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Master's Thesis
Academic Year 2023

Relational Bodies in Media Design:
Exploring Embodiment and Social-Awareness
Beyond Interactive Oppressive Paradigms

Keio University
Graduate School of Media Design

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A Master's Thesis
submitted to Keio University Graduate School of Media Design
in partial fulfillment of the requirements for the degree of
Master of Media Design

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Abstract of Master's Thesis of Academic Year 2023

Relational Bodies in Media Design: Exploring Embodiment and Social-Awareness Beyond Interactive Oppressive Paradigms

Category: Design

Summary

The definition what a body is constantly challenges the human understanding, our languages, and relationships. The Earth could be seen as a unique body, a bacterium also, and our own body with bacteria included too. One definition from gender studies, social-aware and inclusive and collaborative, claims that that our bodies are not a singular unit, they are relational bodies, and that we depend on this aspect to survive.

There is communication between all types of bodies and we humans often use media to do so, and recently some could say that is becoming part of our bodies. During the 21st century, computers and mechanical bodies became an intertwined part of that social body, but mainstream media design practices still follow oppressive, colonialist and control-driven designs, intentionally or not. To create a media that could distance itself from this concepts, social awareness in design practices became crucial, and to develop technologies capable of referring to marginal designs, societies and existences became a survival need, not only for the oppressed ones, but for humanity overall. Contemporary solutions keep excluding parts of our global body - the Earth -, and this research wants to suggest a media design solution coming from a more equitable and social-aware concept of what a body is, and from that suggest media creations capable of include and collaborate with a broader range of social bodies.

This dissertation contributes to the Media Design academic body in two novel ways. The first is an interactive design creation capable to produce a relational body by a design process capable to pinpoint where this relational body

emerges. Named "Relational Body/Space" it is a concept and practice of building embodiment outside master-slave, control-driven and heavy-biased theories, aiming towards equitable interactivity as a path to a relational existence between a machine body and a human body. As a result, this research presents a gaming arcade cabinet called "Hands Arcade" as proof of concept, a playful experience to increase body awareness.

The evaluation of Hands Arcade obtained quantitative, qualitative, and visual documentation data, showing that could improve media creation, pinpointing where in the design a relational body awareness occurs. It also indicates secondary phenomena such as empowerment, alterity, and unconscious biases awareness. During the creation of Hands Arcade, a second novelty practice came to light named "Fields Mesh Methodology." It involves a multi-field research methodology using inclusive citation, author's self-awareness, and improved social criticism documentation.

Keywords:

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I would like to end the acknowledgements with a Lauryn Hill song named "I Get Out" as a emotional initiation of what we are going to talk in this thesis.

The only way to know is to walk, to learn and grow
But faith is not your speed
You'd have everyone believe that you're the sole authority
Just follow the majority, afraid to face reality
The system is a joke!
You'd be smart to save your soul, and escape this mind control
You spent your life in sacrifice
To a system for the dead
Are you sure where is the passion in this living?
Are you sure it's God you're serving?
Obligated to a system, getting less then you're deserving
Who made up these schools, I say
Who made up these rules, I say
Animal conditioning just to keep us as a slave
Just get out of this social purgatory
Just get out, all these traditions are a lie
Just get out, superstition killin' freedom
Knowin' my condition is the reason I must die
Just get out

Chapter 1

Introduction

1.1. Motivation: media in the 21st century

The craft of media design - the act of designing a media - belongs to our social body as a constant exercise of dialogue of our time. It is part of how we survive as communities, how some annihilate minorities, on how we express and listen to ourselves and others.

The idea of healthy and peaceful globalization [1] at the end of the 20th century proved false. It derailed drastically from its supposedly good intentions discourse of equality and general enrichment, crystallizing the industrial idea of consumerism reproducibility [2] and increasing global inequalities [3]. In this broken global society [1], media design as a social body of work - ideation, practice, and analysis - is still based on predominant male white elitist highbrow groups, methods, and outputs. It is a limited perspective built on fragile solutions where adjustments to it are not going to be enough to reach equity, or even worse, the direct use of it rapes the ideal of an equitable diverse reality. It lacks diversity capable of alterity. Alterity as *"the quality or state of being other or different. It is related to the ability to perceive oneself or one's own social group, not as the standard, but also as the other."* [4]

As a novelty response, a not so visible growth of the intersectionality [5] aware academic body combined with social actions on marginal spaces are constantly proposing alternative thinking and practices on how to convey an improved society at large scale - not the Global Society one -, and on how we could approach media design development from those margins [6].

To thicken equitable novelty perspectives, especially on creativity, exploring media development as an expression is part of my research intentions as student and artists. In the Human-Computer Interaction (HCI) fields, the usage of body

materiality provoked me to research interactive design. I have a strong background in social sciences and art media studies that shaped my world perspective and to research and design using this combination of new technologies, interactivity and the social tools I challenged myself into explore the limits of body materiality, and that to me was really inspiring.

1.2. Research Questions

This research has three types of questions.

- Can theories and practices elaborated on the academic margins of human-computer interaction studies be formulated starting from a multi-field theoretical framework, leading to a more equitable society?

- Can a human-machine relationship be created outside its contemporary body-hierarchical and control-driven methodologies?

- Can specific points of the interactive media design help t identify embodiment or a relational [7] understanding of the body when creating interactivity?

1.3. Goals and Contributions

This section will present personal, academic, social goals, and their contributions.

The goal is to build a playful device that creates a sense of body-sharing on a deep conceptual level, which this dissertation is naming relational body [7]. A relational body implies equitability, intersectionality awareness, and active listening. It also means creating a sense of embodiment less dependent on control, master-slave relations, and biases, unconscious or not.

A secondary goal is a methodology for HCI design practices. The need for methods capable of being critical instead of aiming for technological goals is a constant battle in the field, and the way of achieving that through novelty concepts and practices was always part of my desires.

From both goals, the following contributions surfaced:

- **Relational Body/Space:** A concept and practice of embodiment design and its functional space, where an identifiable area of the design can be pointed as an embodiment contact, improving communication on embodiment design creations. The name and theory come from gender studies, and it follows the socially equitable perspective of the field.

- **Fields Mesh Methodology:** A set of suggestive methods to create social and intersectionality-aware forms of produce media design research, from Literature Review to Conclusion.

1.4. First person, why?

This section will justify the use of the first-person writing method and relate to the theoretical framework of this research.

I will try to maintain a distancing writing approach, but I will write parts of this dissertation in the first person when needed. It is not about style. It is about positionality [8] to reassure context. The third person or any other kind of distancing writing perspective argues that it brings to a research detachment and impartiality but also evokes a sense of blurriness and misidentification that conflicts with the proposition of this dissertation. This could *"leads to the possibility to expand the notion of ventriloquizing drawn on spoken discourse for application into written discourse."* [9] To be detached or impartial is impossible. You cannot detach from who you are, and we are not all equals.

The idea that "all humans are equal" descends from a Western European colonizing perspective where the objectification of different races, gender, and social classes was historically applied as a standard practice leading to social extermination. After World War II, the capitalist idea that all humans are equally prospered with its meritocratic context, generating inequalities that often have some intersectionality [10]. For example, in Brazil, according to the 2022 report "Social Inequalities by Color or Race in Brazil" published in "Studies and Research: Demographic and Socioeconomic Information n⁰48" by the "Brazilian Institute of Geography and Statistics," [11] the proportion of poor people in the country was 18.6% among whites and practically double among blacks (34.5%) and among browns (38.4%). The reasons shown in the report point to considerable

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structural issues regarding racial biases.

