical nature of having a baby, conflicting feelings of baby's ownership, and surveillance. Both party will experience the comfort and discomfort from the complicated pleasure from sofa and the pillow. The shape, lighting, movement and materials will inform the viewer the complicated nature of surrogacy process.

The domestic object also speaks to the complicated dynamics with consumerism, where it provides the convenience, goods and services to the mass but we often consume without examining how things are been produced or thinking about the people who are buying them. It also speaks to the culture of solving issues with capitalism, where we exchange goods and services for convenience. However in the case of surrogacy, we are dealing with living human beings, and people's desire to have families, like any other services, some people abuse it but some genuinely needs it.

TECHNICAL EXPERIMENTATION AND EXPLORATION

Wireless Communication

This project requires wireless communication between the two device. Both audio data and analog data need to be transmitted. I purchased off-the-shelf BLE Bluetooth 4.0 Uart Transceiver Module CC2541 and RF audio transceiver for the communication. This allows for the audio from either the pre-recorded baby heart beat or the real baby heartbeat to be transmitted through the transceiver. The FSR data from the sofa are also transmitted on a different channel via the CC2541 using serial communication.

Baby Monitoring Sensors

I purchased four different off-the-shelf sound sensors and baby monitors to test their performance and to test how the signals are been amplified with the sofa and how they vibrate the sofa.



Inside of the Womb Music Heartbeat Baby Monitor. There are two half moon shape piezoelectric the serves as the main sensor.



This is the sensor side Womb Music Heartbeat Baby Monitor.

I purchased Womb Music Heartbeat Baby Monitor by Wusic, Summer Infant Heart to Heart Prenatal Listening System by Summer Infant and piezo acoustic guitar pickup. While all devices worked to some degree, Womb Music Heartbeat Baby Monitor by Wusic has the best sound in terms of the clarity, noise level, and the amplification. It uses two piezo right next to each other to detect the baby's heart beat.

Once I figured out which sensor has the best properties for my project, I was able to start disassembling the sensors from it's original case and install it in my custom design case. I designed the new sensor case that would fit inside the pillow with the sensor sticking out of it. The footprint of the piezo sensors determines the opening of the pillow where the sensor sticks out and it also determines the size of the box that holds the sensor. There are several functions that the electronic housing in the pillow serves; to expose the sensor from within, to enclose all electronics including the battery, housing for the lighting circuit around the sensor area.

Construction and Fabrication

It was expensive to create a custom sofa from scratch. We balanced the design, time and budget by purchasing a pre existing sofa as a base of our design. I worked with Catherine Andreozzi, who is the Associate Professor of apparel department at RISD for the fabrication of the sofa.



We used sponge to add extra padding to prototype the shape of the sofa.

I want the sofa to be inviting so I designed it to have rounded edges to give it a womb-like feel. I also designed the armrests lower than normal to have this inviting and welcoming feel to it.



I took the entire sofa cover off and reshaped it using a large piece of sponge.

We then disassembled all fabrics from the sofa to examine and study how the sofa was put together. The large sheet of sponge was used to prototype the space of the sofa before we decided the pattern of the fabric to use. I also used the existing pattern of the sofa to extend and reshape the sofa to the desired space based on our sketch.

Catherine created new patterns based on my design to drape over the modified shape. It took us a lot of time to staple and stretch the cloth to perfectly fit the entire sofa. I learned a lot about upholstery, and most of it is about how to hide the extra material well.

I rearranged the location of buttons for the sofa, trying to use them to create movements on the surface by pulling them down via strings with servos. Each button is connected via strings through the sponge in the sofa and comes down under the other side of the sofa. The pulling and releasing of the buttons create this uncanny and interesting dynamic movements of the sofa, which resemble the pregnant woman's belly.

The buttons and strings are usually anchored to the base structure of the sofa, it was a delightful and accidental discovery that we could use them to add to the interaction of the sofa.

Eight servos were used together to form wave like pattern on the sofa surface. In order to secure them to the sofa, I made eight custom 3D printed tracks and bases to hold and pull the string from the buttons.

