Sympoiesis

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Robotics as design material

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September 2018

Submitted to the Program Master of Design, College of Engineering and College of Environmental Design, in partial fulfillment of the requirements for the degree of Master of Design (MDes) at the University of California Berkeley
May 2022

Sympoiesis

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Abstract

Current implementations and research around robotics focuses heavily on specific tasks that make use of what robots are actually impeccable at doing: being precise, repetitive and strong. Although this has been essential in industry, this thesis argues that there is more to robotics through the exploration of a richer symbiotic paradigm between robots and humans.

Sympoiesis focuses on the range of nuances in an interaction between industrial robotic arms and humans within creative processes that occur in architecture, design and art. Through concurrent interaction between two creators, a human and a robot, the project investigates what are the elements, behaviors and affordances of designing and creating with robots.

In this project, a KUKA KR6 is equipped with a custom toolhead that holds a series of sensing and actuating mechanisms to assist in a co-creative drawing experience. The movements and actions of the human are analyzed as vocabularies of geometrical elements and act as input to the robot to interpret them and respond through movements and drawing gestures. This “chess-like choreography” is set up as an interactive experience where visitors can interact with the system and co-create together.

As an initial iteration of this project, the experience between robot and human is curated around a version of the Silent Game (Habraken et al) and a series of short planar drawing exercises. As an extension of this thesis, a set of sympoietic objects are created. Sympoietic objects start as ways to document this space negotiation between the two creators and move beyond. They are communicative and exploratory artifacts that manifest this interaction.

As human-machine interactions become more ubiquitous become more and more ubiquitous, Sympoiesis explores the fringes of this relation, the dialogue between the human and the machine, their divergent interpretation of prototypes and finally the teaching and learning that will occur on both sides of the creation table. Sympoiesis aims to contribute to the intriguing, and yet unexplored field of robotics as design material.

Thesis Supervisors:
Professor Dr. Eric Paulos, College of Engineering
Professor Kyle Steinfeld, College of Environmental Design

Acknowledgements

This thesis wouldn't be possible without a series of individuals that were essential in my learning. I am greatly indebted to them for their generous support and inspiration.

First, the people that shaped my pedagogy in this program. The captains of this "pirate ship". Dr. Eric Paulos, for his fun, engaging and caring approach to things, to all things. To Kyle Steinfeld, an intellectual and inspirational compass for all of us, thank you for always seeking meaning to what we did. To Dr. Bjoern Hartman, for being a genuine pedagogist, a true visionary that created the place for us to create.
Also, to the external experts to this project, Dr. Ken Goldberg, Dr. Madeline Gannon, Joel Simon, Sang-won Leigh, who generously offered their time to guide us through our projects, your words and works were crucial to formulate this thesis.

I will always mention the Executive Director of the MDes, the almighty Gwyne Keathley, for pretty much everything. Her help and mentorship, in every shape and form is the reason I am able to complete this program today. Also, Dr. Randy Swearer, for his genuine interest in me, his immensely valuable mentorship and a world of ideas that I will always carry with me.

My professors in the MDes program. Randy Swearer, Yoon Bahk, Floor Van de Velde, Adam Hutz, Vivek Rao, Andrew Blanton, Bjoern Hartman, Kimiko Ryokai, Simon Schleicher and their talented graduate student instructors. You were a crucial part of this journey and I am grateful.

This thesis wouldn't be possible without the magic and help from Dr. Kevin Rudong Tian and Design Specialist Cody Glen. A huge thank you to the Jacobs Institute staff and the team of Design Specialists there; Joey Gottbrath, Gary Gin, Chris Parsell, Chris Meyers, Adam Hutz, and Semar Prom (CED).

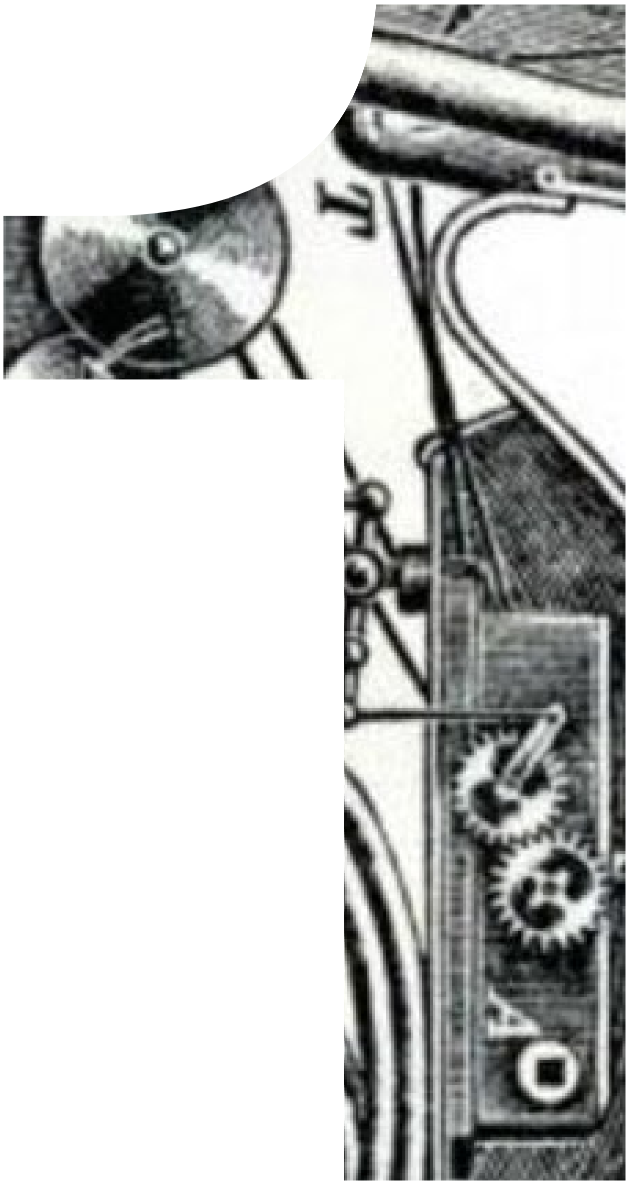
I would also like to thank my co-pirates in this journey, the people of the MDes program, students of the Spring 2022 and Fall 2022 cohorts. I had the chance to learn so many things around and with them. The incredible genuine and supportive people of the #helptradition channel, Jessica Kim, Maya Chen, Denise Heredia, Tee O'Neill, Hannah Bartolomea. A special thank you to my comrade and sanity checker, Jan-Simon Veicht, a true force of nature that I am sure I will meet many times down the road. Joanne Ma, who has been exceptional at always curating the experience, even for a limited period of time. The people of Milvia.

Professor Dr. Anastasios Tellios of the Aristotle University of Thessaloniki, an integral part of my journey. I am thankful that you always gave room to explore new terrains of ideas. To dear friends Julia, Georgios M., Thanos, Nikos. To the romantics of the xyzzy collective. In addition, the incredible, talented and inspiring people of GHOST office. Georgia Skartadou, for her multiplicity of ideas and skills, the conversations with her have always been a deep learning experience. Vasileios Aloutsanidis, for his many years of friendship and his excitement to everything we do together. Dimitrios Chatzinikolis, who is probably behind some of the most inspiring and agonizing things I do, thank you.

I wouldn't be here today without the support of my family. I hope one day I will be able to give back what you have given me. This thesis is dedicated to Georgios Gkogkou (Goulias), his magnitude of character will always guide me.

Contents

Chapter 1



Introduction 1.1

From Ancient Greek σύν (sún, “together”) and ποίησις (poíēsis, “creation, production”)
:co-creation, collective creation or organization

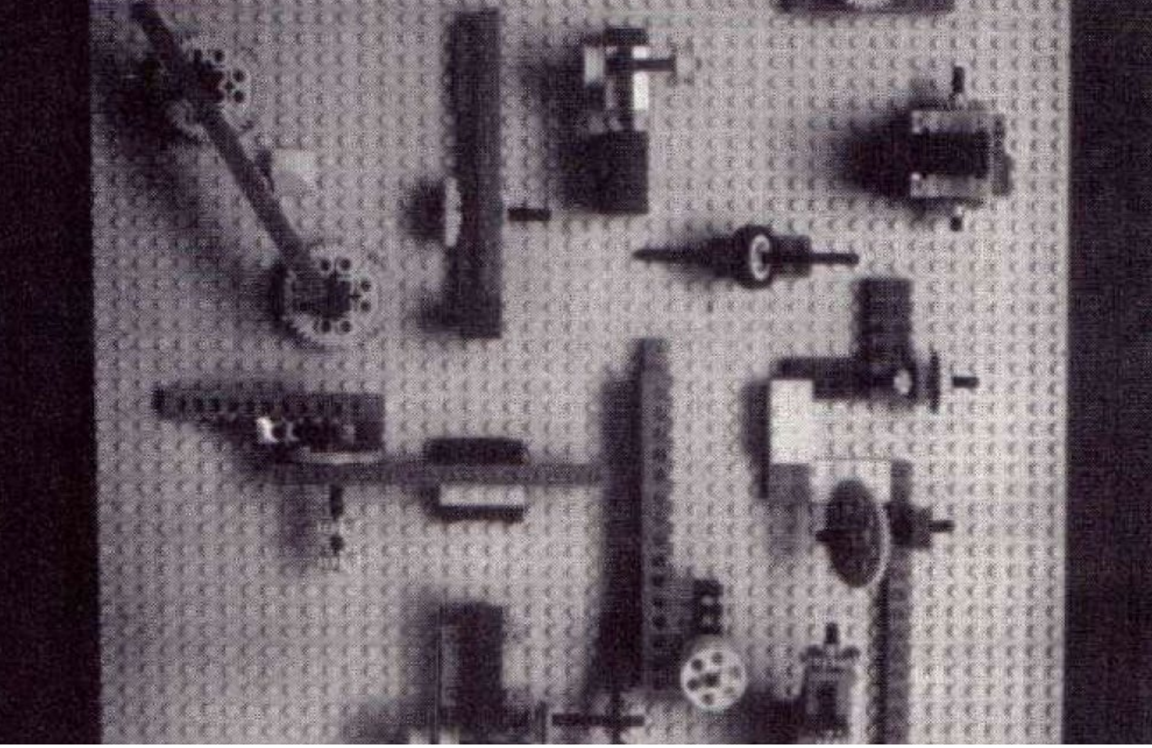
Sympoiesis means co-creation or co-formulation, referring to this extremely dynamic experience of sitting down with another person and creating something together. Humans are collaborative creatures. This process is fulfilling and at the same time challenging with tensions and unpredictable behaviors. This thesis takes this paradigm and provokes the question “what if on the other end of the table was a robot instead of another human being?”. It wonders if humans and robots could co-exist in a similar way under a creative brief and goal.