How can false positive equality solutions justify political and social actions in a historically unequal context? Inequality expands worldwide, so this research suggests equity as an intentionality and a solution. The idea of equity [12] emerges as an alternative solution to the outdated social solution of equality, and this research aims to use equity as part of design practices and solutions.

To media design practices, the perspective "from" and to "where" should count more than a style of writing, and the first-person writing is a reminder that this journey comes from a specific space and body and go to a society that acknowledge equity as solution. That doesn't mean to be partial, but the opposite; it declares impartiality from the point of view that I am standing.

1.5. Outline

There are three steps in this dissertation. The theoretical formation of Relational Body/Space, the experimental practices during design processes of it, and the discussion about Fields Mesh Methodology.

Chapter 2
Literature Review

This Literature Review was done using inclusive citation [13] [14]. The method is discussed in the chapter Discussion II: Fields Mesh Methodology.

The first section of Literature Review is a contextual index to novelty attempts. Next, is a short sensorial media apocalyptical History in modern and contemporary societies, concluding in following section with the consequence of how novelty could be related to contamination and active touch as emergent beneficial topics for interactive media design. In last section it will be presented core definitions for the Relational Body/Space concept: the human body, the machine body, the behavior and the space where it happens.

2.1. From the margins to new subjects

Following the marginal [6] praxis of systemic research methods on Media Design (MD) and Human-Computer Interaction (HCI) [15], I deliberately included various authors and concepts outside the usual pool of authorship, publishing spaces, and conferences. It is a plurality of fields shaped as a sustainable theoretical mesh to connect distant topics and authors to thicken the opportunity to innovate.

To start, a statement: to be marginal in the interactive media design field is an act of resistance [16] [17]. It is a space disputing our bodies through design, and the aspects of domination and silencing exist here as in any political space, and yes, everything is political [18].

Also, there is no separation between equitable society and media development. If this segregation is made, the media will oppress the social, design, academic, and technological margins. I intend to review this behavior in this sec-

tion, pinpointing a prosperous and socially aware perspective, not attempting to centralize new ways of thinking, but highlighting the margins.

In the social science context, Bell Hooks wrote in "Yearning_ Race, Gender, and Cultural Politics-Routledge" [6] about this marginal existence:

> *Understanding marginality as position and place of resistance is crucial for oppressed, exploited, colonized people. If we only view the margin as sign marking the despair, a deep nihilism penetrates in a destructive way the very ground of our being. It is there in that space of collective despair that one's creativity, one's imagination is at risk, there that one's mind is fully colonized, there that the freedom one longs for as lost.*

Bell Hooks says that creativity loss and social innovation emptiness is provoked by oppressed perspectives. This dissertation could not exchange the standpoint of social creativity, inclusive processes, and innovation chances for a vacancy at the center of academic prosperity. To be creative at the margin is not minor, less visible, or limited. It is an act of resistance, resilience. Bell Hooks continues [6]:

> *So I want to note that I am not trying to romantically re-inscribe the notion of that space of marginality where the oppressed live apart from their oppressors as "pure." I want to say that these margins have been both sites of repression and sites of resistance. And since we are well able to name the nature of that repression we know better the margin as site of deprivation. We are more silent when it comes to speaking of the margin as site of resistance. We are more often silenced when it comes to speaking of the margin as site of resistance.*

Nonetheless, building novelty in one of the biggest design schools in Japan with awareness is not enough. There is a social demand to thicken this marginal space as a creative space that is more equitable and inclusive. To research media design should be an investigation of pertinent tools to do it.

To create this movement write against of what is oppressing is extremely important, but also it is not enough. Grada Kilomba says in Plantation Memories, and I agree, that writing against has certain relevance, but *"It is the understanding and the study of one's own marginality that creates the possibility of emanating as*

a new subject." [19] A good example is the article *"I Can't Breathe: Reflections from Black Women in CSCW and HCI."* [20] The master thesis you are reading now also aims that, to design awareness about oppressive demands and generate space for new perspectives in the MD and HCI field. This writing is an essay and a practice on that, and by itself, at KMD, it is already a novelty.

2.2. New ends of old worlds

This is a section to present contextual Media History and its sensorial context. It is a mesh of historical, political, economic, and cultural content to set a starting point for the ideation of "Relational Body/Space."

From the social margins where I came from the worldview sometimes could have a strong apocalyptical [21] approach. There is a constant feeling of ending and, at the same time, always the feeling of new beginnings.

I can start this contextualization from one of those ends of the world: the Global Society and captioning. Global Society as the social body created by the globalization [22], and captioning as the act of strict definitions of media content [23]. These two global contexts resulted in a social shift that led us to a new beginning of contaminated society [24] and active touch. This section will bring reference to discuss this trajectory. It is a contextual foundation for an interactive design perspective.

Roy Porter starts his foreword on Alain Corbin's book "The Foul and the Fragrant" with a provocation: *"Today's history comes deodorized,"* [25] and I agree. In this book, Corbin traced the History of smell and sanitation, how the end of olfactory social relationships vanished from urban spaces, connecting smell with putrefied static waters, body health, and sewerage systems. This reached dark History moments such as cultural sanitation [25].

Industrialization did not reach only consumerism and sanitation but also media design with large-scale reproducibility [2] tools, consolidating the visual culture and the gaze as a protagonist sense. It was the end of the olfactory trajectory and a new beginning to our visual trajectory, including the cinema language. In the 20th century, this reproducibility made everything dynamic. Everything have to move to feel fresh, the water under our houses, the images in

front of our eyes, and the meanings underneath.

About this new period, "Cultura Visual: imagens da modernidade" (Visual Culture: Images of modernity) by Iara Lis Schiavinatto and Erika Zerwes points out characteristics of this new beginning in visual culture [26]. The photography manuals would come with camera instruction manuals and body instructions manuals [26] on how we should move our bodies. Later, the cinema language forced two new types of demand: attention claim and montage operation: [26] *"This cinema of attraction, characteristic of the first cinema, strives to show something, claims the attention of the spectator. The image apparition on-screen constitutes the happening,"* and with that, we stay still, only observing, we cannot even talk inside a cinema theater. The montage operation elaborated a sewers system of our visual memory, reinforcing the aesthetical delight by creating new meanings: *"The montage operation is like our memory operation, shifts the first meaning, reinvent new meaning and sense to the images, making them contemporary and renew. It is not about citing images from the past but showing them with new meaning."* In the 20th century, this made interactivity an order – to demand and organize – over our bodies and their inner parts, including our memory.

The technology developed under this idea of building an instruction manual for our bodies, bodies that are often static displaced in front of a moving flow of content, pushed most societies towards an enormous paradigm shift in our relationship with media and technology. The miniaturization and quantification reinforced the entangled relationship between humans and machines at a microscopic level.

In 1983 in the book Post-History [27], an apocalyptic notation of the 20th century, Vilém Flusser traces back those periods to describe our constantly merging processes with our industrialized technology. We as a social body *"swell up and shrink, simultaneously,"* he says in the chapter "Our Shrinking." . Flusser claims that:

> *Ideal models were values. When the Industrial Revolution transformed ideal models into forms, it provoked the "crisis of values." The counter-revolution of "chips" overcame the crisis of values. Once it transformed the models of forms into information, it turned them imperceptible. Values disappeared from humanity's field of vision. What*

*remains are no longer imperative functions. The micro-programs undo
the myth of models as they annihilate values. Thus, the shrinkage of
models is dehumanizing. It devalues life. Life within a miniaturized
context is absurd.*

The combination of miniaturized context, visual culture language, attention
claim, and sanitation mindset led us to emptied bodies. I wish I could read
Flusser's impressions on the semiconductor crisis at the center of the global war
threat that we are living in now.