I installed two large transducers at the base of the sofa and secure them with screws and hot glue to better distribute the vibration without breaking the sofa apart once it's in operation. The audio receiver and amplifier system were installed under the sofa as well. The sofa is also equipped with a FSR sensor to sense if a person is sitting on the sofa. Power supply and micro controller were installed and hidden below the sofa as well. The installation transforms the sofa into a moving, breathing and "smart" sensing sofa. However the sofa still appears to be a normal sofa, until you look closely. Since the sofa is going to be vibrating a lot, I reinforced the sofa with extra adhesive where the joins meet.

USER TESTING AND INSIGHTS

I invited thirty seven user testers to try out the sofa-and-pillow installation, out of thirty seven users there were twenty participants who completed the survey. I limited the participants to one to three people at a time to try the devices and get their feedbacks. At the end of the experiment, they were asked to rank their experience and provide feedbacks for the survey. I was able to gather ten female participants and ten male participants. The age ranged from forty to twenty and the average age is twenty five. The installation was set up in a way that divides the surrogate and the intended parents, sitting across from each other.



Photo taken from the user study session. This gray sofa represent the surrogate side,



Photo taken from the user study session. This represents the intended mother side.

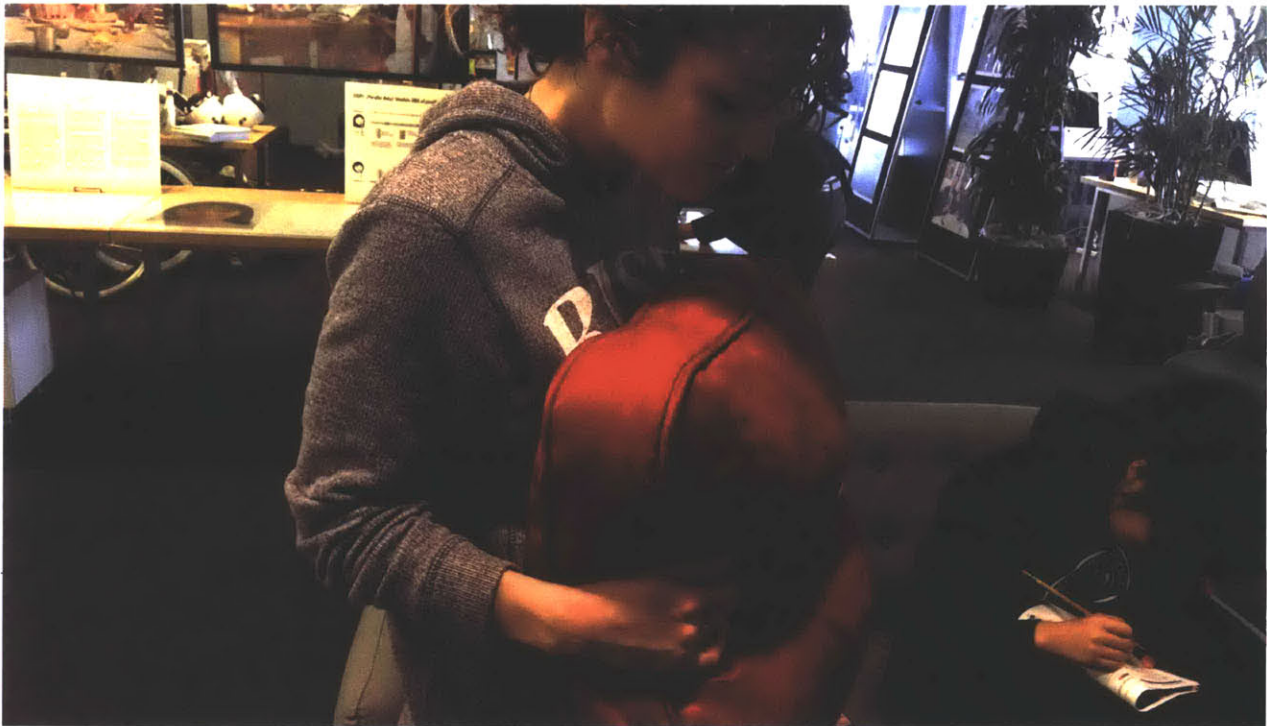


Photo of one of the user testing the pillow.



Photo from user testing session and discussion.

General Comments

The comments reveal different controversial topics surrounding surrogacy. For example, one of the anonymous user wrote “I felt sad when the heartbeat stopped”, suggest the fragility of the digital connection. Another anonymous user wrote “The privacy issue is dreadful by invading surrogate’s womb”, suggesting they are thinking about the awkwardness of having to invade someone’s personal space.

