IN CELEBRATION OF BEING HUMAN

by

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A thesis submitted to the faculty of
The University of North Carolina at Charlotte
in partial fulfillment of the requirements
for the degree of Master of Architecture in
Architecture and Information Technology

Charlotte

2018

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ABSTRACT

NOUSHIN RADNIA. In Celebration of Being Human. (Under the direction of RACHEL DICKEY)

Over time, the relationship between human and technology has been evolving. As a result of this evolution, as Donna Haraway explains in her basic thesis, it is no longer possible to tell where we end and machines begin. On the other hand, this enhancement has been intensified in the interaction between mankind and machines. The realities of contemporary life happen to include living both physically and emotionally far distances away from our extended family and friends, growing reliance on social technology rather than face to face interaction.

As part of this research I have investigated methods, where technology can alter the quality of our communication. For this purpose, I have been interested in involving human emotions in the realm of communication and express it with the use of technology. Furthermore, I have explored the conditions which are crucially relevant for a symbiotic relationship between mankind and machinery.

There is a space between the domain we inhabit and the technology we confront, that nowadays need to be addressed. The intention of this thesis is to build an interactive physical system by the use of software and hardware that can sense and respond to the analog world. This experiment means to accommodate devices that could reflect interactions with its user. These interactions will be choreographed as a way to motivate user's interactions as an input, extract and process it and provide a feedback as an amplified reaction into the space. To this aim, I have created a system that exemplifies how this communication can be altered. Through the usage of sensors, fabrication, and actuators, I first describe the details of how this design was produced. Next, I will explain the prototype, fabrication process and different user experiences in the period of demo.

The final part covers unexpected challenges during the fabrication and demonstration of the prototype and an observation of user's interaction with it.

ACKNOWLEDGEMENTS

I would like to acknowledge my thesis committee Rachel Dickey, Samira Shaikh, and Eric Sauda for their guidance with this project. Additionally, I would like to acknowledge DesComp program and Digital Arts group for their support.

TABLE OF CONTENTS

LIST OF FIGURES

SECTION 1: INTRODUCTION

This project investigates and explores the idea in the domain of art, design, and computing that involves human emotion and engagement of technology for its enhancement. It will touch on a series of projects and research that has been done in the domain of affective computing, social robotics, soft architecture machines and emotions in text analytics. The theoretical backbone of this thesis covers methods from art, design and digital humanities background. The difference in this wide range of approaches helped to understand the attributes and evaluations in each discipline.

The methodology to achieve this project starts with a comparison between principles in the mentioned disciplines, understanding it and classifying it based on attributes and methodology. The literature review will provide a foundation either to criticize or integrate different techniques and highlights the criteria for the final project proposal. Affective Computing is using computers that are recognizing emotions. Not to give skills to machines but create a machine and provide it to people that need more support. Digital Humanities is about exploring the ways in which the affordances of technology can help us explore the deeper concerns of the humanities, from expanding archival access to thinking about what it means to read something. It embodies a spirit of collaboration, experimentation, and play, in which failure is acceptable and part of the normal process, and in which the action of 'making' is as valued as the action of thinking. These two approaches are two ends of the spectrum that covers the range and context of the projects and concept followed.

The overarching goal is to introduce a system that amplifies our inner qualities and investigates different methods where this quality can activate a feedback system. The main idea for this thesis is to help us achieve a better understanding of humans both as the users and occupants of the space and looking for different ways to create both physical and digital respond to that.

The design goal includes:

1. Using novel human quality as an unaffected property to capture momentary behavior (such as emotions and senses)
2. To amplify sense of connection between user and space
3. To convey a sense of awareness through amplified feedback to the users
4. To enable a non-verbal communication both as single user and multi-user system
5. Activate an analogue / mechanical system or object as a way to represent captured input variable
6. Having a digital response as an immediate responsive and manipulative system

In the next section, I will describe different subjective areas that are covered in the reviewing similar projects. Then I will explain the design flow, techniques and challenges followed by the future work I want to explore as the result of this study.

SECTION 2: LITERATURE REVIEW

An important part of my research was the exploration in the theory, thoughts, projects, experiences, installations and history in the domain of Human and Machine. This part is a gathering of highlighted readings as a response in the domain of Human-Machine relationship reflected in philosophy as well as space, and how both scientists and artists relate to technology, take the approach to cybernetic-like systems and speculative architecture space. The range of readings and projects I have chosen to refer have been selected for their ability to cover cross-disciplinary aspects to this topic. This chapter categorizes all the readings to four main categories; Machines that help us think AND Machines that think, Dynamic vs. static space, Soft Architecture Machines and Emotions in Text Analytics.

2.1. Machines that help us think AND Machines that think

This section of studies explores the relationship between human and machines over time. The main goal of this part of literature review was to understand the highlights of human, machine and their correlation.

Negroponte, Nicholas. The Architecture Machine. Cambridge, MA: M.I.T., 1970. Print.

"In our era, however, most people have serious misgivings about the feasibility and more importantly, the desirability of attributing the actions of a machine to intelligent behavior. These people generally distrust the concept of machines that approach (and thus why not pass?) our own human intelligence." (1)

"Why ask a machine to learn, to understand, to associate courses with goals, to be self-improving, to be ethical - in short, to be intelligent?" (1)

"What needs to be articulated, regardless of the format of the man-machine relationship, is the goal of humanism through machines […]The concern is to avoid dehumanizing a process whose aim is definitely humanization." (7)

"Imagine a machine that can follow your design methodology and at the same time discern and assimilate your conversational idiosyncrasies. This same machine, after observing your behavior, could build a predictive model of your conversational performance. Such a machine could then reinforce your dialogue by using the predictive model to respond to you in a manner that is in rhythm with your personal behavior and conversational idiosyncrasies." (13)

"If you are in conversation with a machine and using a machine-oriented code, when the mechanism replies, you report a 'reaction.' However, employing a man-oriented code - a pseudo language - you might attribute to the machine an apparent 'understanding.'" (97)

"As soon as the designer furnishes the machine with instructions for finding a method of solution, the authorship of the results becomes ambiguous." (111)

Bennahum, David. "Mr. Big Idea." New York Magazine 28.45 (1995): 72-75. Print.