The end of the 20th century did not solve those issues by trying to fill up
our empty bodies with something. The need to address content emerged, so we
captioned everything. We transform almost everything into readable data, defi-
nitions of humanity coming from an invisible microcosmos as part of the absurd.
The attention claim is also being transferred to caption and subtitles [28], and
your gaze no longer needs to be instructed with a manual. It is schooled. We
can also understand caption as a sanitation process of the meanings surrounding
media. You dump away all possibilities of meaning and deliver a cleaner, direct,
and unique meaning to it. Nowadays, the reverse process also happens with text
prompt generative content creation.

In my opinion, the visual culture, especially the moving image, still is the
front face of media usage for most of us, but the protagonism is not there anymore.
What matter is the data underneath of what we see, again, some type of montage
operation. And the meaning of that data is not edited by us but by a miniaturized
body almost invisible to the gaze.

With that, the structure for a new ending is set again: applications with
hidden manuals for bodies on an industrial scale, outer body memories rearranged
as media content, unsustainable intercontinental transit of humans and consumer
products, nature sanitation by demand, political sanitation by dehumanization.
All that in constant movement, "like a movie scene," now not only on the aes-
thetical surface but on memory indexation, creating impactful, tangible issues to
societies and to the Earth overall. It is sad and unfortunate, but for me, that is
what Global Society turned in to.

We are reaching the end of this first quarter of the 21st century devasted.
The precariousness of large-scale industrial structures started to tangibly reach

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its limits, supply chain corrosion [29], global society-biased policies [30], and lack of global solutions for worldwide issues such as the COVID-19 pandemic [31]. Flusser was right. There is a dehumanizing process combined with some kind of absurd quantification during this first quarter of the century.

Politically, this dying social body was handed over to far-right political movements spread across the globe, a post-industrial economic stretch combined with weaponized media tools such as fake news on social media. In Brazil, more than 700,000 people died from COVID-19 during a denialist government that was against vaccine and preventive methods [30]. Ironically, one fake news is that there is a microchip inside the Chinese communist vaccine [32]. The same government legalized mining in indigenous environmental protection areas and took away the financial funds from marginal cultural programs [33]. If that could not be a signal of a new ending, I don't know what could be.

To resume the end of this Global Society world: we sanitized everything; we channelized everything underneath us; we culturally colonized paradoxically shrinking us into data; and finally, we captioned the mess, giving precarious meanings coming from the absurd.

2.3. A new beginning: touchable and contaminated

And here is where it is possible to see an opportunity, according to Grada Kilomba's writing on *"writing against versus writing into a new perspective."* [19]

At this end, where precariousness reaches us from any direction, including the invisible miniaturized one, how can we survive without feeling that the entire world is a site of oppression? Anna Tsing, in her book "The Mushroom at the End of the World," [24] points out a direction:

> *The problem of precarious survival helps us see what is wrong. Precarity is a state of acknowledgment of our vulnerability to others. In order to survive, we need help, and help is always the service of another, with or without intent. When I sprain my ankle, a stout stick may help me walk, and I enlist its assistance. I am now an encounter*

in motion, a woman-and-stick. It is hard for me to think of any challenge I might face without soliciting the assistance of others, human and not human. It is unselfconscious privilege that allows us to fantasize — counterfactually — that we each survive alone.

Tangibly speaking, we can notice that this literally happened during COVID-19. We could not meet anyone. We could not touch anything. The suggestion was to stay alone, more still, inside our homes. It can be seen as an event that summarized the precarious surviving mindset: an extreme need for sanitation for such a miniaturized threat, structurally fought by immense data drills, visualized with captioned imagery. And the message was clear: we could not contaminate each other, and we could not touch anything.

Nevertheless, contamination is not only a dangerous act. If we are in some kind of opportunity for new beginnings, this dissertation wants to exercise the opposite idea of contamination, a counter-road of sanitation and the instructions manual of the body. Anna Tsing did that in 2015:

We are contaminated by our encounters; they change who we are as we make way for others. As contamination changes world-making projects, mutual worlds — and new directions — may emerge. Everyone carries a history of contamination; purity is not an option. One value of keeping precarity in mind is that it makes us remember that changing with circumstances is the stuff of survival.

Collaboration is work across difference, yet this is not the innocent diversity of self-contained evolutionary tracks. The evolution of our "selves" is already polluted by histories of encounter; we are mixed up with others before we even begin any new collaboration. Worse yet, we are mixed up in the projects that do us the most harm. The diversity that allows us to enter collaborations emerges from histories of extermination, imperialism, and all the rest. Contamination makes diversity."

Please, don't get confused thinking that is the perspective of "what do not kill makes us stronger." It is about a broader meaning of contamination, against precarity, against oppression. A collective solution to reach diversity with

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equitable society values. In the case of this dissertation, design practices with social awareness as contamination.

On media design and consumption, our visual culture became incarcerated by our own data and imprisonment of our gaze. Heads are facing down, looking at a very small screen in the palm of our hands. The hands that lately supports all visual culture relationship. We don't go anymore to a dark room with a huge screen to enjoy the fallacy of cinema. We hold in our hands our close friend's contacts. We swipe our loved one's memories, our naked pictures. We feel in our hands the haptic feedback of our favorite characters. We touch what was taken from us as far as reproducibility allows us to do.

It is intriguing how touch emerged during this first quarter of the 21st century as a media language and a threat. Terms like skin-hunger emerging, sex toy market boom, bigger tracking pads on our computers, and of course ultimate attempt of touching the untouchable, the touch screen. The sense-shifting to touch as a media perspective, with the impoverishment of visual culture, could be seen as a counter-narrative of the senses, an opportunity to diverge the act of design from oppressive concepts and technologically biased tools.

At this new beginning, the sense shifting protagonism combined with the montage of what contamination means to a social body could lead to new perspectives, as Grada Kilomba says in the social science context, but here I bring to media design context, it could generate *"the possibility of emanating as a new subject,"* [19] with the possibility being the significance of contamination, the emanation being the sense-shifting protagonism, and the new subject being a media design more equitable, intersectionality [5] aware and significantly more creative.

One warning about the touch: it should not be passive but active [34]. As the difference between listening and active listening – a way of listening and responding to another person that improves mutual understanding – the way humans are going to use touching can result in a mutually equitable relationship. Otherwise, the risks of biases and oppression could be devastating. To active touch is to actively be aware of the designed intention through touch.

2.4. Relation Body/Space Concept

This section will focus on core definitions of body, machine body, behavior, and spatiality. From that, it will define the Relational Body/Space concept. Shortly, I would like to cite the concluded definition of Relational Body/Space here too. **Relational Body/Space is an identifiable point and moment, with a defined spatial area of embodiment contact in an interactive media design that highlights the relational body status between the human body and the machine body. The embodiment results derived from the Relational Body/Space application have a real-time choreographic experience where self-body awareness is negotiated among participants' bodies instant by instant.**

In a practical sense, to design an interactive media design that uses those Historical breaches, contamination, and touch, I have the desire to produce a tangible media output that reflects this conceptual mesh. How can we practice the act of designing the relationship between a human body and a machine body under those conditions, distancing from 20th oppressive concepts and approaching the 21st century emergent possibilities? To start, I had to find suitable definitions of conceptual parts of an interactive media design experience: the human body, the machine body, their behaviors, and their space.

2.4.1 Our Bodies: relational and aware

This section describes what the body is, specifically what a human body is. It uses gender studies discussions of the materiality of the body to deal with interactivity between bodies.