Survey Results

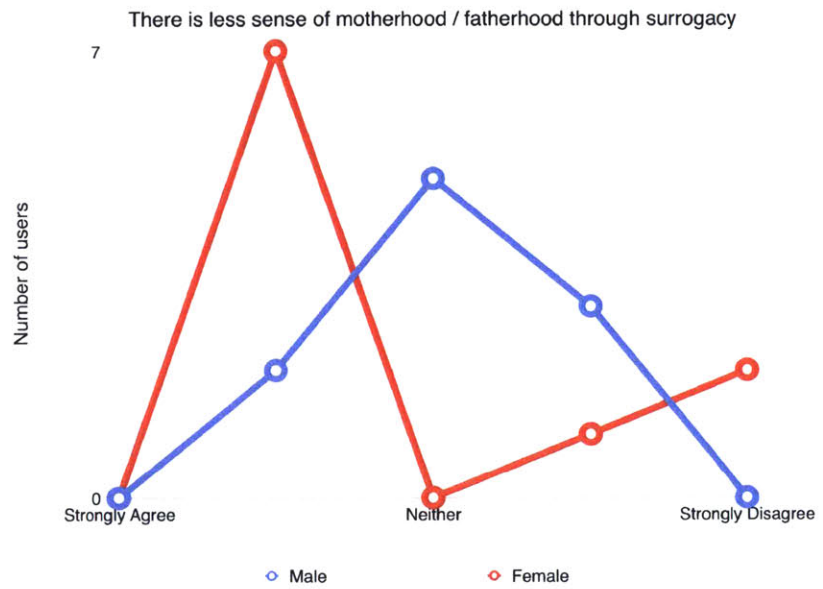


Figure 1

Figure 1 shows the topic is controversial for female users as the chart is bimodal. None of the responders say neither. But the male responders center around “neither”, meaning that surrogacy is not much of a controversial topic for a lot of them.

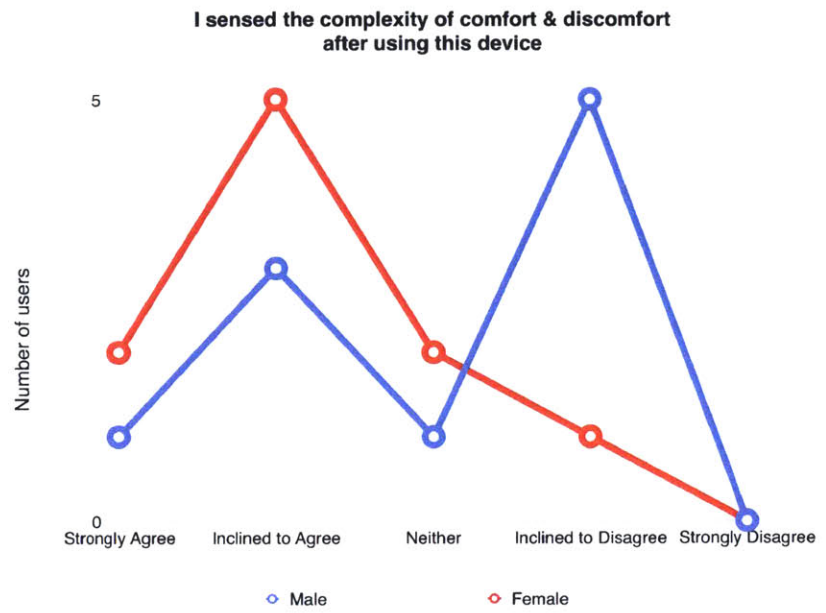


Figure 2

Figure 2 indicates the female participant consistently showing that they have the complicated feelings after using the device while it is less controversial among men.