"Starner calls this the first phase of the BodyNet - a computer network wired through human bodies." (72)

"The transaction initiated by the handshake was in this case an exchange of business cards. The computers understand that the gesture 'handshake' means exchange business cards. A more intimate gesture, such as an embrace, would lead to the sharing of more personal data - say, a medical record on sexually transmitted diseases." (74)

"As an architect, Negroponte wanted to develop *a machine that would sense what the architect desired and work together with him to create better buildings." (75) (goes in support with idea of machines helping us think rather*

Negroponte, Nicholas. Soft Architecture Machines. Cambridge, MA: MIT, 1975. Print.

“The machine must be constructed in such a manner that its behavior gives us enough confidence to presume that it is acting intelligently and with common sense, that is, in context.” (33)

“The central issue seems to be how to endow the machine with that undefinable capability called ‘understanding.’ The evidence of ‘understanding’ in humans as well as machines is some intelligent response that is ‘meaningful’ and pertinent, although not necessarily ‘right.’” (54)

“The manipulative environment is a passive one, one that is moved as opposed to one that moves. In contrast, *responsive*, sometimes called *adaptable*, or *reactive*, means the environment is taking an active role, initiating to a greater or lesser degree changes as a result and function of complex or simple computations.” (132)

Johnson, Matthew E. "How to Be a Being: On Brainless Bots, Martin Heidegger, and Mental Representation." (2013).

http://ir.icscanada.edu/icsir/handle/10756/312451

“In 1948, inventor William William Grey brought to life Elsie and Elmer, two simple three-wheeled robots who seemed to have minds of their own. They could explore rooms, ‘dance’ with each other, and even find their way back to their hutches to recharge when their batteries ran low.”

“Their simple reflex commands led to complicated behaviors, allowing them to act in a way that made them seem incredible lifelike.”

“You actually don’t need an inner experience or a complicated central processor to do complex things; even the simplest responses to a complex world can result in complicated behaviour”

Brown, Arnold. "The robotic economy: brave new world or a return to slavery?." The Futurist 40.4 (2006): 50.

http://search.proquest.com/openview/130d44322686131fd62b73a85d03048a/1?pq-origsite=gscholar

Term “robot” first used by Karel Capek in his 1922 play *R.U.R.*

George Devol and Unimation (universal automation)

“As these machines become more humanoid - in appearance, in personality, in thinking - how will their relationship to humans develop?” (52)

“The bigger challenge may be learning to live with our progeny even as they surpass us in intelligence and capability. As our mechanical and computerized creations perform more of the tasks formerly performed by humans, and as they come to resemble us to a greater degree, we may need to reconsider more than simply how we interact with these devices. We may need to entirely redefine what it means to be human.” (55)

Bishop, Rollin. "Intelligent Design: Robot Builds Successive Generations of Small Robots." Popular Mechanics. Hearst Communications, Inc., 13 Aug. 2015. Web.

http://www.popularmechanics.com/technology/robots/a16878/robot-builds-robots/

“The mother can take a look at results of its children and design future generations to incorporate certain traits over others. That’s without any signal from a human to pick one or the other.”

“Each child could be composed of between one and five total plastic cubes, and the mother ultimately judged them based on how far they moved from their start point during a set amount of time.”

Wrenn, Eddie. "Intelligent Design: Scientists Create Robot Which Can Build Its Own Tools - but Is This a Step Too Far for Robotics?" Daily Mail. Associated Newspapers Ltd, 24 May 2012. Web.

http://www.dailymail.co.uk/sciencetech/article-2148000/Scientists-build-robot-design-tools.html

“One of the key signs of intelligence is tool-building - and thanks to the team, robots can now join that small group of ‘smart’ beings.”

"The achievements of this robot are remarkable, leading to a point where robots will be given tasks and have the ability to design the tools they need to accomplish them."

"The researchers dream about a robot that can adaptively extend its body how and when it deems fit, and also suggest these kind of techniques could be used to create robots that can repair themselves, increase their own size and functionality, or even construct other robots."

Aouf, Rima Sabina. "Wall-climbing Robots Build New Structures from Carbon Fibre." Dezeen - Architecture and Design Magazine. Dezeen, 02 Aug. 2016. Web.

http://www.dezeen.com/2016/08/02/wall-climbing-mini-robots-construction-carbon-fibre-university-stuttgart-achim-menges/

"The agile robots, which climb walls and ceilings, work in concert to pull fibre filaments across a space, creating a structure onsite."

Atherton, Kelsey. "Robot Saws Its Own Wood, Designs Its Own House." Popular Science. Bonnier Corporation, 19 May 2016. Web.

http://www.popsci.com/architecture-students-make-robot-design-and-assemble-wooden-building

"Cameras scanned the trees and algorithms plotted the shape of the wood, finding the center lines and individual strength. Mechanical brains tessellated the shape into a working form, and the robot knew what it must build."

"The machine, limited by its body, planned and crafted the structure."

Turing, Alan M. "Computing machinery and intelligence." Mind 59.236 (1950): 433-460.

http://www.jstor.org.librarylink.uncc.edu/stable/2251299?seq=1#page_scan_tab_contents

The turing test of artificial intelligence: if an interviewer cannot differentiate between a computer and a person through a series of questions, then the computer can be considered "intelligent"

"ADD Thought #9: Testa/Weiser - Collaboration Machines." Aalto University Digital Design Laboratory, ADD. Aalto University, 11 Oct. 2012. Web.

http://addlab.aalto.fi/discourse/add-thought/9-testa-weiser

"They presented the conceptual and pedagogical framework for the new SCI-Arc Robot House, a cutting edge robotics and simulation lab focused on architecture and media arts, and also other recent projects at the convergence of advanced materials and robotic fabrication."

"'Contrary to popular assumptions and preconceptions about computers the inputs do not strictly define the outputs as the objects we work with hold more secrets than one can imagine.'" (soft computing)

Breazeal, Cynthia. "Toward sociable robots." Robotics and autonomous systems 42.3 (2003): 167-175.

http://www.sciencedirect.com/science/article/pii/S0921889002003731

"Our social-emotional intelligence is a useful and powerful means for understanding the behavior of, and for interaction with, some of the most complex entities in our world - people and other living creatures"

"Autonomous robots perceive their world, make decisions on their own, and perform coordinated actions to carry out their tasks. As with living things, their behavior is a product of its internal state as well as physical laws."

"Does the robot only appear to be socially intelligent or is it genuinely so?"