Current implementations and research around robotics focuses heavily on specific tasks that make use of what robots are actually impeccable at doing: being precise, repetitive and strong. Although this has been essential in industry, this thesis argues that there is more to robotics through the exploration of a richer symbiotic paradigm between robots and humans. It starts from a fascination about robots as multipurpose tools in industry and moves beyond that. It draws inspiration from older and contemporary precedents and works where robotics are considered a new medium to explore.

It also considers robotics as the physical vessels of our computation capacity as humanity. Their physical presence and ability to take actions in the real world based on the computation that occurs on the backend is something that is not new, but for sure is an evolving domain that offers opportunities to explore.

Back in 1982, Marvin Minsky published one of his many influential articles called “Why people think computers can’t” [1]. In this article, Minsky went on to explain how the whole notion of creativity and imagination in artificial intelligence and computer systems is ill-defined, making a strong argument that we might approach what constitutes a creative computer in a wrong way. This thesis chooses to extend this argument by not trying to address it but rather develop a propositional framework that could showcase a symbiotic relationship in a creative context between humans and robotic systems.

In this thesis, it is argued that this discourse from several decades ago about computers and creativity is now feeding, in a similar way, the discourse about robotics and creative tasks. This thesis does not pose problems to be solved but rather tries to identify the vectors and trajectories of how we can better understand this symbiosis in a creative context. To identify a terrain to explore.



Overview of the Thesis 1.2

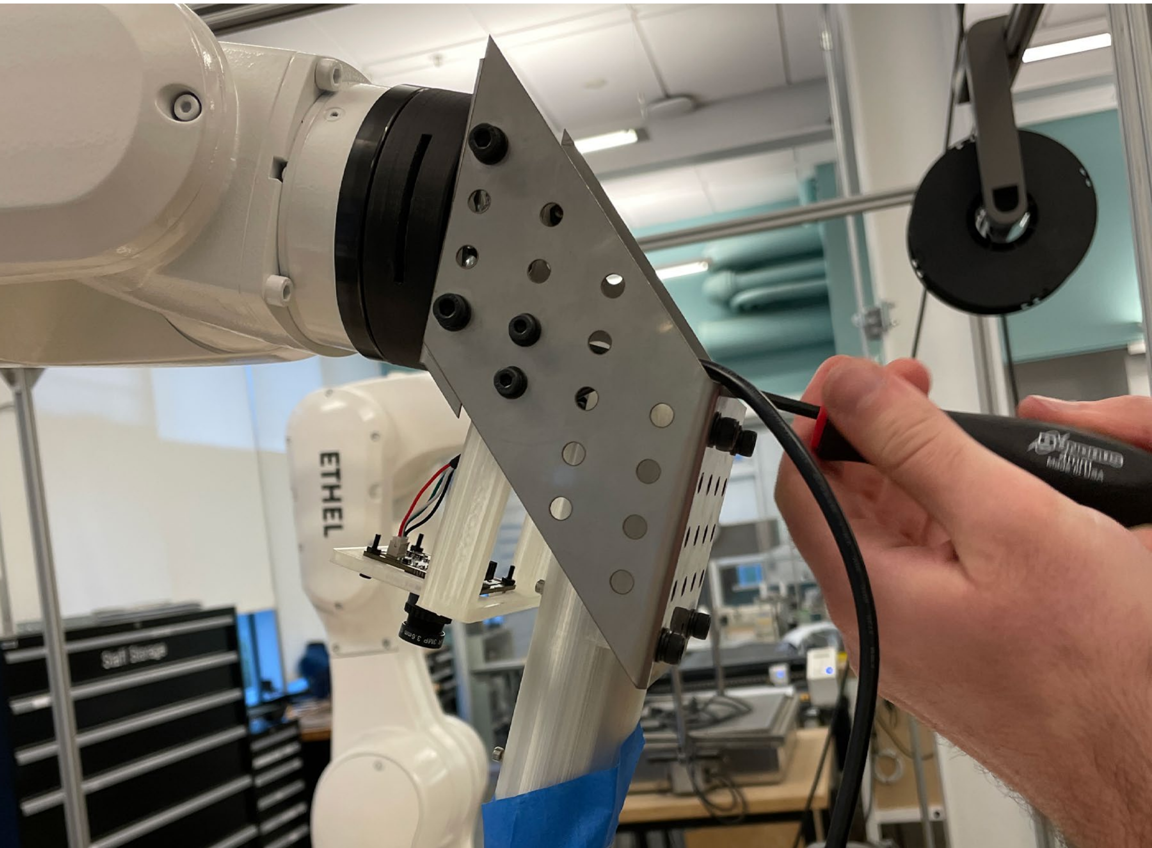
This thesis is organized around 5 chapters.

Chapter 1 provides an overview of the topics and domain that this project is working on and within. It introduces the domain of research which is robotics as a creative and design material and the motivation behind it.

Sympoiesis was developed as part of the Machine Poetics cluster in the MDes Design Studio during the Spring 2022 semester. It was inspired by the long history of robotics and research on it but also by a series of precedents in the field of creative robotics that paved the way for our current new trajectories to explore. These topics are presented in Chapter 2.

Chapter 3 introduces the materials and technical elements of the installation of Sympoiesis. What are the key specifications of this experience and what was implemented during the first iteration of Sympoiesis. In addition, potential alternative technologies and limitations of the system are presented.

Finally, in chapter 4, is the final conclusion of this thesis with what is envisioned as future steps of further development.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Summary of Contributions 1.3

The primary objective of this thesis is to explore ways that humans and robots can be co-creative in a symbiotic way. For that reason, an interactive installation was developed and implemented. During this process, a series of references, technical solutions and systems were explored. The contributions of this thesis could be summarized as:

1. A literature review of the domain of Machine poetics

2. A survey on the body of precedents that revolve around robotics and creativity

3. A case study for an interactive co-creative robot-human experience

4. A framework of human-robot collaboration under a creative brief or context

5. Design and fabrication of a modular industrial robotic arm end effector that can be alternated to experiment on examples of co-creative experiences

6. A potential human-robot live interaction system architecture

Chapter 2

Background 2.1

This project was developed during the Design Studio class at the Master of Design program at UC Berkeley and it is part of the Machine Poetics cluster, a cluster of designers interested in how humans can work with machines to create artifacts that talk about this symbiosis. In this instance, a machine could be a series of computational tools, generative deep learning or finally robots.

In the still-nascent age of machine-augmented creative work, what new poetics might emerge, and what new opportunities might designers embrace? At a time of increasing automation across industries and design practices, rather than understanding the presence of a human "in the loop" as a failing of a process to become fully automated, what if we saw this as an opportunity to more fully embrace and celebrate the inherent "humanness" of interaction with computational systems?

The fascination of humans about the aesthetics and potential of machines runs fairly deep throughout the years. Over the last century, machines have successfully automated large parts of production and labor. As they get progressively smarter, lighter, and more ubiquitous, automatization has expanded into the broader creative process. This paradigm shift spawns a surprising amount of questions as the distinction between production and creativity is central to the discourse. While the former is mostly a matter of mechanical manipulation and simple feedback loops, the latter requires many qualities that are profoundly "human". Machine Poetics is a cluster of designers and projects that attempt to articulate people's relationship to machines.

We may observe that the term "machine" still carries much of its industrial age connotation. To many, it evokes imagery of gears, pulleys, and pistons whirring to the rhythm of production. In contrast to that imagery, machines today are a ubiquitous part of everyday life - they are all around us. They assist us with tasks ranging from brushing our teeth to communicating with loved ones and everything in between. While the tasks we ask our machines to assist with have gotten more and more complex over the years, the fundamental relationship between humans and machines has remained consistent: it can be distilled into a series of transactions. As we stray further and further from the industrial era, that relationship is starting to change. Poetics in this cluster has a twofold meaning also. Etymologically the word is used as is but also based on its root, therefore poetic as a poem, but also poetic as poiein, meaning making things. Poetics as creative works that are poetic but also poetics as machines that craft things.

The work conducted during Sympoiesis is considered a “Machine Poetics project” for several reasons. It uses robots as physical vessels of humanity’s computation capacity, their interpretation as creative work and the poetic annexes of bodily negotiations between humans and robots.

Survival Research
Laboratories
Performances

History 2.2

From their conception, humans were always fascinated by the potential of robots. The whole notion of robotics, of artificial systems that could take physical actions is surprisingly an old one. One could trace fragments of the concept in many cultures around the world throughout the centuries.

A representative example comes from Greek Mythology and the story of Talos, a giant bronze Automaton that would guard Crete and protect Europa from pirates and invaders [2]. Talos was, as in many cases, anthropomorphized, having the shape and form of a bronze sculpture of a young man. It wasn't up until centuries later where the whole concept took the name of "robots". It is believed that the term surfaced at the beginning of the 20th century and comes from the czech word "rabota", meaning slave [3].

We came a long way, from our initial conceptions of artificial creatures that could serve us as rabota, all the way to extremely sophisticated solutions in today's industry and fabrication landscape. The Industrial revolution was an integral part of the advancement of robotics. Starting from simple automation solutions and leading the way to bigger, faster and precise machines. Today, the landscape of robotics is an ever growing one, as most of the advanced manufacturing processes rely heavily on robotic solutions for welding, moving, packing, sorting and doing a huge set of precision tasks.

The notion of robots carries for sure a lot of "cultural cargo" [4], being present for several decades in books and movies all around the world. This heavy cultural connotation sometimes makes even the definition of what constitutes a machine and what a robot a rather difficult one. In the premise of this project, robots are considered multi-axis robotic systems that are used in industry and research, such as industrial robotic arms.

Telegarden, 1995


The Architecture Machine
INTERDATA

Precedents 2.3

This thesis starts from a fascination about robots as multipurpose tools in industry and moves beyond that. It draws inspiration from older and contemporary precedents and works where robotics are considered a new medium to explore. Focusing on the works of the late 20th and early 21st century, it draws inspiration from works that take the form of installations, experiments, research projects and art performances. This chapter aims to briefly compile a body of references and precedents that are closely related to the arguments and research fields that this thesis tries to explore.