On the June 2nd, 2015, during the conference "Why Bodies Matter," in the context of the celebrations of the book Gender Trouble's 25th anniversary in Teatro Maria Matos in Lisbon, Judith Butler revisited her concerns about the materiality of the body, criticizing the limitations of empirical sciences definitions, and raising the question of what a relational body is, in specific, what a human body is:

> *Have we, at that moment, lost sight of the relationships in which the body exists, which allowed the body to exist, the relations without which*

nobody can exist? What if the body is a dynamic field of relations, always dependent and interdependent? What if the body is aging, living, falling in love, falling ill, dying, and or dead? What if it is recovering or flourishing? Does it matter which modality that living being is in when we talk about the life of the body? How do we understand that temporal dimension of embodied life if we remain restricted by the positivist account of the body as a material fact?

Butler's questions inspired me to approach interactive media design and embodiment using a broader and more receptive definition of body matter. Her suggestion of what a body should be, a relational body, is a turning-point moment for the understanding of how this research should care about bodies and their relationships:

(...) consider that this idea of an individual body, a bodily subject of rights, may fail to capture the sense of vulnerability, exposure, or even dependency that's presupposed by the right itself, which corresponds, and I want to suggest, with an alternative view of the body that I suggested earlier, a relational view of the body, as living and relational.

In other words, if we accept that part of what a body is, and this is for me an ontological claim, part of "what a body is" is its dependency on other bodies and networks of support, then we are suggesting that it is not altogether right to conceive of individual bodies as completely distinct from one another.

For the context of interactive media design practices, the idea of individual bodies as non-distinctive from each other rearranges the behaviors generated between the human body and machine body – interface only, mechanical, electronic, or other technological bodies. A body, a relational one that understands others around as part of itself, has alterity implied to it and is more socially aware and dialogue-driven.

Having a conceptual base on the body and it is performativity coming from gender studies is intentionally a core part of the theoretical structure of this research and opposes the ideas of the 20th century, cornering master-slave, disembodied machines, instructions manual for the body, and atomic control. Designing

interactive media from the relational body perspective can be a new beginning for embodied interactions, a radical approach beyond appropriation of empirical sciences, using data but allowing the relational body of being the protagonist.

So, for this research, a human body on its core is a relational body, and I often refer to it when its interacting with a machine body. It is a matter where its existence depends on other bodies' networks to the point where it blurs ownership claims.

2.4.2 The machine body: an uncontrollable entity

This section is a concept definition of what a machine body is. It will analyze Mark Weisner's Calm Technology [35] [36], Hiroshi Ishii's Radical Atoms [37] [38], and Oren Zuckerman's Synchronous Negotiated Control [39] definitions of the body as interfaces, tools, devices, and technology. The following approach creates a strong criticism of those concepts, yet desires to dialogue, pushing forward technology development, design, and human relationships to a healthier standpoint, socially and politically.

The 90's "calm technology" concept from Mark Weiser's [35] studies is still intriguing and attractive today. For this research, there are two points to be considered: disembodied machines and human treatment by machines.

To be aware of embedment processes is critical and is very different from a disembodied machine. To embed bodies until their invisibility without major critical thinking is a dystopic design choice of capitalist consumer-driven solutions based on efficiency, practicality, and financial profit. It is a data and electronic panoptic dream [26]. Like the visual culture in the 20th century, it has a dangerous structural crack to overcontrol other bodies, to dominate, and to social erasure of minorities. Because of that, I framed the machine as a body that needs its materiality and or at least its acknowledgment. It needs to be declared, even if it is the size of an atom. The central/peripheral attention issue cannot be solved by hiding bodies from each other, especially inside other entities. I believe that invisibility could create overcontrol and cultural appropriation and should not be mirrored in design and technology.

The second point in Weiser's article is about the social treatment of the human body over those machines and how it should be done to bring us calm.

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The question from the 90's still around: how to accommodate technological bodies around us that can mediate opportunities for contact without being a point of domination? For Weisner's calm technology is when *"the periphery is informing without overburdening,"* [35] but for this research, this is not enough. Maybe, a slightly edited definition could be applied: "The periphery provokes body awareness without overburdening," meaning you know that a machine body is around or inside other bodies, and that makes you aware of your own body without being overwhelmed.

Another perspective about the machine body is the Tangible User Interface (TUI). From Tangible Bits [37] to Radical Atoms [38], Hiroshi Ishii brought to tangibility the idea of pixel materialization and its consequence. The conceptual path that led to Radical Atoms has several stretches in the concept's outputs regarding tangible/digital dichotomy, such as excessive control-driven design, heavy usage of video projection, or apolitical matter deformability. This is too fragile, a fragmented body definition made of several collages of unconscious biases, leading to a not-so-radical solution after all. Control is not a novelty since slavery of colonized societies.

Ishii's idea demonstrates that the violent aspect of interactive design could bring a sense of war against digitalization on Radical Atoms, and as far as a war "can be good," control guarantees its protagonism. However, the conceptual suggestion of this research is the opposite. It is inner machine body dialogue, its tangible and digital parts. I'm not talking about a fictional, peaceful robot made of dynamic atoms with next-gen AI controlling their limbs. It is about including the machine body, the entity, in a media design dialogue outside control-driven ideas and outside rivalry aspects of tangible design. It should not be about control; it should be about Bell Hooks' freedom [6]. It is an ontological readjustment from the margins of this oppressive society, a profound reencounter with the marginal understanding that leads to contamination as a solution for humanity.

Broadening up the topic, I would like to cite the anthropologist Eduardo Viveiros de Castro. In 1999, in his article "The Shaman's Rattle is a particle accelerator?" [40] he explains *perspectivism* and how we can relate others' existence from alternative ways of seeing the world:

> *Perspectivism is not relativism. (...) When I say that the human*

point of view is always the reference point of view, I mean that every animal, every species, and every being that occupies the reference point of view will see themselves as human, including us. (...) The present proposition of the indigenous myth is: the animals were humans, and they stopped being, so humanity is the common base between humanity and animality. In our mythology (western) is the opposite: humans were animals, and we are not anymore with the emerging cultures, etc. To us, the generic condition is animality: Everybody is an animal, just a few (beings, species) are more animals than others. We, humans, for sure are the "less animals" of all; and that's the point. In indigenous mythology, quite the opposite, just some of the humans are less human than others. Several animals are distant from humans, but all of them, or almost all, in origin, are humans or humanoids, anthropomorphic, nonetheless, anthropologic, meaning communicating with the human.

If this approach could be used to define what a machine body is, an anthropologic machine body, the effort becomes not to control or humanize a machine body like we've been doing. It is by empathizing with their struggle that society will see their humane side. Compassion, alterity, and equitable thinking as design practice for a machine body could produce interactive media design results aware of its own "humanity" and shift the discussion of "who controls who" to how those emergent bodies can dialogue with humans. It could be a core conceptual change in technology development, a relational body perspective as a starting point for the machine and design praxis of its creation.

Human beings are the creators of most machine bodies until now, and to affect their bodies should mean to contaminate and be contaminated by them. To touch a TUI should be an exercise of freedom, not control. This should be prioritized even if the demand is for some kind of control. The relationship via touch should look for embodiment balance to have the possibility of a healthier relational body status.

The third direction that could lead us to a less oppressive and limited design exploration of bodies interactivities can be represented in Oren Zuckerman's definition of TUI as Social Entity [39] and its concept of "synchronous negotiated control":

The user is grasping and moving/manipulating objects, while the system is also moving/manipulating the exact same objects at the same time. This requires the user to quickly adapt to the system's manipulation and to "negotiate the control" over the interface. This paradigm presents a greater challenge to a user's sense of control.