"Kismet is designed to be a robotic creature that can interact physically, affectively, and socially with humans in order to ultimately learn from them"

"Flight assembled architecture, 2011-2012," Gramazio and Kohler

http://www.gramaziokohler.com/web/e/projekte/209.html

"...first architectural installation assembled by flying robots, free from the touch of human hands"

"...the flying vehicles, together, extend themselves as 'living' architectural machines and complete the composition from their dynamic formation of movement building performance"

Breazeal, Cynthia. "Toward sociable robots." Robotics and autonomous systems 42.3 (2003): 167-175.

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"...first architectural installation assembled by flying robots, free from the touch of human hands"

"...the flying vehicles, together, extend themselves as 'living' architectural machines and complete the composition from their dynamic formation of movement building performance"

Gage, Stephen, and Will Thorne. "Architecture as Ecosystem - Edge Monkeys: The Bartlett, UCL." Intelligent Agent 4.3 (n.d.): 1-4. Web.

http://intelligentagent.com/archive/IA4_3architecturegagethorne.pdf

Discusses the concept of the “intelligent building,” with maintenance robots that stay within a designated ecosystem

Bennahum, David. “Mr. Big Idea.” New York Magazine 28.45 (1995): 72-75. Print.

“Starner calls this the first phase of the BodyNet - a computer network wired through human bodies.” (72)

“The transaction initiated by the handshake was in this case an exchange of business cards. The computers understand that the gesture ‘handshake’ means exchange business cards. A more intimate gesture, such as an embrace, would lead to the sharing of more personal data - say, a medical record on sexually transmitted diseases.” (74)

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Johnson, Matthew E. "How to Be a Being: On Brainless Bots, Martin Heidegger, and Mental Representation." (2013).

http://ir.icscanada.edu/icsir/handle/10756/312451

“In 1948, inventor William William Grey brought to life Elsie and Elmer, two simple three-wheeled robots who seemed to have minds of their own. They could explore rooms, ‘dance’ with each other, and even find their way back to their hutches to recharge when their batteries ran low.”

“Their simple reflex commands led to complicated behaviors, allowing them to act in a way that made them seem incredible lifelike.”

“You actually don’t need an inner experience or a complicated central processor to do complex things; even the simplest responses to a complex world can result in complicated behaviour”

2.2. Dynamic vs. static space

The question that was raised in this part of study was " How our perception of space is changing". The intention of exploration this part was to understand transformation of solid physical space to a more adaptive and responsive environment over time with the use of available technology. This transformation both in the definition and actual physical space is selected as the following references:

Beaumont, John Russell. "Architectures of Firmness and Softness." Interactive Architecture Lab. The Bartlett School of Architecture, 05 Nov. 2015. Web. 06 Oct. 2016.

http://www.interactivearchitecture.org/architectures-of-firmness-and-softness.html

"Hardness immediately evokes the physical building materials which comprise the majority of the built environment. … Another kind of hardness in architecture is situated in the psychological and social role it plays in our lives."

"Negroponte explores how architecture might become softer, both in its movements and its materials, and more personal, by introducing intelligent computers which allow non-architects to participate in the design of their homes intuitively. Negroponte's work is still poignant today because of his emphasis on buildings with *agency*, as opposed to merely using technology to facilitate human agency. His ideas conjure images of a world where buildings are not hard, static structures, but soft characters in our lives—animate, thinking, and emotive beings which actively house and protect us physically as well as psychologically."

Negroponte, Nicholas. Soft Architecture Machines. Cambridge, MA: MIT, 1975. Print.

"This is to say, we propose to sidestep the typical partitioning of labor, letting the machine do what it is good at doing and letting the man undertake what he is good at doing. The proposed model for joint venture is most closely approximated by the working relationship enjoyed by two professionals who happen to be good friends" (5)

“In short, the theory is that I can be the best architect for my needs, and I do not need a paternalistic human or mechanical architect to dictate my decisions. I need an understanding friend (not necessarily a professional architect), preferably one with whom I can share the risks” (5).

“‘Part of the design process is, in effect, the procurement of this information. Some is gathered by doing research in the preliminary design stages. Some is obtained through experience, overlaying and applying a seasoned wisdom. Other chunks of information are gained through prediction, induction, and guesswork. Finally, some information is handled randomly, playfully, whimsically, personally’” (34)

“Tools like intuition (sharpened by experience) are valuable and are often responsible for the major joys in architecture, and we should strive to bestow such devices on machines” (34)

2.3. Soft Architecture Machines

"Crazy-Radical Soft Architecture, From The 1950s To Today." Architizer. Architizer, Inc., 07 Aug. 2013. Web.

http://architizer.com/blog/soft-architcture/

“The term "soft" is expansive in its meanings. Soft material, soft sound, soft-mannered, soft sell, soft power, soft management, soft computing, soft politics, software, soft architecture. It describes material qualities, evokes character traits. It defines strategies of persuasion, models of systems thinking and problem-solving, and new approaches to design. But the most obvious associations with soft have been material characteristics—yielding readily to touch or pressure; deficient in hardness; smooth; pliable, malleable, or plastic.”

Tveito, Haavard. "Sound and Soft Architecture." Interactive Architecture Lab. The Bartlett School of Architecture, 05 Nov. 2015. Web.

http://www.interactivearchitecture.org/sound-and-soft-architecture.html

"The concept of soft architecture describes an architecture which both responds to our actions but also inscribe our behavior, as Usman Haque describes it: 'Pask's early experiments with mechanical and electrochemical systems provide a conceptual framework for building interactive artifacts that deal with the natural dynamic complexity that environments must have without becoming prescriptive, restrictive and autocratic.'"

2.4. Emotions in Text Analytics

Saima Aman and Stan, Szpakowicz. "Identifying Expressions of Emotion in Text"

https://link.springer.com/chapter/10.1007/978-3-540-74628-7_27

Expressions of emotion in text, emotion annotation task of identifying emotion category, emotion intensity and the words/phrases that indicate emotion in text. Also, exploring computational techniques for emotion classification.

Jelle Saldien, Kristof Goris, Bram Vanderborght, Johan Vanderfaeillie and Dirk Lefeber. "Expressing Emotions with the Social Robot Probo". July 2010

https://link.springer.com/article/10.1007/s12369-010-0067-6

Probo, a huggable animal-like robot, designed to act as a social interface. It will be used as a platform to study human robot interaction (HRI) while employing human-like social cues and communication modalities. The robot has a fully actuated head, with 20 degrees of freedom, capable of showing facial expressions and making eye contact. The recognition of the underlying emotions based on the robot's facial expressions were tested in different user studies and compared with similar robotic projects. This paper describes the concepts of the robot Probo and the ability to express emotional states.