SEEK by Architecture Machine Group (1969)
One of the most influential bodies of work in the space of machine intelligence, design and human-machine interaction was the one at the Architecture Machine Group at MIT during the early days of human computer interaction research. This is where project SEEK (1969)[5] was developed by Nicholas Negroponte and the Group. SEEK was an installation of an acrylic encased set of cubes and a computer-controlled robotic system that would rearrange the environment based on the commands that the authors would program. Inside this environment, a group of gerbils would also rearrange the setting, creating a negotiation between the two sides. SEEK was shown at the “Software” exhibition in 1970, and it was one of the first examples of serendipitous and explorative installation investigating interactions between creatures and artificial systems. [6] [7]

Works by Survival Research Laboratories (1978-2022)
Another set of inspiration points is the body or works of the Survival Research Laboratories(SRL), founded in 1978 by Mark Pauline in California. SRL creates performances and experiences of machinic controlled chaos, and invites people to be part of it. The group is famous for creating custom-built machines or robotic systems and operating them in a destructive fashion in open public environments. These performances are characterized by their disruptive, noisy and almost violent nature. Sympoiesis draws inspiration from this

Architecture Machine Group
1969

group of pioneers, as it views their work as explorative on the tension between human and artificial bodies. [8] [9] [10]

Telegarden by Goldberg and Santarromana (1995)
Telegarden was deployed in 1995 and was directed by Ken Goldberg and Joseph Santarromana. It is considered one of the most distinctive robotic art installations and is part of the Ars Electronica permanent collection at the Ars Electronica Museum in Austria. The installation consisted of an Adept-1 industrial robotic arm and a circular garden around it. The robotic system was connected to the internet, allowing people from all over the world to plant, take care and water the plants of the garden. Telegarden was one of the first art installations incorporating industrial robots and it stayed in operation until 2004. It is referenced as part of this thesis for its propositional nature, the notion of not only creating art with and from robots but also organizing communities around them. [9] [10] [11]

Quipt by research studio ATONATON (2015)
One of the more contemporary precedents of this work is the research and work of the ATONATON group and Dr. Madeline Gannon. One of the most important examples of this body of work is the project Quipt developed in 2015. The project investigates intuitive ways to communicate with industrial robots through gestures and motion capture systems. Quipt is using wearable markers on the hand and around the body to inform the system, therefore creating an interactive experience with an industrial robotic arm that is spatially and contextually aware of its surroundings and actors in the field. Quipt was one of the first references of this thesis, as it incorporates many of the elements that Sympoiesis aims to investigate, such as repertoires of behaviors of the robotic systems, spatial awareness, live interaction and close bodily choreographies between human and robotic bodies. [12] [13] [14]

SEEK, 1995
Architecture Machine Group

These are some of the many projects and works that include and explore robotics in a new and creative way. They are great examples of a symbiotic paradigm of robots as something to create new types of communities around it, to explore the tensions between human and artificial bodies and approach them as creatures or actors in an, up until this point, mainly human activity which is creating.

In addition to these precedents, a series of conversations with external domain experts took place during the Spring semester of 2022. The external experts of this project were Dr. Ken Goldberg, Dr. Madeline Gannon, Joel Simon, Sangwon Leigh. These discussions informed and influenced the trajectory of this project in a genuinely constructive and creative way.

From the computational machines of Architecture Machine Group and the machine theater of Survival Research Laboratories, all the way to the delicate interactions of the ATONATON works, this thesis aims to explore the in-between spaces of these important propositional works of what constitutes machine poetics and come up with its own future protocols and trajectories of interaction. Its intention is to seek for the notion of exploration and accident, the love of apparatuses in humaine making operations.

Survival Research Laboratories

Telegarden, 1995

Quipt, 2015
ATONATON

SEEK, 1995
Architecture Machine Group

Chapter 3


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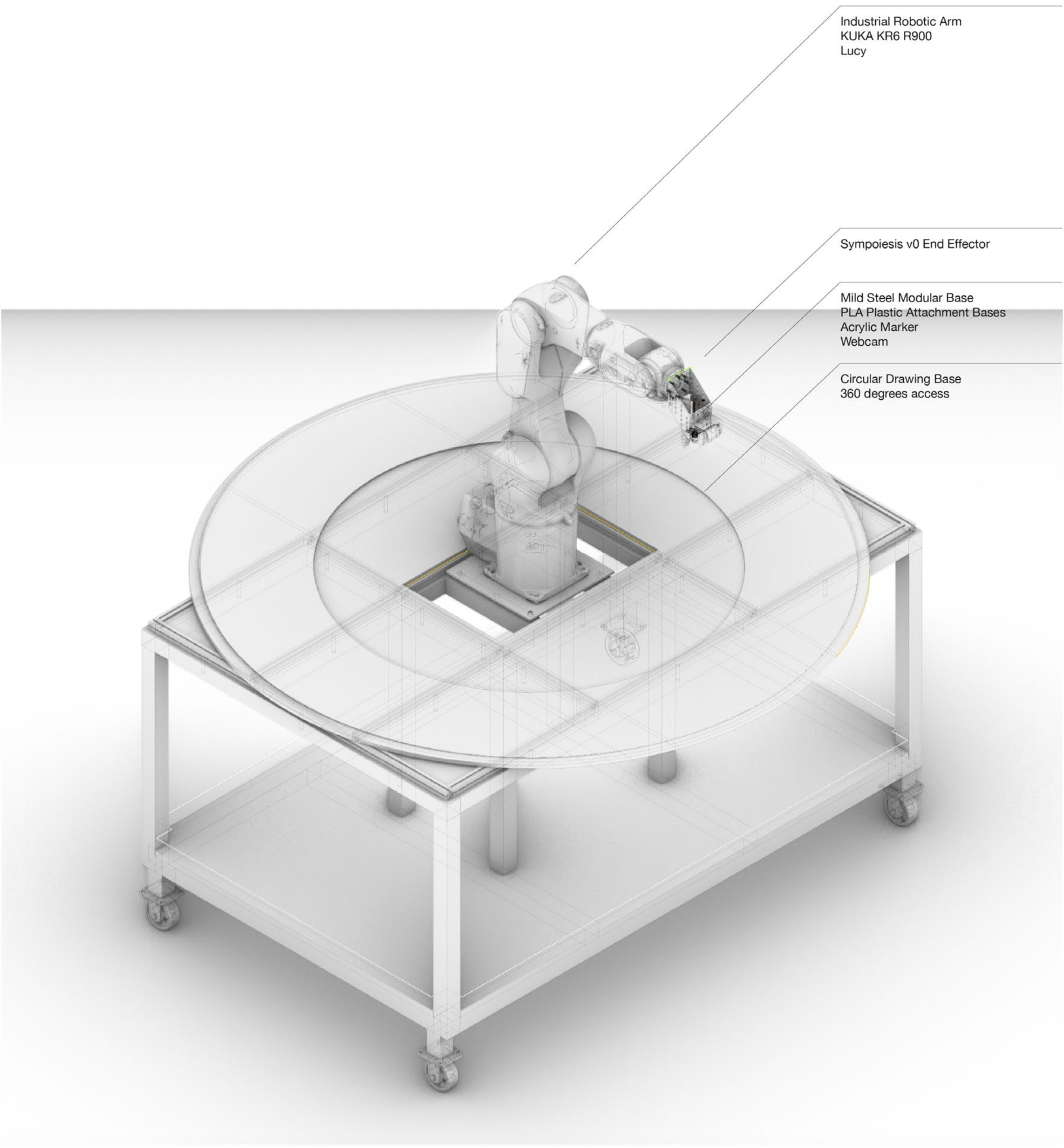
STOP

Materials 3.1

Design is a messy process that involves a lot of transactions. One of them is materials. Wherever designers operate, either in the digital or the physical world, they deal with materials [15] [16]. Chapter three briefly goes through the materials of this thesis.

The key material in this project is a Kuka Agilus KR6-R900 robot. A small scale industrial robotic arm used in industry and research for tasks such as CNCing, welding, drilling and other fabrication and packaging tasks. The KR6 is a 6 axis robotics arm, has a maximum reach of 900 millimeters around its base and a maximum payload to the end effector of 6 kilograms. The robot is mounted in a stainless steel metallic frame and is part of the research resources of the Jacobs Institute for Design Innovation at University of California Berkeley. The name of the robot is Lucy.

Besides its relatively small size, the KR6 presents certain disadvantages when it comes to human-robot interactions and tasks. This type of Kuka Agilus robots are not inherently safe, meaning they can move very fast without being aware of their surroundings, posing a certain degree of danger for humans. In comparison, there are smaller research focused 6-axis robotic arms with embedded sensors that allow for spatial and collision awareness to the robot, therefore making them more appropriate for this type of project. To mitigate these considerations during this project, the speed of the robot was limited to 25% of initial speed for point-to-point (PTP) movements and 0.25 m/s for linear movements (LIN). At the same time, at all times of operation, a safety switch had to be pressed to allow the robot to execute the choreography. This was done to ensure that there won't be any collisions or unwanted conflicts with human input during the interaction.