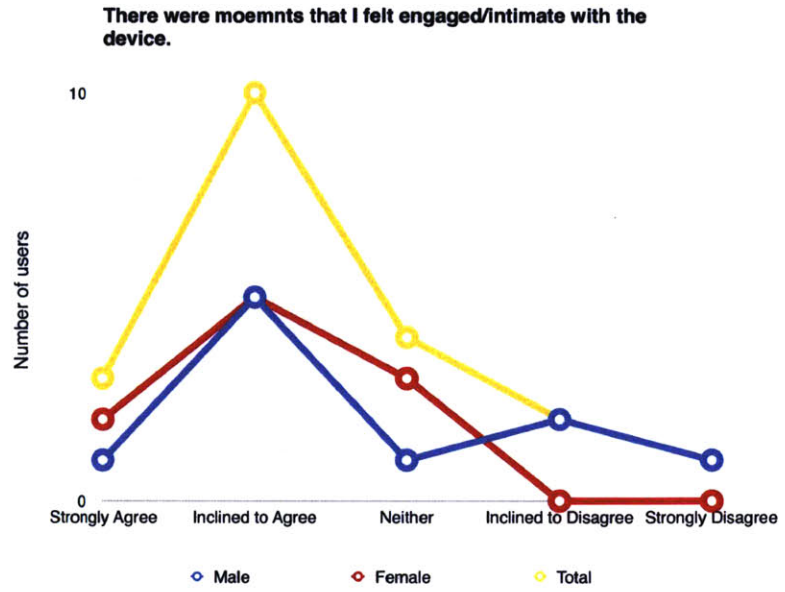


Figure 3

Figure 3 shows the bimodal chart shows while the majority of people agree that they form some sense of connection with the baby but some did not.

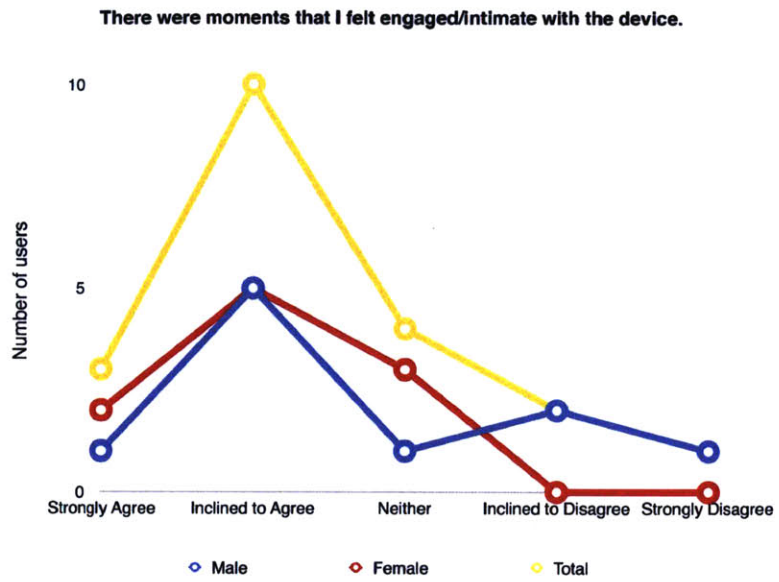


Figure 4

Figure 4 indicates that for most people, there is a moment of engagement. This could mean that the device is performing its job, whether or not the sofa and the pillow is effective.

Learnings from The User Testing

One thing that I would change after the second round of the experiment is to add more privacy for the pillow and sofa testers, either isolate them or have them in different room. The experiment was setup so that the surrogate and the intended parents sits across each other. This arrangement was me trying to spark the discussion about this complex human dynamic.

However, a few people expressed that they would probably enjoy the experience more by themselves instead of having lots of people watching. This way the experience is also more intimate and more true to the experience.

The majority of the conversations and the comments were around the intimacy between the parent and child, the effects of the heart beat on their emotion and the fear of invading some one's privacy. While it does not directly reveal the issue of surrogacy with Silicon Valley and exploitation of surrogacy in India, it does however facilitate the conversation, inviting users to imagine what the relationship of surrogacy could be like.