SECTION 3: DESIGN AND MATERIAL EXPLORATION

Two motivational questions that helped the direction of this section of the study are; First, what if our future environment could feel us, and reflect our collective emotions? Followed by, How we can animate the built environment through our day-to-day conversations? Humans, as the main activator of space and built environment are not an individual piece. Our body acts and responds as a system with various components. Our biological body in relation to our emotions, feelings, senses and our spiritual dimensions define us, and these values are the characteristics that differentiates us from the person next to us. Meanwhile Da Vinci's Vitruvian Man (Fig 1) defines the geometry and proportions of human body that defines physical aspect of surrounding space, Valero Doval's illustration (Fig 2) reveals multiple layers and qualities that can influence the ambient around us, either we are aware of it or not.

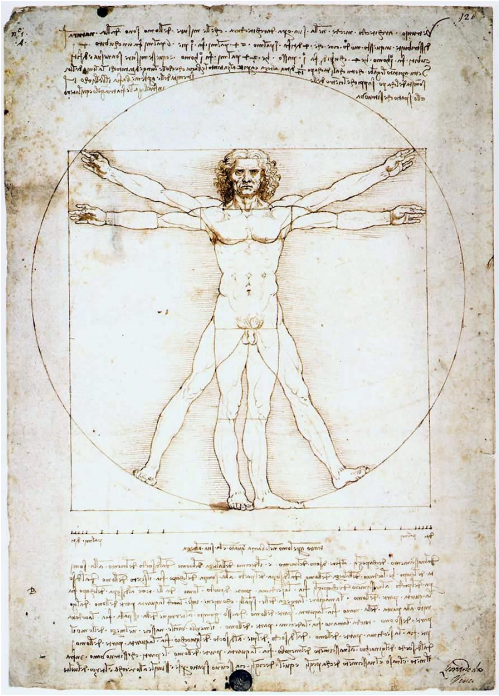

Fig 1: Leonardo Da Vinci's Vitruvian Man

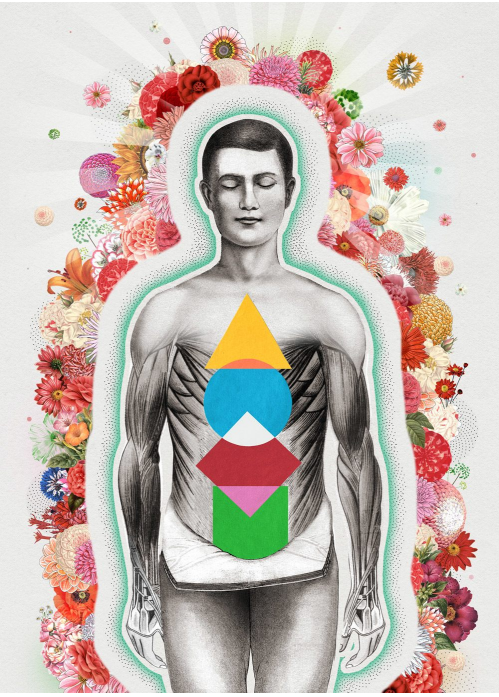

Fig 2: Illustration by Valero Doval

In search of designing a space or environment that could feel us, I selected significant human emotions that recognize and curate specific emotional states. Even though we are often consciously aware of our current emotional state, such as anger or happiness, the mechanisms giving rise to these subjective sensations have remained unresolved. Here we used a topographical self-report tool to reveal that different emotional states are associated with topographically distinct and culturally universal bodily sensations; these sensations could underlie our conscious emotional experiences. Heart Rate Variability (HRV) recognize and corresponds to calm-neutral state (Relax), positive elicitation (Joy) and negative elicitation (Fear). Standard HRV analysis in time and frequency domain is performed. down the inputs from the user body to temperature and pulse. These two measures have been shown by different studies to have some indication of different human emotions. However, in this work, I am less concerned with exactly what emotions these measurements can communicate than to create a physical object that translates these body related variables to the space around us. The temperature in our fingertips has a good range of variation when we are dealing different situations and an intuitive interaction that reveals our internal reaction. To sync it with another variable, I selected pulse as an indicator of our inner feelings with similar considerations to temperature. Temperature Sensor (TMP36) (Fig 6) and Pulse/Heart Rate Sensor (Fig 3) were the sensors to capture those inputs. As a response to these inputs Servo Motor (Fig 4) was picked to translate Heartbeat/Min. To a linear movement and clear RGB LED (Fig 5) combined with 0.3 mm Fiber Optic (Fig 7) would respond to temperature sensor.

Fig 3: Pulse Sensor

Fig 4: Servo Motor

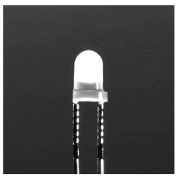

Fig 5: RGB LED

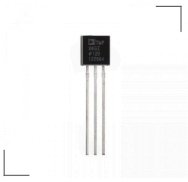

Fig 6: TMP 36

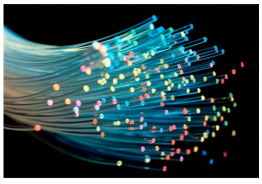

Fig 7: Fiber Optic

In the next round of case studies, I looked at mechanical kinetic systems where a delicate movement can result in a wider range of movement. A series of Wood and Steel kinetic sculptures by Mohammadreza Yazdi (Fig 8) was a source of inspiration to understand and try to replicate an exaggeration of movement in the designed piece. Although the kinetic behaviour as a response was a key component for the response but the choice of material, the effect it creates and flexibility and character of material was a considerable factor. This notion is follow by a quote by Greg Tran:

"*Architecture's ability to mediate spatial and perceptual experience has historically been tied to the inherent qualities of material form and function. However, our lives have become colored by immaterial stimuli as well.*" (Greg Tran, Mediating Mediums)