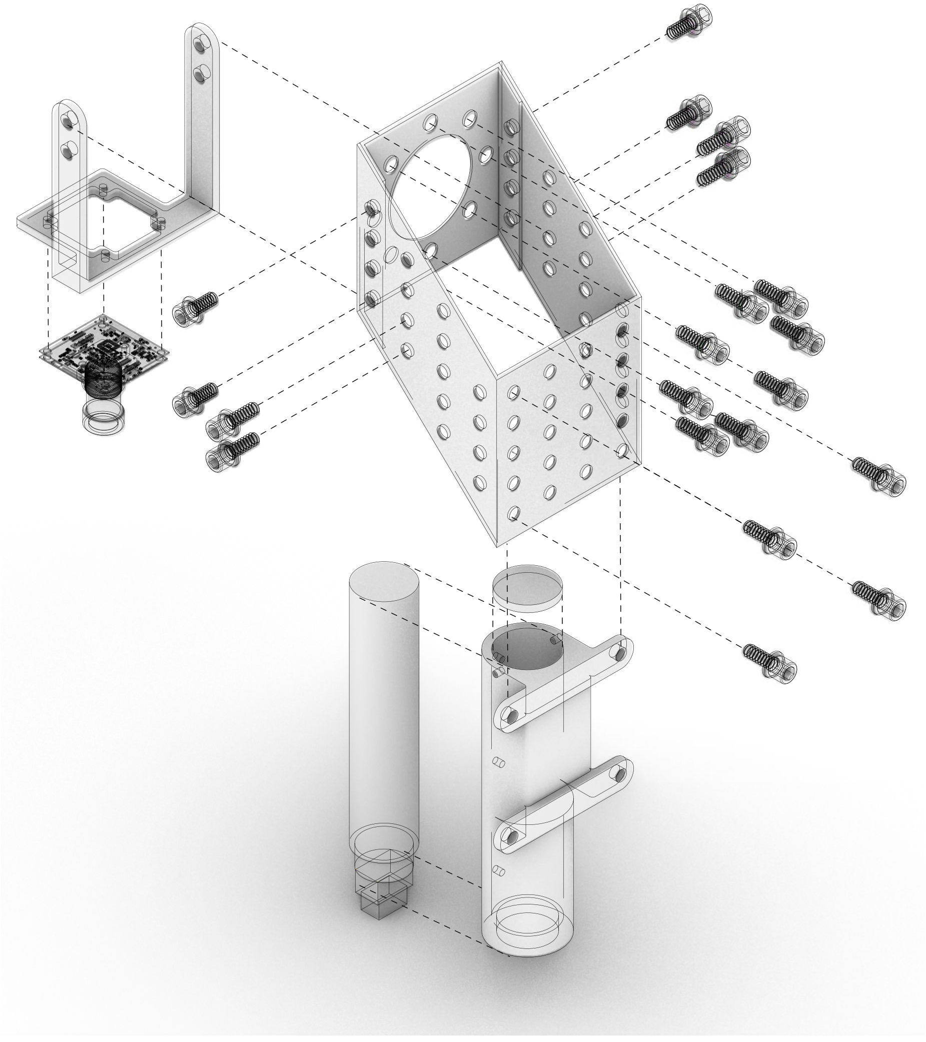
Sympoiesis v0 Setup

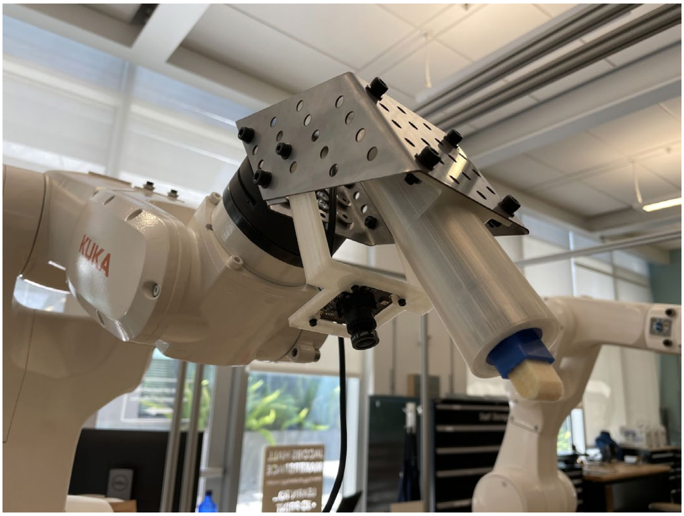
The second material of this project is the design and fabrication of the end effector. On the end of the KR6, a modular circular base allows for a plethora of multipurpose end effectors to be mounted. Given that the nature of this project is on the exploratory side, it was decided to design and fabricate a modular end effector, to allow for different tools and sensing mechanisms to be deployed. The first iteration of the end effector base is fabricated out of two pieces of bended stainless steel. The base contains a grid of perforations to allow for modularity, to allow different tools and sensory devices to be embedded in and on it.

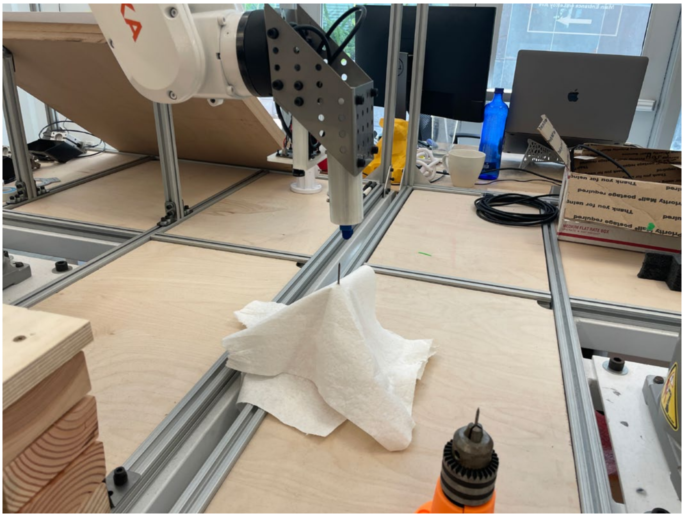
In addition to the metal base, a set of 3D printed attachment components were designed based on the needs of the first iteration of Sympoiesis. In this instance, a cylindrical case for an acrylic marker and a light holding structure for a small scale web camera were developed, fabricated and mounted to the robot. These components were fabricated out of PLA plastic and were mounted with metal hex socket screws on the metal frame.

Finally, every design process has to have a task or a brief as a material. Being creative can be broad, a plethora of tasks fall into this categorization. For this iteration of Sympoiesis, 2D planar drawing is chosen as the main task of the interaction. For that reason a 15 millimeters acrylic marker is used to draw on PET transparent sheets. To allow for a shared artboard surface between humans and the robot, a wooden circular base was designed, with the intention to allow for an all around interaction between multiple contributors. For the showcase of the project, a part of this base was fabricated.

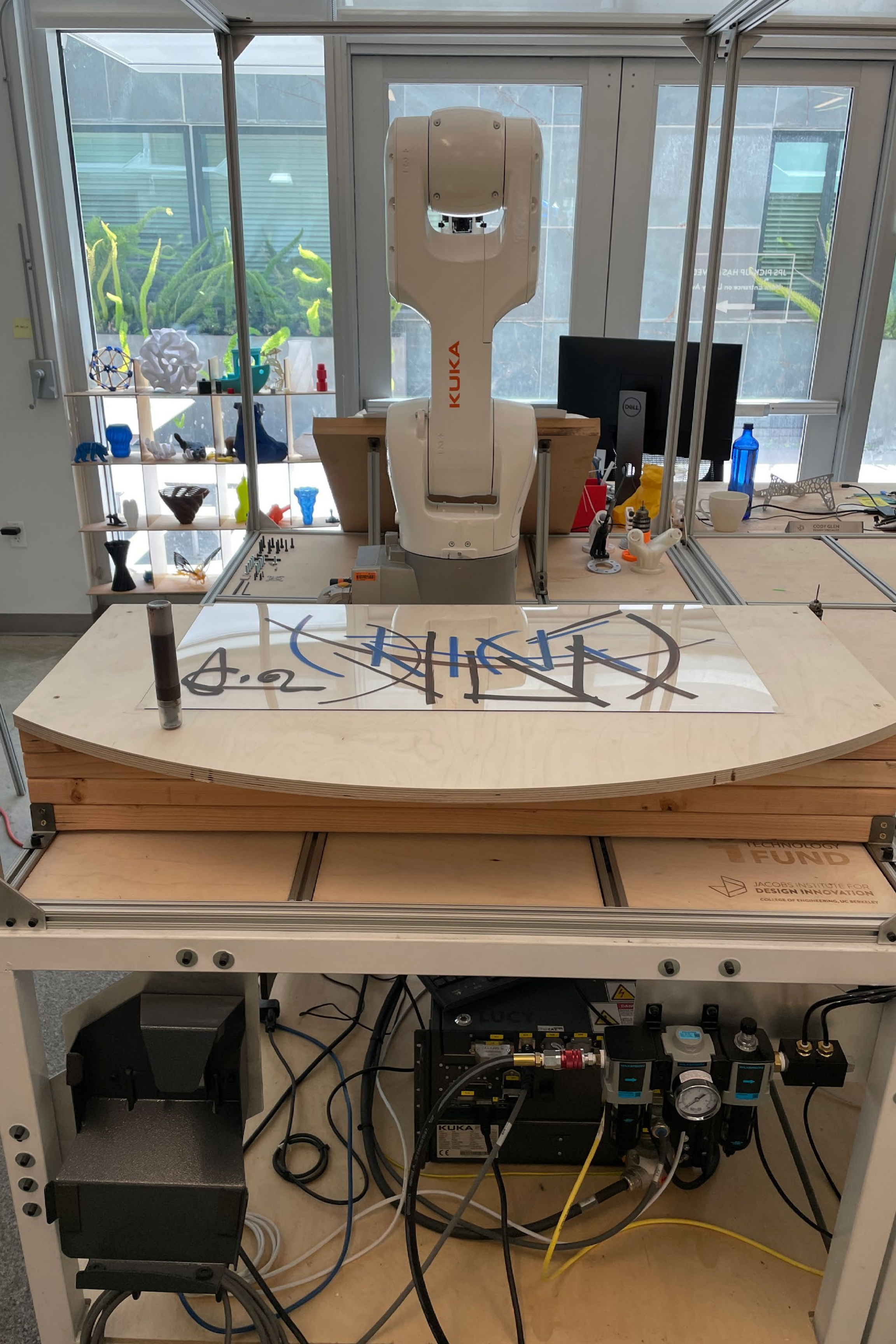
Sympoiesis End Effector
Design and Assembly