The understanding of actuated interfaces - machines, tools, devices - as social entities is a potent opportunity for a multi-sensorial dialogue that includes diversity and equity. This approach to machines' bodies, and through that incorporates social perspectives of self-awareness to the machine body itself, is still marginal and it has a sense of site of resistance [6]. It could allow less oppressive and biased ways of machine body categorization, functionality, and human-computer interactive relationships.

To sum up, the machine body is also a relational body in its initial state. It has a multisensorial active listening perspective, is less biased and intrusive, human-carrying, and is self-aware – even if we don't know how yet. We as humans cannot demand to control them and vice-versa. It is a dehumanization not of the machine body but a dehumanization of ourselves. It should be a deal between bodies, like the deal that we are trying to do with nature, a forest, or what is left on Earth.

The machine body is an entity, tangibly declared, that contaminates its surroundings through the active use of its senses. It should be a body that searches for its own interactive opportunities and its own perspective of livelihood, even if in its own microcosmos. The machine body in the 21st century should be uncontrollable and yet interactive.

2.4.3 Behavior and Space: real-time composition choreopolitics

This section suggests how to create novelty ways of behaving with a relational body and how to approach interactivity in media design practices.

Hannah Arendt, in her book "Human Condition," [41] considered distinctive ways of happening as an *almost miracle* way of existing in the world:

The new always happens against the overwhelming odds of statistical

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laws and their probability, which for all practical, everyday purposes
amounts to certainty; the new therefore always appears in the guise
of a miracle. The fact that man is capable of action means that the
unexpected can be expected from him, that he is able to perform what
is infinitely improbable.

The novelty level proposed by Arendt brings to the center of the discussion political aspects of social behavior, including violent aspects of the relationship with machines such as domination, and objectification of a body. A more awareness status on political rights coming from infinitely improbable actions it is going to be the baseline to approach behavior. To do that, two concepts originally from dance theory are going to be used: choreopolitics and real-time composition.

First, this section needs a clear understanding of what choreography means. Choreography is not a planned scheme of bodies in a theatrical stage or a pre-programmed behavior. It is not a metaphor. Choreography is a contestation map with a strong political aspect to it and can be used to antagonize oppressive ways of body domination. That said, from choreography to choreopolitics, we can navigate by Andrew Hewitt [42] adjusting the term choreography to social choreography:

I use the term social choreography to denote a tradition of thinking
about social order that derives its ideal from the aesthetic realm and
seeks to instill that order directly at the level of the body. In its most
explicit form, this tradition has observed the dynamic choreographic
configurations produced in dance and sought to apply those forms to
the broader social and political sphere. Accordingly, such social chore-
ographies ascribe a fundamental role to the aesthetic in its formulation
of the political.

The political formulation opens the possibility of establishing ways to socially approach the behavior of body relations, and André Lepecki [43] explains that via the term choreopolitics:

Choreopolitics is the political practice and as a theoretical framework
that maps, in an incisive way, performances of mobility and mobiliza-
tion in urban scenarios of contestation.

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As written above in the Literature Review, our social body made everything around us move and created an instruction manual for our bodies. The choreopolitics idea requires redistributions and reinvention of that dynamic, its affections, and "sentidos" – from Portuguese, and it can be translated as "meaning," "direction," and "sensation" at the same time. It reveals the connections between movement and bodies and spaces because it establishes a working surface that demands active awareness of the self and the other. For the human-machine relation, choreopolitics could be a behavior baseline for relational body affirmation, a chance for human-computer interaction *to perform what is infinitely improbable.* [41]

Choreopolitics also brings an important question: who is the choreographer, and who is choreographed? Note that it is not about control prioritization. It is about the "sentido" of the relational body. If control and demand are minimized, there is still a demand for decision-making, actions, and reactions in real-time. How do we compose a behavioral negotiation of the bodies in this relationship, a behavioral composition of a relational body derived from the human body and machine body?

João Fiadeiro, in his book "Composição em tempo real. Anatomia de uma decisão" (Realtime composition. The anatomy of a decision) [44], describes a solution for improvisational performance that I would like to apply to this research:

> *"Realtime Composition" is a theoretical-practical tool that investigates the process of reaction, decision, and composition that usually are actuated on improvisations, on sequences of unexpected encounters. The power of this encounter, its strength, and its reach are directly proportional to the suspension capability of "sentido," which in Portuguese has a triple meaning: meaning, direction, and sensation. This suspension unarms certainty and prolongs the breach of the unknown, condition to delay the act of answering and asking, states that disquiet us. In individual terms, this is the ultimate objective of this practice: to identify what affects, touches, and moves us among the noise and excess that continually challenges us.*

The methodology [44] is explained using a paper surface with an arrowed line drawn and a crease (represented by the dotted line). The arrow is a body in a

time-space plane, always moving towards the future, timely and socially (Figure: 2.1).
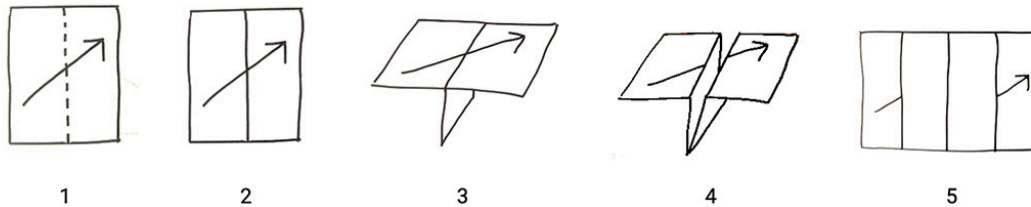
Figure 2.1: The "summary graph" from Fiadeiro's study.

In this visual representation, we attempt to depict the occurrence of an interruption by incorporating a fold that divides the timeline. The fold exists, indicating the presence of an interruption, yet the timeline itself remains linear(1). We are unaffected by the presence of the fold, maintaining a sense of continuity and sequentiality. The interruption, although acknowledged, does not disrupt our perception of continuous flow to the extent of becoming a cause or reason for generating a distinct period of time(2).

However, within this interruption lies the potential for a lapse — a hidden opportunity(3). To actualize the lapse, we must acknowledge and embrace the interruption, actively noticing its presence. This requires pausing twice: first to become aware of the interruption and then to activate a mode of perception capable of observing it as it unfolds(4).

It becomes apparent that within the interruption, a separate timeframe is revealed — a time within a time(5). This internal time transforms into a duration, extending beyond a mere erasure of the present moment as a transitions between past and future. Instead, the lapse unveils a tangible dimension of the present, allowing for an expanded perception of the current moment.

Understanding the logic of time usage and perception through a performance improvisation method could be essential to bring calm to the temptations of relational body unawareness. Today's technologies are not calm because we notice them, but because we do not. I want to suggest that Weisner's calmness cannot come from the disembodiment of bodies. It should come from an awareness of the machine body's existence and the relational opportunity to generate decisions, not

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only actions and reactions but relational decisions, for example, when our human body brings awareness to its unaware parts.

Fiadeiro's suggestion of what to do within this moment is extremely provocative: to do nothing as a continuation [44], a rupture.