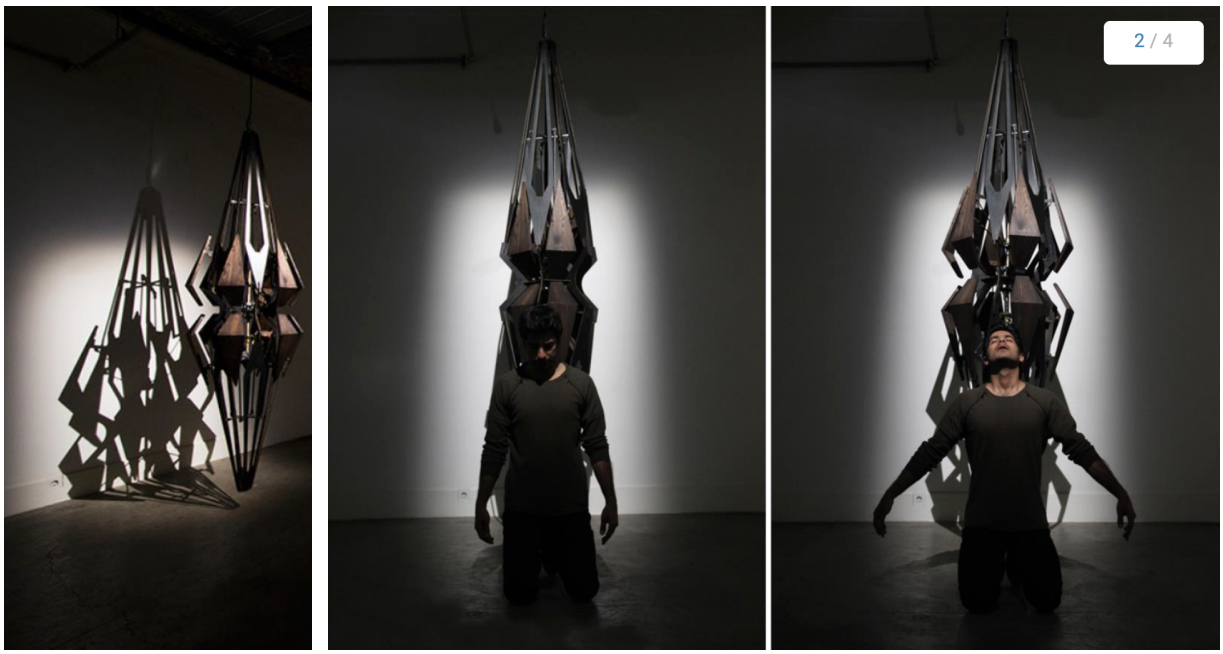

Fig 8: I Breath, Therefore I am, 2017, Steel & Wood, 280.100.100cm, Kinetic Sculpture by Mohammadreza Yazdi

The other case studies that I investigated in the design section was more specific to the heartbeat and temperature as input variables. Pulse Room by Rafael Lozano-Hemmer is an interactive installation that activates with the heartbeat of participants. The three hundred clear bulbs are uniformly distributed over the exhibition room, filling it completely. An interface placed on a side of the room has a sensor that detects the heart rate of participants (Fig 9). When users hold the interface, their pulse immediately sets off the closest bulb to flash at the exact rhythm of their heart. The moment the interface is released all the lights turn off briefly and the flashing sequence advances by one position down the queue, to the next bulb in the grid. Each time someone touches the interface a heart pattern is recorded and this is sent to the first bulb in the grid, pushing ahead all the existing recordings. At any given time, the installation shows the recordings from the most recent participants.

Fig 9: Pulse Room interactive installation by Rafael Lozano-Hemmer

Breathing Heart by Johanna Keimier is an art installation that offers a walk-in heart experience. Up to 20 participants can lay and sit at the same time around the atrium. This heart fills itself with air and pulses in a breathing rhythm accompanied by light, video, scent, and sound. All happening in the 1600 square meters where the visitor perceives to be inside their body. This project was exhibited at Art Basel 2017 in Miami in a historical water filter building.

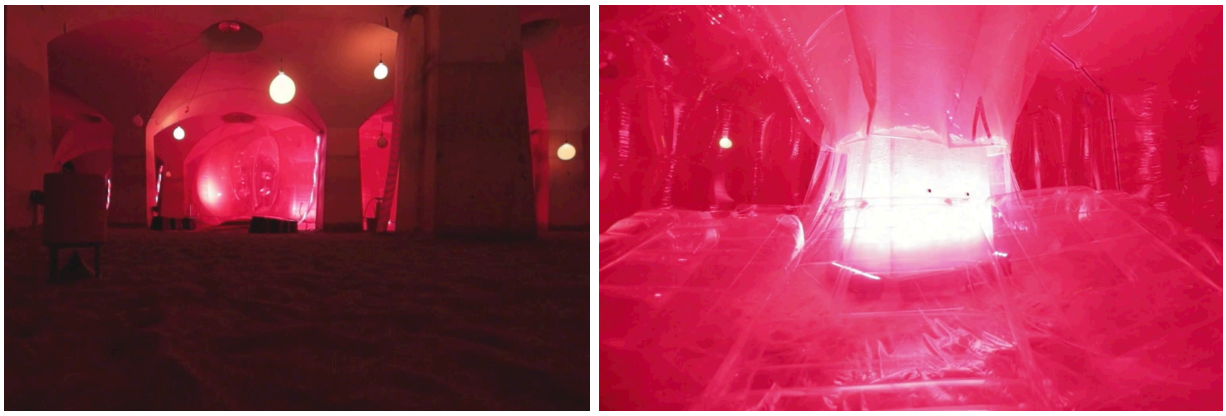

Fig 10: BREATH ing HEART; an art installation by Johanna Keimeyer at Art Basel 2017

Astro Balloon 1969 Revisited - Feedback Space is a heart-shaped installation, resembling a double sphere or the eyes of an abstract insect. Based on the idea of COOP HIMMELB(L)AU's „Feedback-Circuit Program" from 1971 which would be called 'network' today, the non-verbal communication (network) of the physicalness should be seen as module of the development of a city. Wolf D. Prix, the Design Principal says "Not architecture is changing the human being, but the human being is able to change architecture. The theoretical contribution refers to the heartbeat and the body that is changing the space. Architecture has the duty to create spaces which are committed to new experiences for our senses. This is what Astro Balloon 1969 Revisited - Feedback Space shows."