Sympoiesis End Effector Design and Assembly and Calibration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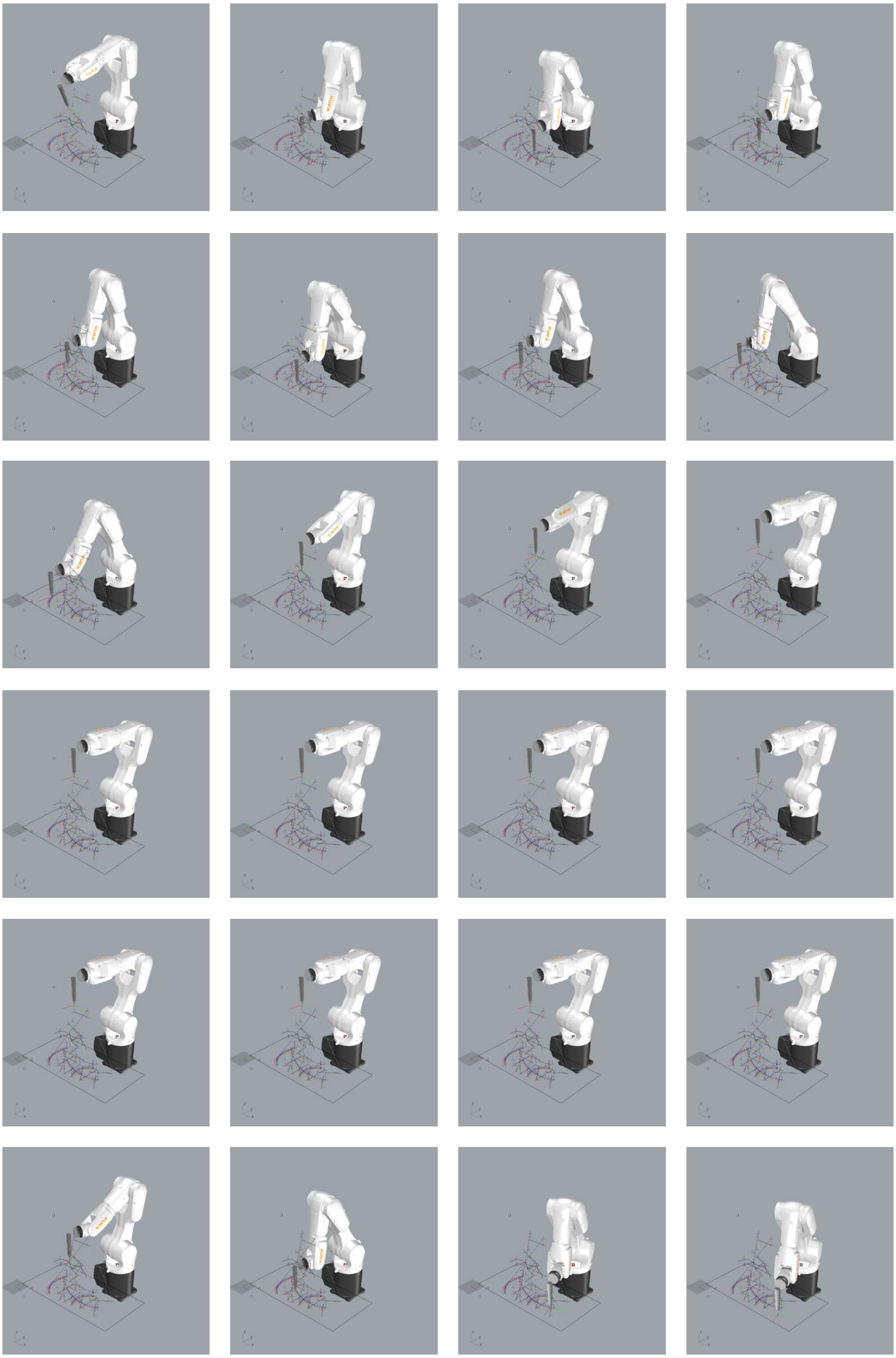
COLLEGE OF ENGINEERING, UC BERKELEY
KUKA

System 3.2

The first iteration of Sympoiesis was developed as an offline programming example. This means that the choreography of the robotic arm was pre-programmed and loaded to the system to execute. The commands and settings of the system were programmed through Rhino and KukaPRC [17], allowing for quick testing of several small choreographed movements and what they could mean and feel like, in the presence of humans contributing to the interaction.

For future iterations of this system, it is envisioned the development of a live interaction system, moving away from the offline programming paradigm. This system, influenced by the work done by the team of the project Adroid [18], envisions a live system through the use of the open source library KukaVarProxy [19] [20] and the setup of a node.js live server that could handle the interaction events in real time.

Sympoiesis v0
Choreography



Limitations of the System

One of the main limitations to develop similar projects is the cost of such settings. Although the cost of industrial robotic arms is currently decreasing, it is still quite high to allow for these types of interactions and experimentations to take place in diverse contexts and be widely available. This means the deployment of this suggested framework is limited to settings where access to the robotic system is available and open.

In addition, most of the manufacturers' software tools and frameworks for live communication with the robot are proprietary and costly, therefore posing a high entry point to this kind of experimentation. In this case, the software that would allow for live communication with the system (Kuka mxAutomation) was costly and was rejected as an option from the start. There were several open-source solutions that were explored, such as ExMachina, ofxRobotArm and others but none of them could cover the full spectrum of intended interactions and technologies for the final installation.

During the development phase of this project, it was intended to curate this installation around two identical industrial robotic arms with different instructions and "behaviors", aiming to showcase and explore a more dynamic creative environment with multiple actors. This was not implemented as the complexity of the system wouldn't allow for consistent evaluation at this point.

As part of the development phase, it was chosen to frame this interaction around 2D planar drawing, which only explores a small part of what can constitute creative interaction. It is envisioned that additional tasks and design briefs could be choreographed and developed around the Sympoiesis frameworks. Such exploration will for sure include tasks that deal with space in a more direct and expressive way.

Finally, the notion of industrial-level safety and multiple safety features in the system and interaction was not fully developed. As mentioned before, the industrial robotic arm of the project is not human oriented when it comes to safety features, therefore posing questions and concerns when it comes to safely operating it while humans are part of the experience. The absence of a robust and fully designed safety system around the robot and during the interaction were some of the reasons that the first iteration of Sympoiesis was developed through an offline programming approach and the safety features of the robot teaching pendant always deployed.

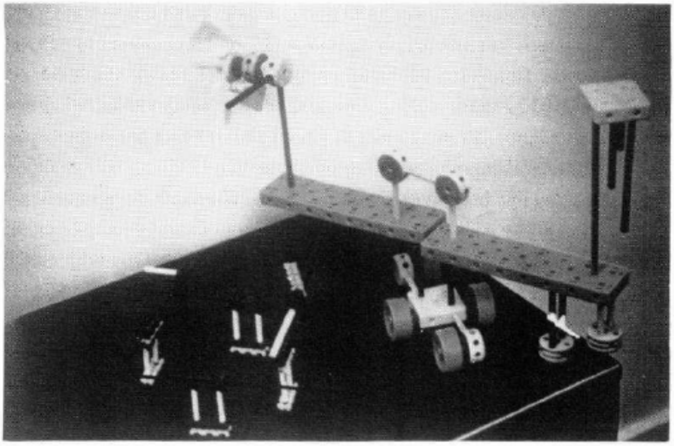


Figure 2. Modula Bricks.

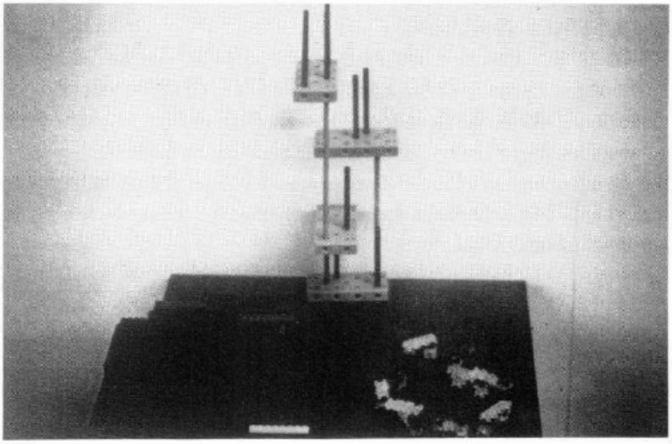


Figure 3. Bob's Constructions.

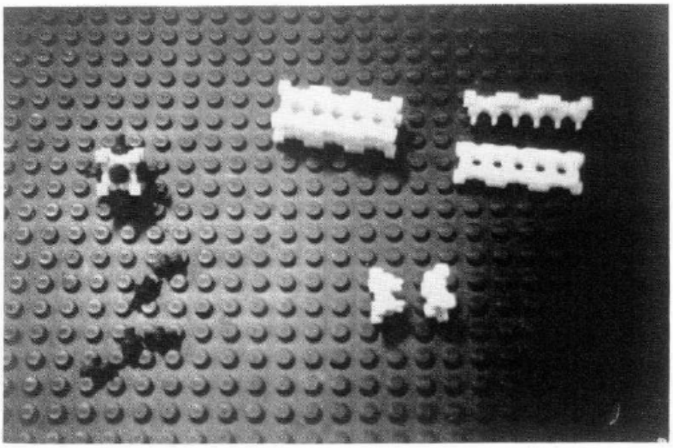


Figure 4. Mimi's Constructions.

How do you work to create co-creative machines?