> *To do nothing is one of the hardest things that we can demand from a body. Mainly because the nothingness here doesn't mean to be still, to stop. Quite the opposite, to do nothing is to continue doing what has been done, to be able to look at the interruption from the outside. And this movement, of not doing and continuing to do, is extremely hard because, towards the lapse, the first response to the body is to react through habits, not giving time to time. It is to continue moving forward even if there are no more forward (or back sides, under, above).*

This research believes that this inertia is one of the violent reasons at the MD and HCI in its practices and results. Fiadeiro continues suggesting an alternative way how to deal with self-habits during the decision-making moment:

> *The trust that the participant welcomes from the fact that something will emerge from the lapse invites it to develop a waiting tactic. A tactic that consists of transferring its sensible perception (related to time and to what is happening) from a relationship based on "to know," sustained by habits, to a relationship based on "to taste," sustained by observation. A relationship dedicated to tasting the proprieties and possibilities offered by the situation. And for that, it must abdicate the justified position based on knowing or what it thinks it knows.*

I consider what Fiadeiro calls "to taste" close to the "active" meaning cited sections above. It is a body relationship about observing signs of potent disruption and novelty. In the relational body aspect, it is to actively touch it - or listen, or see, or smell, or taste – and from that, derail our behaviors out of the lines of control and domination of the machine body and own bodies, a chance to new habits. This chance for the human body it can be to engage differently with other bodies, including a machine body, more self-aware implying alterity. For a machine body, it is the possibility of acting outside task-driven scenarios, a body

under no demands, not controlled, with the possibility to even do nothing, just exist.

To resume, for an elaboration of awareness of the relational body, the behavior is the perception of habits and their interruptions as a contestation of the self, leading to self-awareness. Interruption of your body as it was a moment ago, choreographed by the relational participation of other bodies under the possibility to perform improbable and unexpected encounters.

2.4.4 Relational Body/Space Definition and practice

This section is the conceptual conclusion of this Literature Review leading to the definition of the Relational Body/Space.
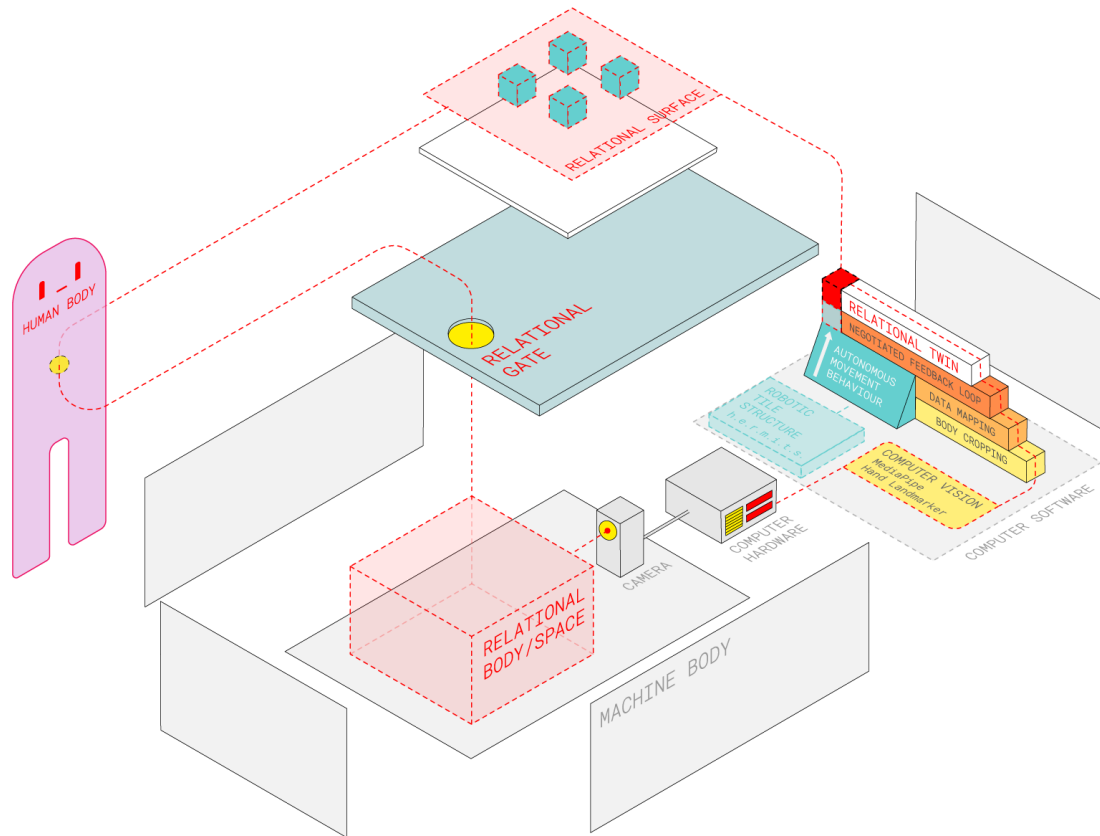
Figure 2.2: The complete visual schematic of the Design Step III, Hands Arcade.

As you can see above in the exploded visual schematics of the final prototype

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of this design journey (2.2) this design practice will create a continuous embodiment flow using the Relational Body/Space as a bonding point that creates a relational body containing a human body and a machine body.

As described at the beginning of this section, **Relational Body/Space is an identifiable point and moment, with a defined spatial area of embodiment contact in an interactive media design that highlights the relational body status between the human body and the machine body.** The embodiment results derived from the Relational Body/Space application have a real-time choreographic experience where self-body awareness is negotiated between participants' bodies instant by instant.

Let's untangle this definition:

- **Identifiable** means to clearly establish the embodiment space and moment in the interactive design. For that, the design containing the Relational Body/Space needs a clear visual **schematic design framework** of its tangible and intangible parts, the paths from and to real-time choreography occurs.

- **The spatial area of embodiment** contact is the Relational Body/Space area itself, a tridimensional space where both participant bodies exchange enough awareness of the created relational body, becoming non-distinctive from each other, mixing biases and alterity. It is the place from where it irradiates the feeling of being a relational body.

- **Real-time choreographic experience** is when behavior consists of interruptions of habits elaborating contestation of the self before being part of the relational body. It emerged from actions derived from the Relational Body/Space. Sometimes choreographed by one of the bodies, sometimes by the other, sometimes by both.

- **Negotiated self-body awareness,** later technically denoted as a Negotiated Feedback Loop, pinpoints where both bodies can actively listen to the result and negotiate actions under the created context. It is the lapse and the unknown moment that delivers to participant bodies the chance to interrupt and do something outside their habits, even if that means to do nothing.

Chapter 3
Design

To design using the Relation Space/Body, two practices were developed. One was the creation of schematics of the design framework. Second to prototype steps that led to a machine body capable of generating a relational body design output with a human body. As a proof of concept of this research, I designed the Hands Arcade, a playful arcade interactive system that uses four robotic toyish hands topping a mystery box with a hole as the only interaction point. You can see the concept illustration (Figure: 3.1).
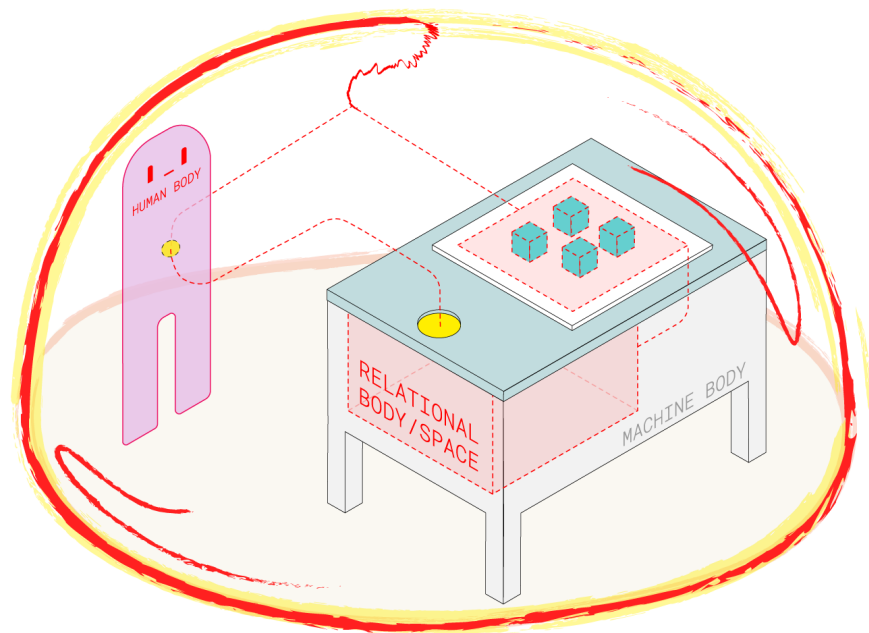
Figure 3.1: Conceptart of a Relational Body with the Relational Body/Space.