Before Use

Gender
 Female Male prefer not to answer

There is less sense of motherhood / fatherhood through surrogacy
 Strongly Agree Inclined to Agree Neither
 Inclined to Disagree Strongly Disagree

If the parent have no biological issue to carry a child, then the surrogacy is unethical.
 Strongly Agree Inclined to Agree Neither
 Inclined to Disagree Strongly Disagree

I want to be a parent some day
 Very likely Fairly likely Slightly likely Not at all likely I am already one

If you & your partner can't have a baby biologically, how likely would you consider surrogacy?
 Very likely Quite likely Fairly likely Slightly likely Not at all likely

I might have a hard time bonding with the baby when using a surrogate.
 Strongly Agree Inclined to Agree Neither
 Inclined to Disagree Strongly Disagree

I would use a surrogate to delay pregnancy to further my (or your partner's) career
 Very likely Quite likely Fairly likely Slightly likely Not at all likely

After Use

I sensed the complexity of comfort and discomfort after using this device
 Strongly Agree Inclined to Agree Neither
 Inclined to Disagree Strongly Disagree

I like being comforted by the Sofa and feel sense of connection with the "baby"
 Strongly Agree Inclined to Agree Neither
 Inclined to Disagree Strongly Disagree

Are you happy with the device?
 Very dissatisfied Moderately dissatisfied Slightly dissatisfied Neutral
 Slightly satisfied Moderately satisfied Very satisfied

The device is "serves" its function in bonding with the baby
 Strongly Agree Inclined to Agree Neither
 Inclined to Disagree Strongly Disagree

There were moments that I felt engaged/intimate with the device.
 Strongly Agree Inclined to Agree Neither
 Inclined to Disagree Strongly Disagree

This device questions the quality of intimacy with digital connection.
 Strongly Agree Inclined to Agree Neither
 Inclined to Disagree Strongly Disagree

I might be invading surrogate's privacy with this device
 Strongly Agree Inclined to Agree Neither
 Inclined to Disagree Strongly Disagree

Comments and suggestions (Optional):
 The "heartbeat" of the device was not too strong like a heartbeat. A glow would be nice. It made me feel which worked than computer.
 There was no real sense of connection as heartbeat seemed to be mechanical. Even if it was not, there is the chance of connection with the surrogate. I would like to see if it is possible to have a more natural connection.
 The device was not too loud for the baby. It was comfortable to hold and use.

Survey Sample

FUTURE WORK: STORYTELLING TO SPARK DEBATE

While the installation facilitates the conversation between the baby, intended parents and the surrogate, it does not however address the surrogacy issue in India or how Silicon Valley is utilizing the surrogacy. In order to tell the story and spark wider debate around the topic of surrogacy, I hope to create a short film as a way of storytelling, rather than just telling the story sculpturally through the installation. This could be a documentary on how the sofa and the pillow would be used under a larger context.

CONCLUSION AND FUTURE WORK

Any services that involve human labor often have an imbalance in power dynamics, and exploitation under such structure. In the case of surrogacy, new advances in reproductive technologies make surrogacy much easier and safer, in the same time making the ethical quandary more difficult. This new method of reproduction faces different cultural and ethical challenges, mainly caused by the economic force, for the surrogacy agency, intended parents, the surrogates and the corporation.

While the “smart” sofa and pillow was designed to spark debates, it does not reveal all layers of the complicated issues surrounding surrogacy - it was mainly focused on the relationship between the parents and the baby through the surrogate. Unfortunately, due to time constraints, I was unable to create a sufficient narrative around this designed product to post it online and have an exhibition to inspire more public discussion. I feel that the immediate future step for my project is to create a film or photo narrative that illustrates the relationship between the biological mother and the surrogate using the sofa, to stimulate imagination that such products may exist in the near future. There are no other speculative design projects exploring the issues of surrogacy so directly and specifically as my project, so I hope this project, when the visual narrative is completed and posted online, could serve to initiate those conversations that are much needed in many parts of the world.