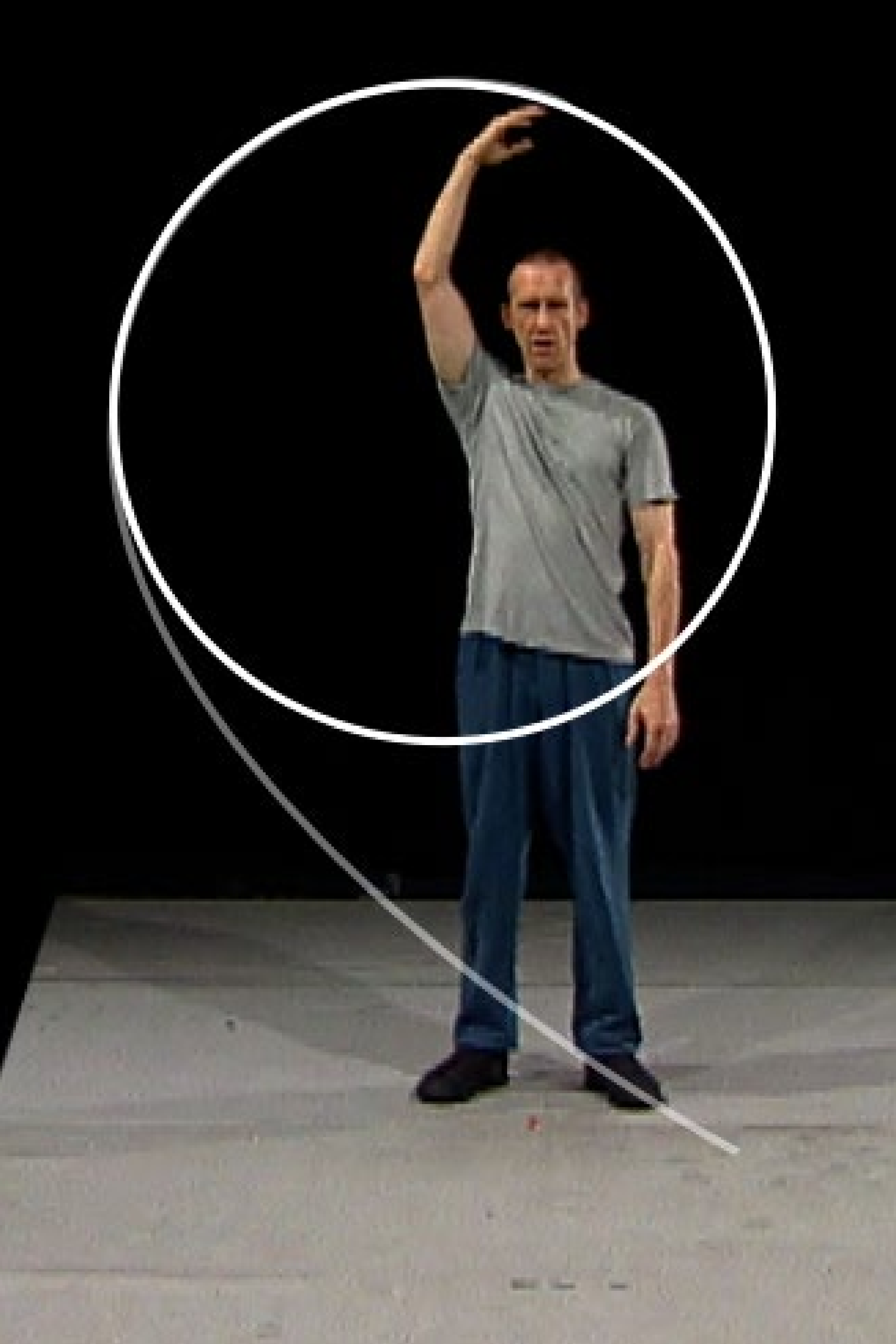
What could be considered creative contains a certain degree of ambiguity, meaning that creating a system to respond creatively might be difficult and be open to different interpretations on the degree of this creativity. This thesis does not intend to answer the question “Can robots be creative” but rather explore how creative robots will feel during a potential co-creative experience. This thesis references two types of work for this part.

The first reference is a series of design experiments called “Silent Game”, developed by John Habraken and his colleagues during the decades of 1970s and 1980s [16] [21]. In this design concept game, two builders are given a certain set of materials or objects and they are asked to participate in a turn taking exercise without communicating with each other.

‘‘ Design can be understood as a dialogue of prototype. Each designer creates their own design world, with their own set of rules and tries to communicate them to the other side. These design worlds come with a set of rules that derive from prototypes. In the Silent Game, we have two builders, A and B. Out of a certain set of materials A is asked to initiate a design proposal that embodies a rule. Without communicating, B is asked to continue the design according to what they think builder A is building as a rule.
...Silent game teaches the player to be open to what is done by others. It triggers a discussion afterwards about the images and visions we implicitly share when designing”

[16]

Silent Game Variation
Donald A. Schon

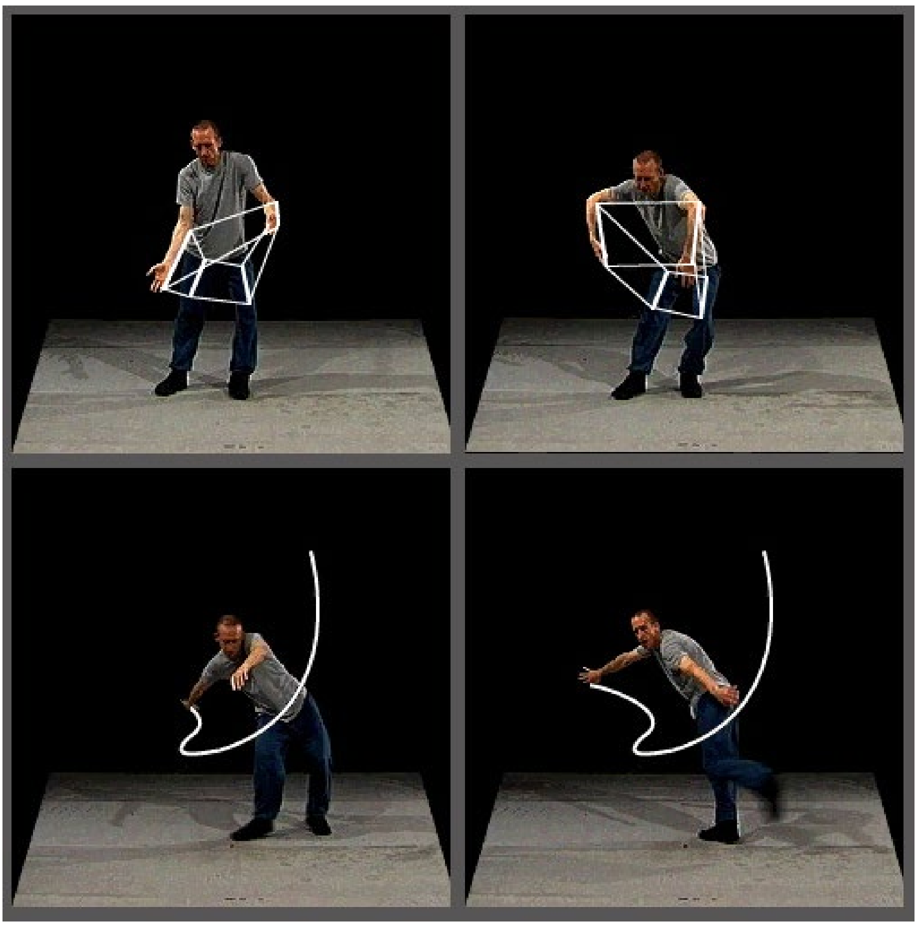


The second reference speaks to the bodily negotiation between human and artificial bodies. There is an argument about the embodiment of this interaction. How the two bodies interact and move around on the task. How the body movements are perceived and how do we talk about this constant negotiation.

Drawing inspiration from the work of choreographer William Forsythe and the project "Improvisational technologies" [22] [23] and "Choreographic objects" [24], this project goes on to create a series of Sympoietic Objects. Sympoietic objects start as ways to document this space interaction between the two creators and move beyond. They are communicative and exploratory artifacts that manifest this interaction. They ask "What else could be there?".

In "Improvisational Technologies", Forsythe analyses bodily movements as simple geometries like points, lines, planes etc. The movements and actions of the human are analyzed as vocabularies of geometrical elements and are recorded in such a way. This type of analysis acts as inspiration for the behavioral part of Sympoiesis. Through several video recordings between two humans and between a human and the KR6, this thesis takes a stance that co-creation is a bodily negotiation, as the gestures and space vectors of movements seem to carry more significance and tension about the nature of the interaction. Having said that, the way that Forsythe and his team analyses bodily gestures is chosen as a method for the sensing protocols of the robotic part of the system.