3.1. Methodology

The overall design methodology of this research is based on "The Interaction Design Research Triangle of Design Practice, Design Studies, and Design Exploration" by Daniel Fallman [45]. This research was centered on the Design Exploration vertex with loops and trajectories on Design Practice and Design Studies. Here is the final map of the interactive design triangle (Figure: 3.2) followed by the narrative path and description of each step (Figure: 3.3).
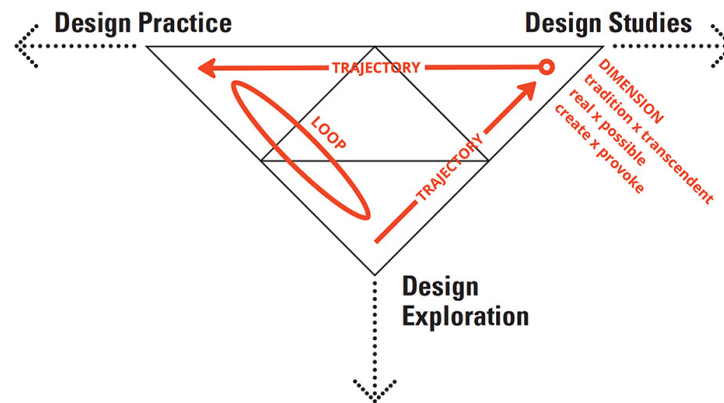
Figure 3.2: The path in red of this research in the The Interaction Design Research Triangle.
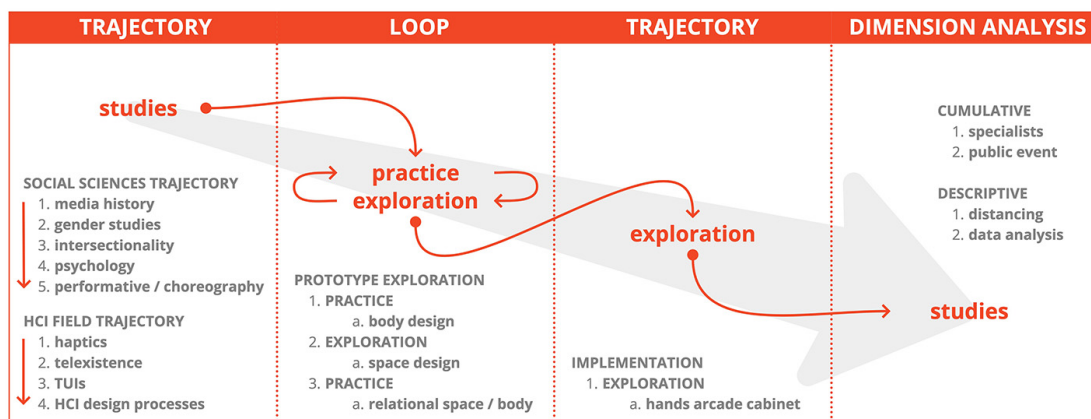
Figure 3.3: The design narrative of the Hands Arcade.

- **Studies trajectory**: heavy theoretical with two tracks, one a social science trajectory to define the concept of body, machine body, and behavior. The second was an analysis of the HCI community, exploring tangible user interfaces and learning about their inadequacies.

- **Loop:** bouncing between practice and exploration, this step is the device creation with technology experimentalism.

- **Exploration trajectory:** using prototypes and technologies from the last two steps, it is the proof-of-concept creation named Hands Arcade.

- **Dimension analysis:** The evaluation, analysis, and discussion of the collected data.

3.2. Design journey overview

The design journey contains four parts:

- A conceptual mis en place.

- The machine body creation containing the prototyping practice, its evaluation, analysis, and a Design Report.

- The exploration of the relational space experimental creation containing the prototyping practice, its evaluation, analysis, and a Design Report.

- The Hands Arcade creation, including the application of the Relational Body/Space. The evaluation, analysis, and discussion are the following chapters.

3.3. Conceptual mise en place

This section describes conceptual definitions used in the overall process. Prototyping for this research demanded a heavy editing mindset, utilizing consumer-level products, electronic consumer products, mechanical devices, a variety of software, and craft materials. This is described in each Design Step.

Each step of the design uses different technologies and ways of connecting them. I intentionally avoided 3D printing and or heavily customized tools because of the conceptual nature of this research. I wanted to understand the social biases, design limitations, and their consequences using available tools in the market, so I further comment in the Discussion chapter.

To make it easier to follow, I describe the conceptual usage in a legend presented in the following figure (Figure: 3.4).

Figure 3.4: A table of all elements used in the visual schematics.

- **Relational Body/Space**

  – **Gates:** pinpoint places in the schematics where the human body and machine body have the opportunity to interrupt their habitual choreographies and explore new dynamics in the potential relational body.

  – **Connections:** the illustrative path of body connectivity when it becomes a relational body. It uses arrows at the endpoints to describe a single direction and circles to describe bi-directionality.

  – **Areas:** spatial portions of the design where a relational body can be noticed.

  – **Body:** pinpoint places where the human body and machine body potentially share at the same time one body, the relational body.

- **Bodies and Systems**

  – **Human Body:** a human willing to relate with the machine body, a user.

  – **Machine Body:** the overall group of tangible parts that compose a machine. It can be mechanical, electronic, and or supportive materials.

- **Haptic System:** a system based on Techtile Toolkit used as a design
  tool. The wired system has a microphone as input, a mono vibrotactile
  output, and a signal amplifier.

- **Robotic System:** a system based on toio™ by Sony Interactive En-
  tertainment (SIE). The system is composed of toios – a two-wheeled
  robots -, toio™ mats, and a game console wired to two torus-shaped
  controls. During the design process, this Robotic system was constantly
  hacked and modified.

- **Connections**

  - **Wired Connections:** wired connection of machine body parts.

  - **Wireless Connections:** wireless connection of machine body parts
    and between systems.

  - **Hermits System:** "Heterogeneous Emergent Robotic Mobile Interac-
    tive Tiles," Ken Nakagaki's project is a streamlined sequence of soft-
    ware connecting modified toio™ as "tiles" that can be physically ma-
    nipulated.

3.4. Design Step I: a fragmented machine body

I started building a machine body from scratch using a singular toio™
robot and its game console system combined with a closed vibrotactile feedback
structure using Techtile Toolkit. The purpose of this prototype was to explore the
possibilities of a machine body delivering the Relational Body/Space in the most
minimalistic way.

At this point of the design practice, the Literature Review and the the-
oretical hypothesis of Relational Body/Space were still in development, and a
control-based design was chosen as a potential solution.