ENDNOTES

- 1 Sydell, Laura. Silicon Valley Companies Add New Benefit For Women: Egg-Freezing. <http://www.npr.org/sections/alltechconsidered/2014/10/17/356765423/silicon-valley-companies-add-new-benefit-for-women-egg-freezing>
- 2 Bindel, Julie. Outsourcing pregnancy: a visit to India's surrogacy clinics. <http://www.theguardian.com/global-development/2016/apr/01/outsourcing-pregnancy-india-surrogacy-clinics-julie-bindel>
- 3 Hodal, Kate. Suspected human trafficker and Thai 'baby factory' under investigation. <http://www.theguardian.com/world/2014/aug/14/police-hunt-japanese-man-suspected-human-trafficker-bangkok>
- 4 Dunne, Anthony, and Raby, Fiona. *Speculative Everything: Design, Fiction, and Social Dreaming*. January 1, 2013. Page 58
- 5 Dunne, Anthony, and Raby, Fiona. *Speculative Everything: Design, Fiction, and Social Dreaming*. January 1, 2013. Page 34
- 6 Dunne, Anthony, and Raby, Fiona. *Speculative Everything: Design, Fiction, and Social Dreaming*. January 1, 2013. Page 39
- 7 Ranner Veronica. *Survival Tissue*. <http://www.veronicaranner.com/biophilia-survival-tissue/>
- 8 Ranner Veronica. *Survival Tissue*. <http://www.veronicaranner.com/biophilia-survival-tissue/>
- 9 Cohen, Revital and Balen, Tuur Van. *Artificial Biological Clock 2008*. <http://www.cohenvanbalen.com/work/artificial-biological-clock>
- 10 "Surrogate Babies: Where Can You Have Them, and Is It Legal?" Web. 17 Apr. 2016. <http://www.bbc.com/news/world-28679020> BBC, 6 Aug. 2014.
- 11 AFP. India bans foreigners from hiring surrogate mothers. <http://www.theguardian.com/world/2015/oct/28/india-bans-foreigners-from-hiring-surrogate-mothers>
- 12 here are unfortunately some surrogacy agencies that see this as an opportunity for profits, abusing the system for their advantage.
- 13 Ronan, Alex. *Inside the Dark Realities of the International Surrogacy Industry*. <http://nymag.com/thecut/2015/03/dark-side-of-international-surrogacy.html>
- 14 Ronan, Alex. *Inside the Dark Realities of the International Surrogacy Industry*. <http://nymag.com/thecut/2015/03/dark-side-of-international-surrogacy.html>
- 15 Carney, Scott. *Inside India's Rent-a-Womb Business*. <http://www.motherjones.com/politics/2010/02/surrogacy-tourism-india-nayna-patel>

- 16 Sydell, Laura. Silicon Valley Companies Add New Benefit For Women: Egg-Freezing. <http://www.npr.org/sections/alltechconsidered/2014/10/17/356765423/silicon-valley-companies-add-new-benefit-for-women-egg-freezing>
- 17 Cheung, Helier "Surrogate Babies: Where Can You Have Them, and Is It Legal?" 6 Aug. 2014. Web. 17 Apr. 2016. <http://www.bbc.com/news/world-28679020>
- 18 "Cheung, Helier" Surrogate Babies: Where Can You Have Them, and Is It Legal?" 6 Aug. 2014. Web. 17 Apr. 2016. <http://www.bbc.com/news/world-28679020>
- 19 Lee, Stephanie M.. Outsourcing a life. <http://www.sfchronicle.com/local/bayarea/item/India-surrogacy-23858.php>
- 20 India Surrogacy Boom Gives Birth to Parenthood for Foreign Couples, Joe Harkins, <https://www.globalhealthquest.ca/Articles/surrogacy.html>
- 21 Despair over Ban in India's Surrogacy Hub. BBC, 22 Nov. 2015. Web. 17 Apr. 2016. <http://www.bbc.com/news/world-asia-india-34876458>
- 22 Doshi, Vidhi. 'We pray that this clinic stays open': India's surrogates fear hardship from embryo ban. Saturday 2 January 2016 19.05 EST, <http://www.theguardian.com/world/2016/jan/03/india-surrogate-embryo-ban-hardship-gujarat-fertility-clinic>
- 23 Despair over Ban in India's Surrogacy Hub. BBC, 22 Nov. 2015. Web. 17 Apr. 2016. <http://www.bbc.com/news/world-asia-india-34876458>
- 24 Despair over Ban in India's Surrogacy Hub. BBC, 22 Nov. 2015. Web. 17 Apr. 2016. <http://www.bbc.com/news/world-asia-india-34876458>
- 25 Ronan, Alex "Inside the Dark Realities of the International Surrogacy Industry." New York Media LLC, 30 Mar. 2015. Web. 17 Apr. 2016. <http://nymag.com/the-cut/2015/03/dark-side-of-international-surrogacy.html>
- 26 "Surrogacy laws by country." Wikipedia: the free encyclopedia. Wikimedia Foundation, Inc. 7 April 2016. https://en.wikipedia.org/wiki/Surrogacy_laws_by_country