Improvisational
Technologies
William Forsythe

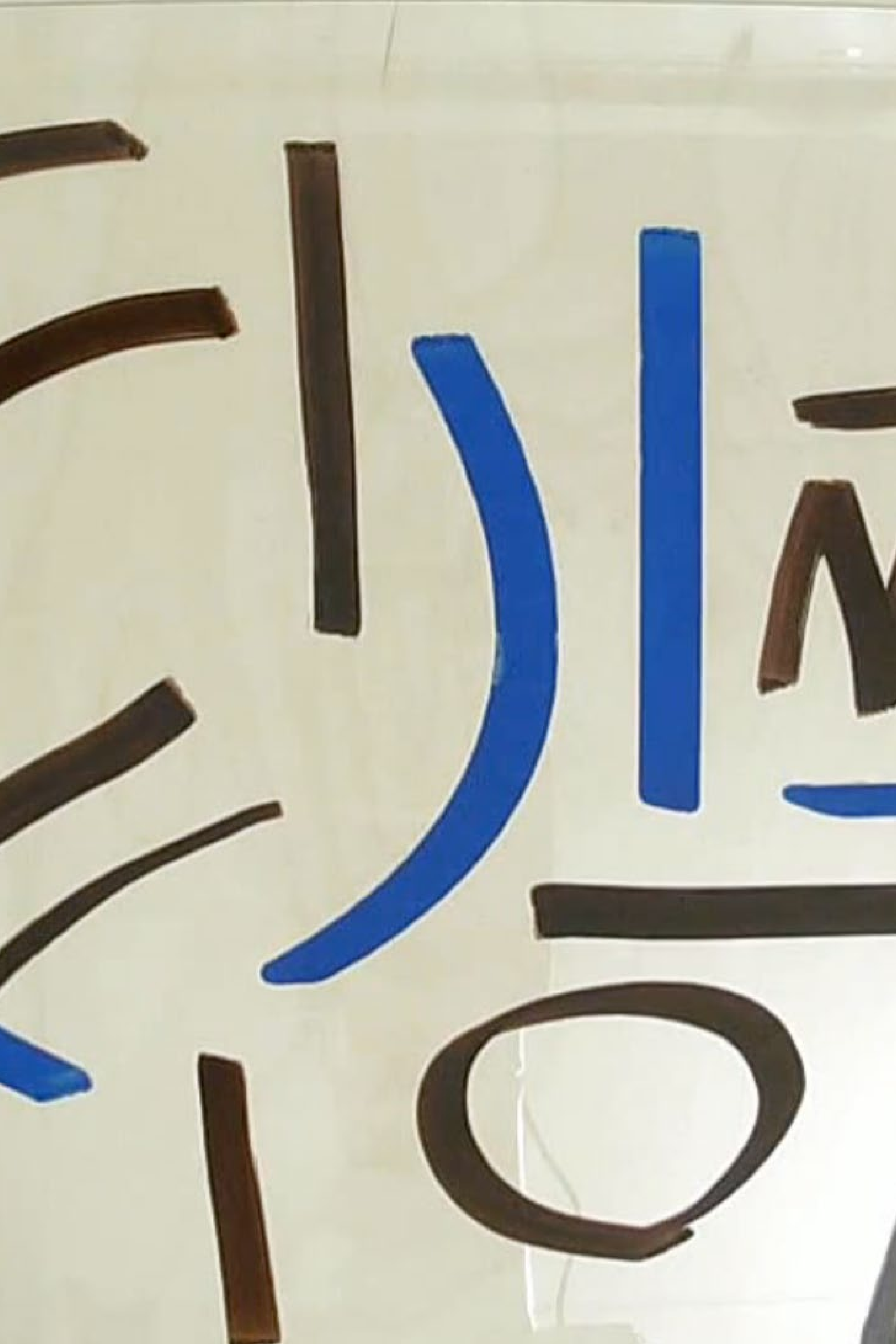


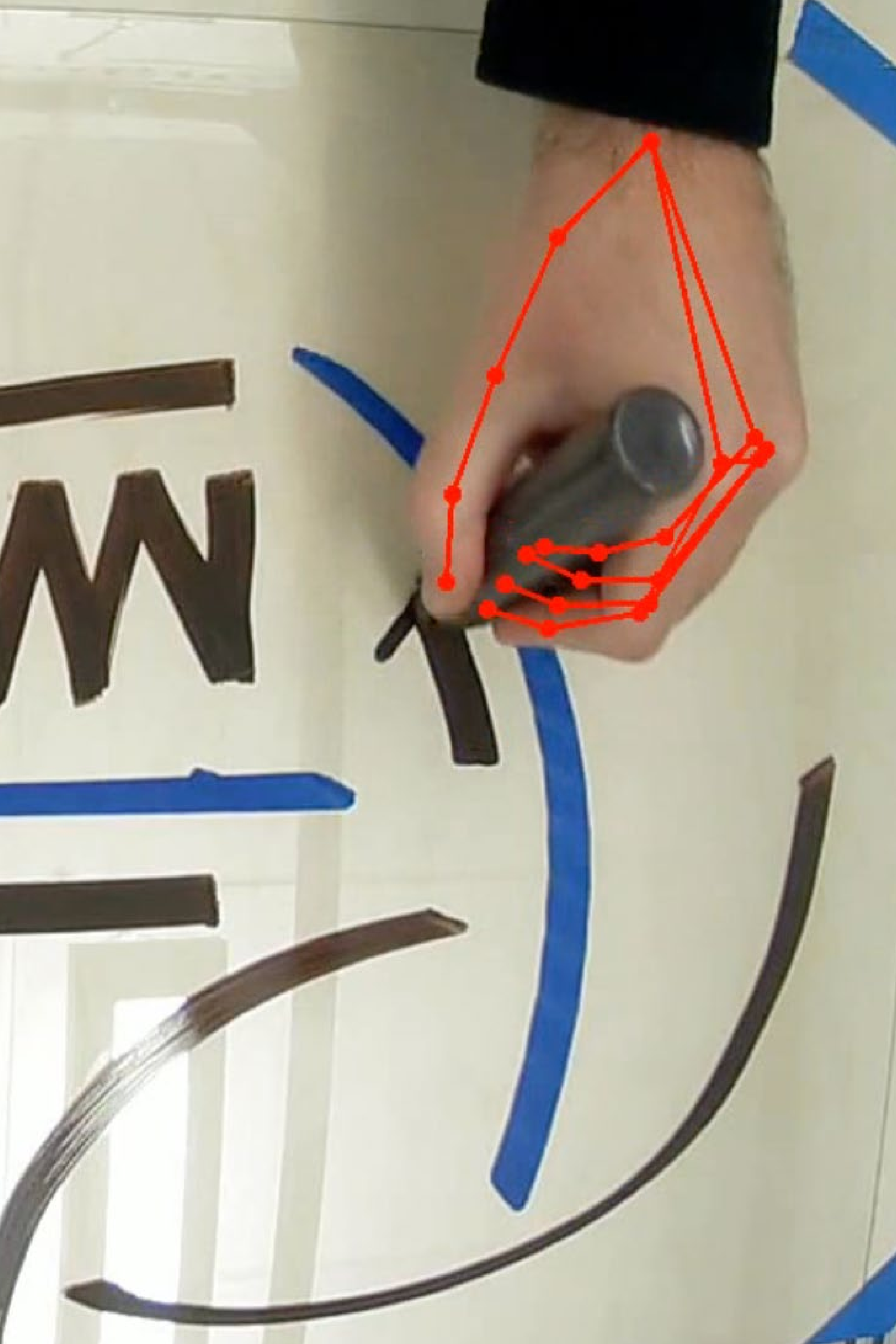
Choreographed interaction

In this iteration of the Sympoiesis, the KR6 robot (Lucy) is the Actor A and initiator of the interaction. The human participant is Actor B and the group of people around the installation form Actor C and observer. Lucy starts with a series of pre-programmed movements and joins the artboard together with Actor B. She starts with a set of movements, pauses and finally an initial set of sketches. After that, it is choreographed to invite the other side and wait for 10 seconds to allow the other actor to respond to her movements. This choreography repeats for three rounds until Actor A terminates the interaction.

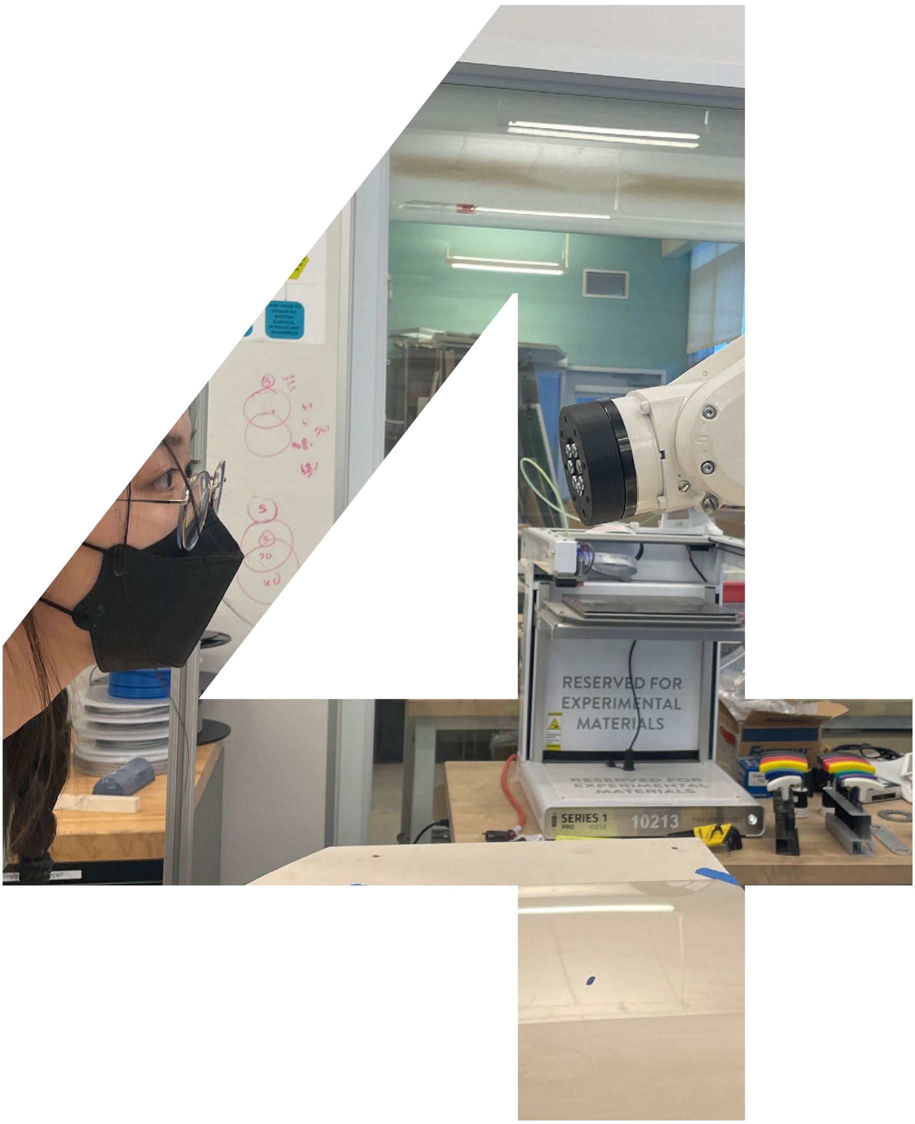
The discussion that followed this initial iteration of the project focused heavily on the potential behavioral patterns of the robotic arm, more than what it was actually drawn on the shared work surface. This amplified the initial argument abount the fact that co-creation is a bodily negotiation between several parties and sides.

Through concurrent interaction between two creators, a human and a robot and a simple series of design games, Sympoiesis showcases how we could explore what are the elements, behaviors and affordances of designing and creating with robots.