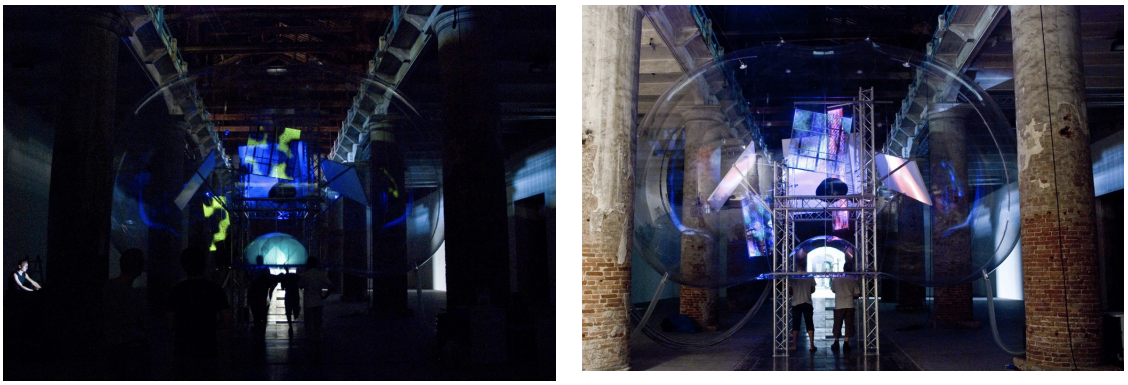

Fig 11: Feedback Space - Astro Balloon 1969 Revisited by COOP HIMMELB(L)AU. La Biennale di Venezia

The two previous case studies were a thorough understanding of responsive environment where offers an immersive environment to the user and embeds the occupant within itself. The scale of the installation, inflatable and habitable characteristics of it and engagement of light in the quality of space that has been create were highlighted and distinguished properties that it creates. The next step is to design and fabricate a prototype that includes the characteristics defined before. Furthermore, what is important is the experience that the users have had with the prototype both as an individual interaction or a collective multi-user experience.

3.1. Physical Prototype

3.1.1 Design of the artifact

The main concept of this project is celebrating being Human. For this purpose, I would like to capture two vital factors in human body that can also reflect the quality of the context we are in. As part of this system, the main idea for designing the object that will respond and interact with the user is not separate from this concept. Initial brainstorming and sketching for the piece varied among topics that includes Giving life to an object, DNA structure, Microscopic Life, Vein, Living Creatures (Fig 12). The final geometry was a hexagonal form with a combination of six triangle shape panels. These panels will embed fiber optics that reflects to body temperature and changes color based on different individual input.

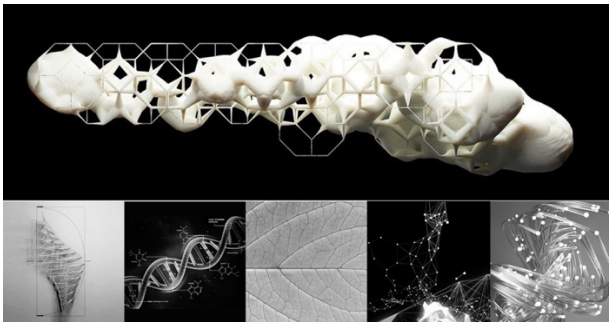

Fig 12: Collection of design inspirations

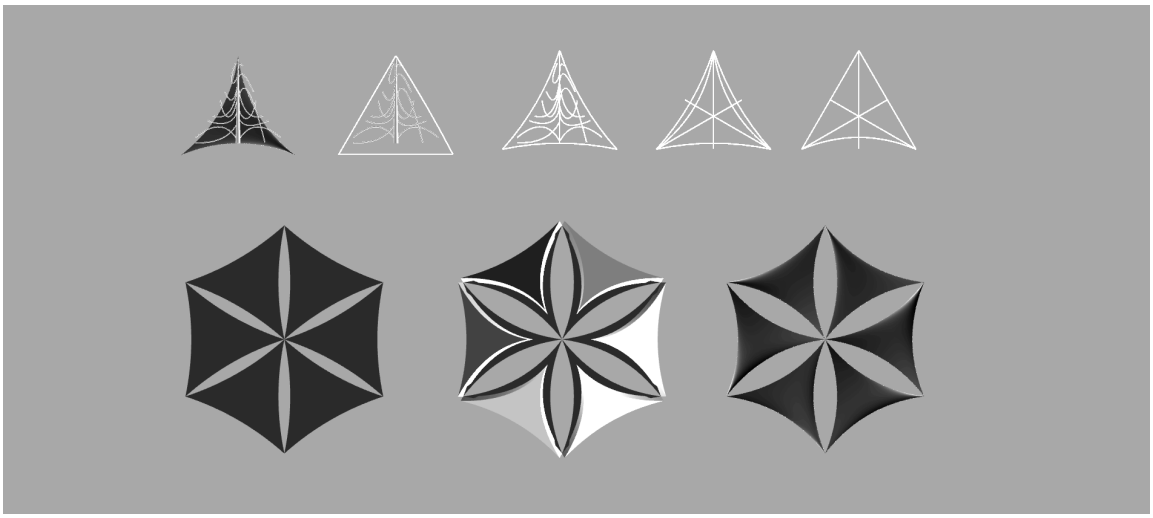

Fig 13: Hexagonal form consist of triangle panels

3.1.2 Fabrication Method, Material and Geometry

The important aspect in this phase was to reproduce the same form, have enough flexibility for the servo motor response and be able to embed fiber optics in the designed veins. For silicone casting I used Smooth-On SORTA-Clear series pouring resin in ⅛" thickness acrylic molds. Getting the best result for the central tubes to embed 0.3 mm fiber optics was a challenging test. Acrylic gave the smoothest surface compared to tests I did with Balsa and Chipboard. As the original design of the panel was a 3d panel not flat, I tried 3d printing mold, CNC routed mold and Vacuum Heat. The most available and fast way was to use laser cut flat mold as seen in Fig 12 and Fig 13.

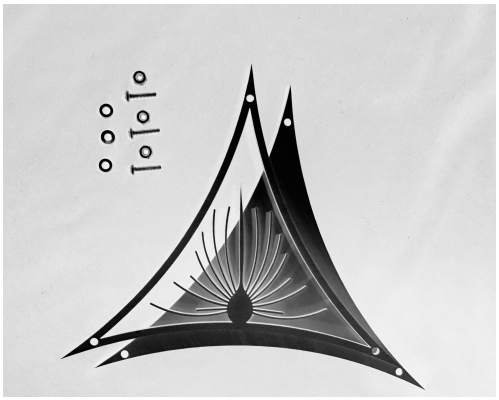

Fig 14: ⅛" Acrylic mold with bolt and screw for disassembly

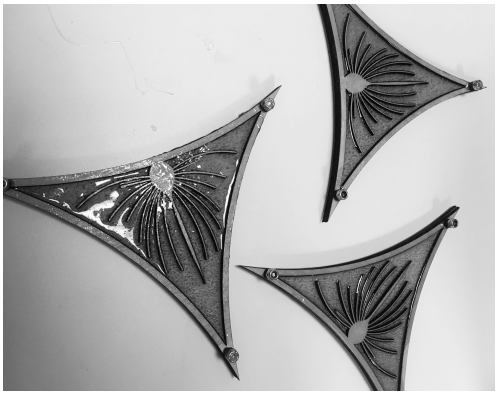

Fig 15: Silicone casting inside the mold

3.1.3 Sensors and Responses

The first component of the responsive object is silicone triangle panels embedded with fiber optics that react to the fingertip temperature of the users. The initial color created will range in the color spectrum from Blue to Red (Fig 14), mapping from lower (cold) to highest (hot). The color will fade to similar tones until it detects a temperature with 0.5° F change.