Chapter 4

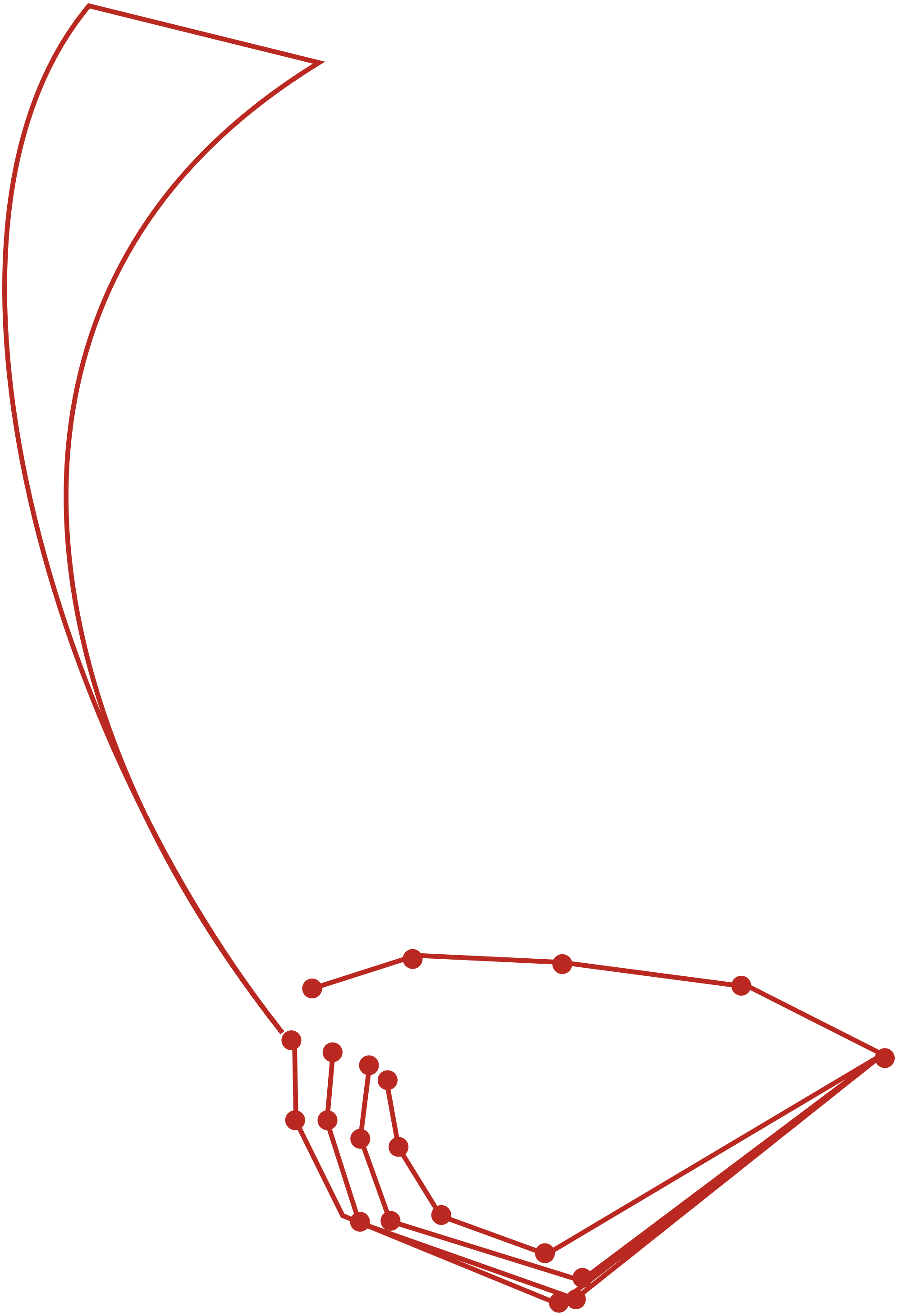


Future work 4.1

One of the main trajectories of this project is the development of a live interaction framework, similar to the one briefly mentioned in chapter three through the deployment of KukaVarProxy. In that way, it is envisioned to make the robotic part of the system to record and respond to human input in the co-creative context in a more dynamic way, allowing an even deeper understanding and discovery of the design process with robotics.

Beyond the first iteration of Sympoiesis, many of the limitations of the current system and findings during the discussion phase of this project propose opportunities for further development and exploration. First, an exploration beyond the initial iteration of the Silent Game could be of interest, something that will inform our understanding on what constitutes a “co-creative machine” and the protocol of action taking with it. In addition, the design and curation of the robotic setup can be explored further through different types of technologies and hardware. A system that leverages advances in computer vision and artificial intelligence might introduce different behavioral patterns into the interaction and inform the choreography and negotiation between human and robot. The use of more than one industrial robotic arm will allow for a more dynamic environment with multiple actors and contributors to the experience. The use of different sensing mechanisms, such as infrared camera sensors, could inform how the robot perceives human input and respond in alternative ways.

A very important next step would also be the development of a more robust safety framework for the interaction that will give room to more serendipitous and intuitive behaviors between humans and the system. Finally, the formulation of a more comprehensive evaluation framework would allow for a deeper understanding of the interaction, allowing observers to document the interpretations of each actor in a more transparent way, therefore informing the design process.



Conclusion 4.2

This thesis presents an investigation and exploration into the design of human robotic interactions and relations. It uses the context of creative interactions that occur in architecture, design and art to curate experiences around human and robot co-creation.

During this project, a survey was conducted on the history and precedents of the field of robotics as creative material. An interactive installation was designed, deployed and presented as part of the final showcase of the MDes program. Drawing inspiration from design studies and the concept of Silent Game, the project explored this symbiotic relationship through a series of short, planar-drawing, turn-taking exercises and an evaluation and interpretation phase that followed.

For Sympoiesis to take place, a metallic modular end effector was designed and fabricated to allow an open ended approach for the curation of the experience. The intention was to allow future iterations of the project to incorporate different hardware and software components and expand the explorative part of it. Finally, the initiation of this type of work is intended to function as a framework for human-robot co-creative experiences, informing our understanding of the negotiation between the two sides and positioning emerging technologies such as everyday robotics deeper into the design process and design research.

Robotics has a long history in human culture and industry. Although rich, there is no doubt that a new wave of technologies introduce robotics in everyday life in a very different way with great consequences. While the shape, scale, materiality and feel of these “devices” is currently taking shape, there needs to be a discourse and a body of exploration on what our intended and unintended interactions with them will look like, and what the implications of these “tools” will be . As with many technologies in the past, the creative industry needs to be present to find out what else could be there, and what the new set of transactions will entail.

Returning back to the writings of Marvin Minsky [1]:
“... those new ideas will give us new ideas for new machines, and those, in turn, will further change our ideas on ideas. And though no one can tell where all of this may lead, on thing is certain, even now: there’s something wrong with any claim to know, today, of differences of men and possible machines - because we simply do not know enough today, of either or possible machines.”

Although we are several decades away from this set of ideas, and our understanding got deeper, we might extend the same or a similar argument when it comes to robotics or machines in the fabric of today’s or tomorrow’s society. There is for sure great potential for new learnings, for new bodies of findings, something that this thesis argues that will happen through propositional work.

This thesis argues that if we want to explore robotics as design material, we need to create several similar frameworks that will allow us to explore this new terroir of ideas. That will allow designers to deeply engage with all aspects of robotics, helping them understand better the nature and affordances of this new field. While doing that, there is great confidence that designers will explore and discover new ways to design robotic systems for everyday life but also incorporate new vocabularies and technical aspects into the design process. Sympoiesis aims to inform our understanding of the teaching and learning that happens on both sides of the drawing table.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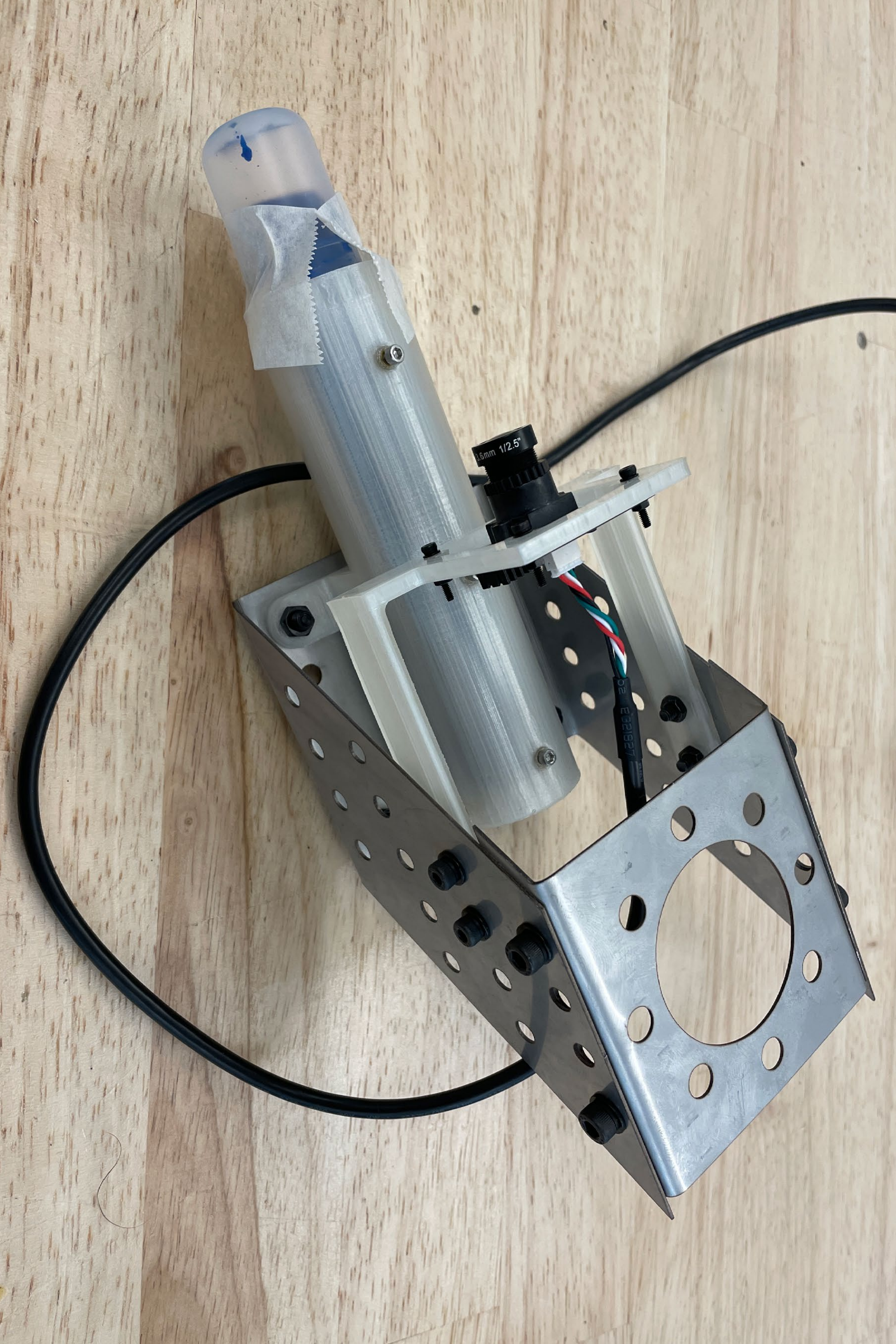
This thesis argues that if we want to explore robotics as design material, we need to create several similar frameworks that will allow us to explore this new terroir of ideas. That will allow designers to deeply engage with all aspects of robotics, helping them understand better the nature and affordances of this new field. While doing that, there is great confidence that designers will explore and discover new ways to design robotic systems for everyday life but also incorporate new vocabularies and technical aspects into the design process. Sympoiesis aims to inform our understanding of the teaching and learning that happens on both sides of the drawing table.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