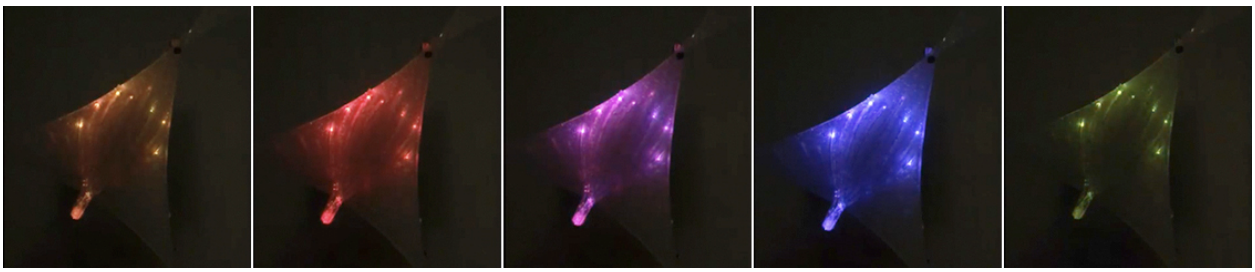

Fig 16: RGB color spectrum sourced from RGB LED passed to fiber optics

Heartbeat sensor activates servo motor and will create a linear movement based on calculated perimeter of the attached designed gear. This combination is the kinetic response that the system will create which for further exploration I would like to try both delicate changes and larger scale motions as the behavior of the system.

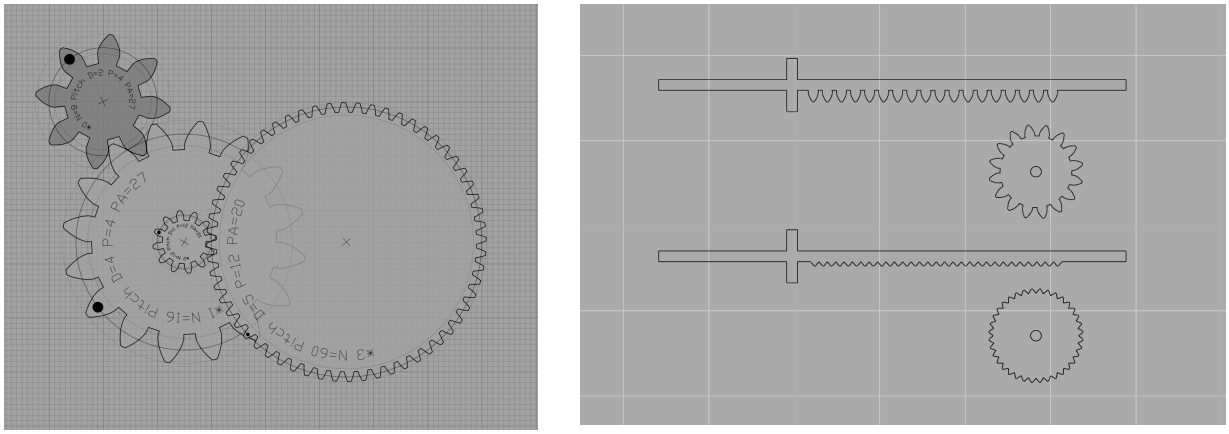

Fig 17: Designed gear for calculated linear movement as servo motor attachment

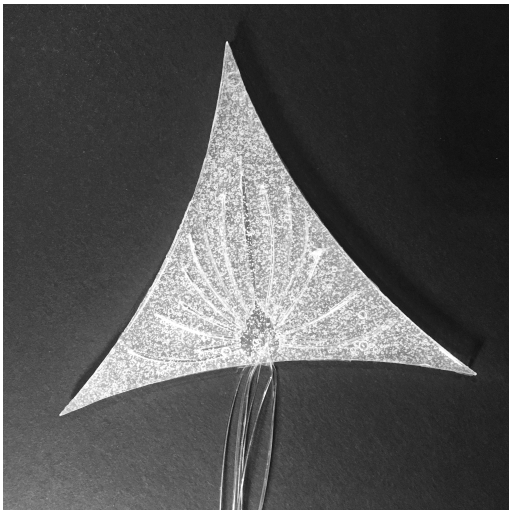

Fig 18: Silicone mold and embedded fiber optics

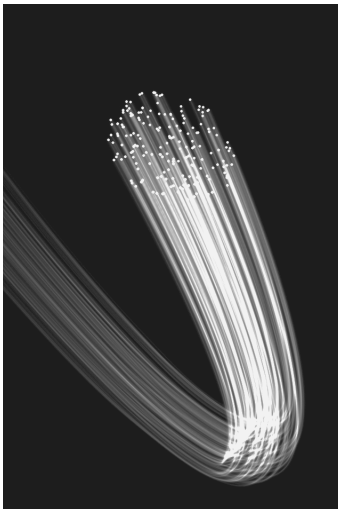

Fig 19: Linear Movement

The final piece is a combined object that contains desired sensors and the responses with the design. The piece was exhibited as two different prototypes (Fig 18 and 19) during the presentation on April 26th at UNC Charlotte's School of Architecture. Below are some images while the participants were interacting (Fig 20).

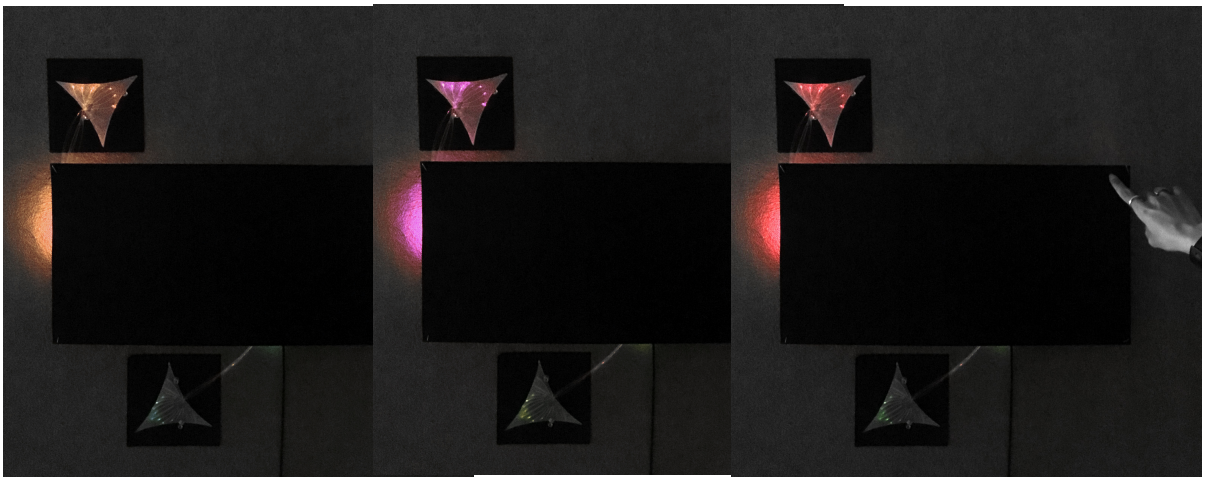

Fig 20: Color range as a response to temperature sensor

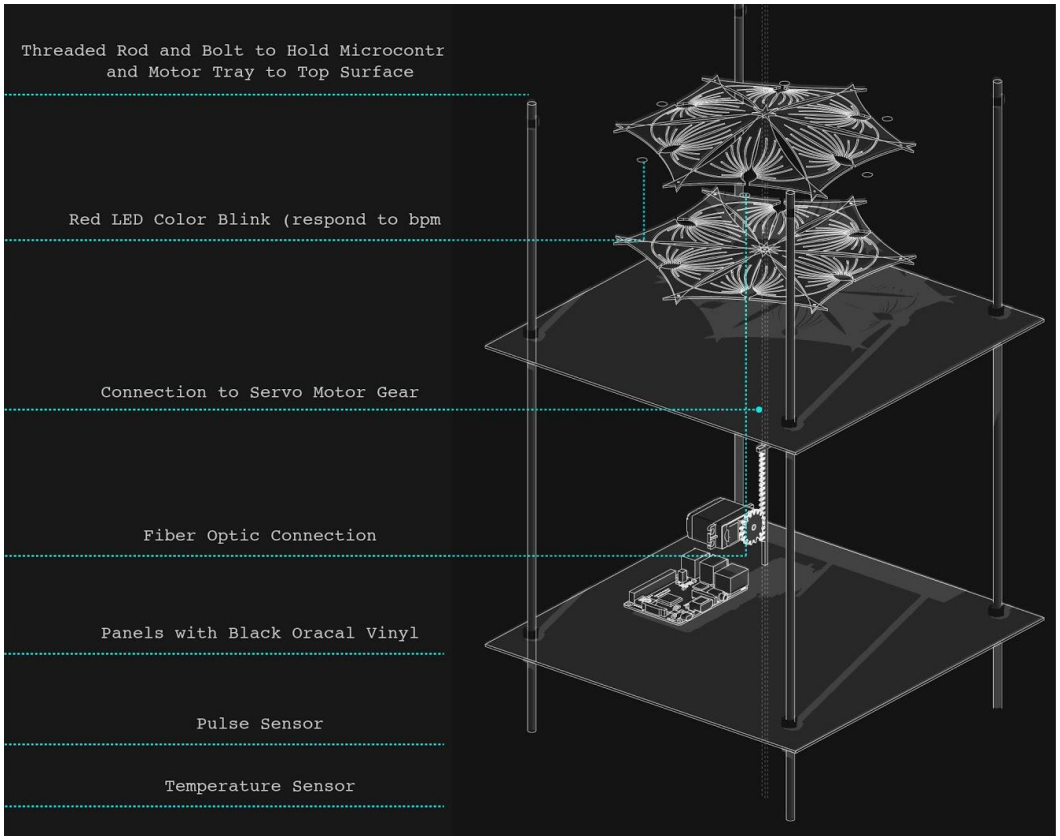

Fig 21: Different components of the combined prototype

Fig 22: Participants interaction with the prototype

4. CONCLUSION

With my thesis, my aim was to research how our inner feelings and vital signs can be celebrated as a response in a system. And how our future environments can start to react to our momentary behavior. I assume that ambience cannot be perceived apart from its occupant's mood. Because I am very interested in how the human body explores space through the senses, I depended mainly on György Kepes's definition of communication where in his book Language of Vision by acknowledging Berlin-based Gestalt psychologists, Kepes asserts that "Visual communication is universal and international; it knows no limits of tongue, vocabulary, or grammar, and it can be perceived by the illiterate as well as by the literate…[The visual arts, as] the optimum forms of the language of vision, are, therefore, an invaluable educational medium". Frequently when we communicate we do not sense this communication; A misperception that occurs only in our mind. In this perspective, communication should not be seen as a disjointedness of the mind from the body, but rather as a moment of hyper-felt connectedness with our non-biological body, that disappears and becomes one with our biological one. Rosmini's original idea of the fundamental feeling as the source of consciousness of being and its expansion outside the burden of the biological body follows the same idea where Ascott rehearses that later.

When we relate this experience to Pulse Room case study by Rafael Lozano-Hemmer, another question has to be asked. When we observe a larger impact of our human body properties, signals from our body and signals from the medium and the environment seem to merge without struggle in one experience that becomes easily identifiable.

To consider technology not as an extension of the body, but as a complementary part of the networked body that we use, it would enrich our idea of self, mind and body and would offer

inspiration for more effective and responsible design of responsive space. In this same context, it would be useful to turn our attention to other nodes of the networked environment that we are part of, and that our mind is part of, by exploring multiple layers of perception that the environment around us can reflect. A larger study of perception would not only enlarge our knowledge of the human body and affect, but it would bring to attention how our behavior and actions affect other agents within the network and emphasize how we constantly make use of these other agents in ways that we do not always realize.

To conclude my thesis, I would like to raise this question that how we can facilitate new forms of communication with qualitative properties of human body. This communication will involve both individual and collective experience where an exchange of unaffected properties of human quality would take place. Mapping the relationship between qualitative human body and quantifiable physical environment, while raising awareness of this potential allows us to capitalize on the power of Human.

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