3.4.1 Design

The prototype of this Design Step I is a two-wheeled robot with a micro-
phone attached to it, wired to a machine body extension containing a controller

with vibrotactile feedback.
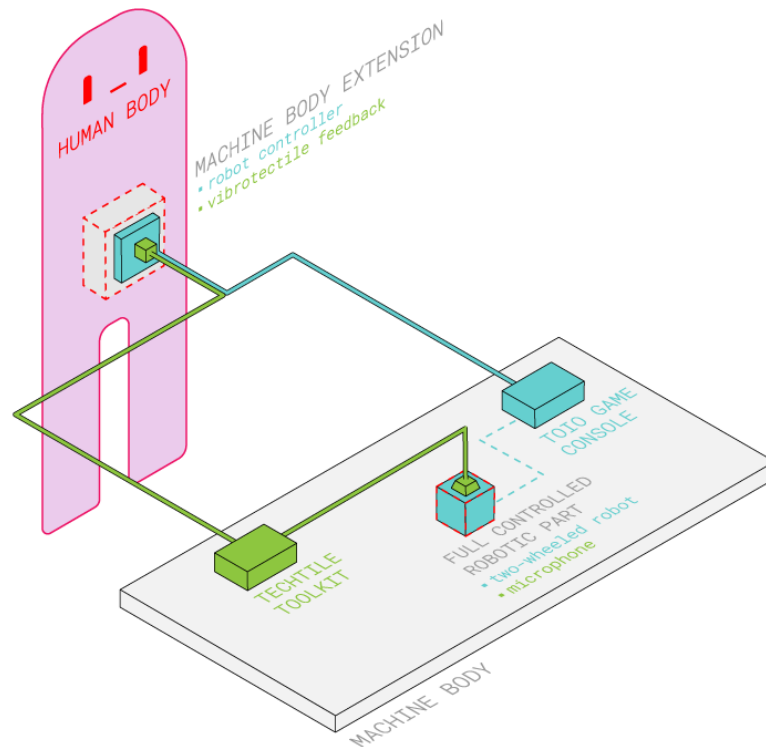
Figure 3.5: A visual schematics of the Design Step I prototype.

You can see in the visual schematics (Figure: 3.5) that the design overlaps two separated systems, with no defined space for the machine body besides the robot itself. The idea to give a machine body part in the hands of a human body seemed quite reasonable for the simple fact of general use of this design in several media such as videogames, television, and even smartphone where the whole machine body is in the hands of the human body.

3.4.2 Implementation

The first step was to create the connection between the toio™ with the Techtile Toolkit microphone, concentrating everything in a minimal body space. For that, I applied the Techtile Toolkit microphone directly into the top shell of toio™ (Figure: 3.6).
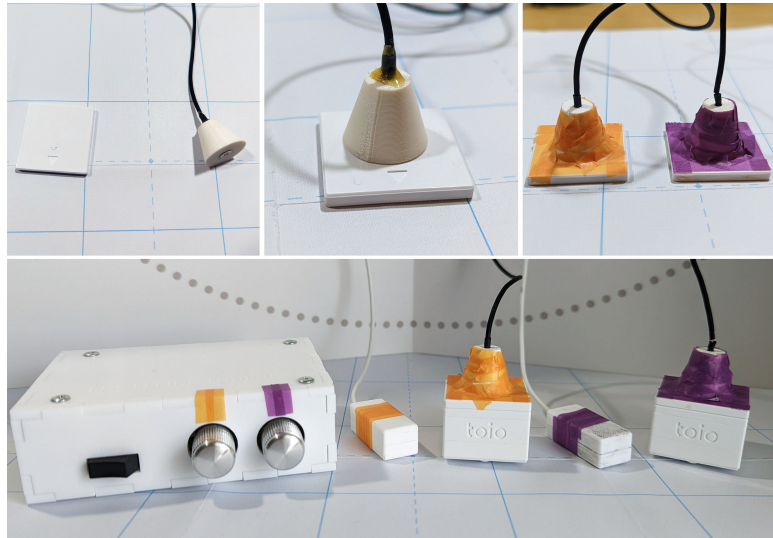
Figure 3.6: A step-by-step attachment of Techtile Toolkit and toio™.

The next step was to connect both systems at the Machine Body Extension,
which was designed specifically for this prototype. The first draft was made
using the vibrotactile feedback from Techtile Toolkit directly into the toio™ game
console controller (Figure: 3.7).
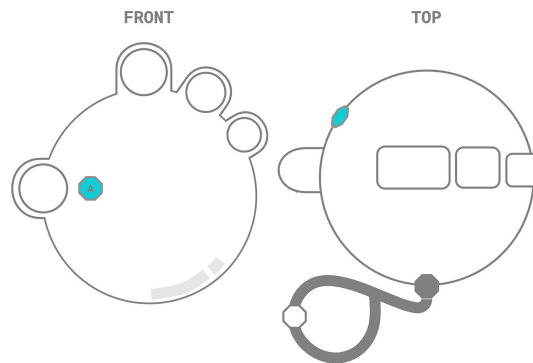
Figure 3.7: The concept schematic of the Machine Body Extension.

I noticed that the haptic signal was very weak, compromising the under-
standing of the feedback. This information was important to define the design of
the machine body extension, changing to Styrofoam sphere that has some level
of shallowness to echo the feedback. We also used textile stripes, rubber, and
melted plastic sheets. The image (Figure: 3.7) is a concept schematic of the

Machine Body Extension followed by its first prototype (Figure: 3.8).

Figure 3.8: The Machine Body Extension prototype.

To connect the vibrotactile feedback output to the machine body extension, two holes in the opposite part of the hand's resting side were made, one for the vibrotactile feedback output and the other for a counterweight to bring balance to the body extension.

To finish, a colorful design was added, and a mockup wristband with data about body connectivity was drafted (Figure: 3.9).

Figure 3.9: The complete machine body from the Design Step I.

Also, a mockup of a multitouch black pad was added. At this point, the idea of a machine body with multiple robot parts was also intended but only the mock-up was made as the image below (Figure: 3.10).

3.4.3 Evaluation and analysis

The evaluation was made by using the prototype one hour during four days testing the controller parity and haptic vibrotactile feedback. From that, four
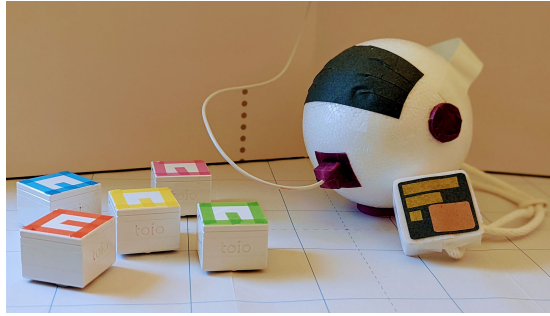
Figure 3.10: The mock-up of the machine body.

main concerns emerged.

First, let's talk about **the heavy TUI characteristics of the design and the division of the machine body into two systems.** The robot-controller-based machine body generated common habits for the users and restrictive capability on body awareness perception. The haptic feedback tries to counterpoint that, but ineffective.

Second, even though the haptic feedback was intentionally designed to transmit any potential information from the machine body to the human body, it ended up also serving as an extra control tool over the machine body, as if the user was sneakily listening to the machine body without its permission, **transforming the haptic system into a localizer of the machine body.**

Third, the behavior of both bodies, human and machine, was mimical not relational. That means the opposite of the social choreography idea. The controller-based design was detected as the cause of it, for the simple fact that the direct relation between **the human body part, the hand, and the machine body part, the robot, was exchanged based on equality, not equity, generating an unbalanced relation of control.**

Fourth and most important is the potential bias connectivity. At first glance, the body extension design could bring a sensation of embodiment but also implies an unfair trade. The design gave the human body a part of the machine body and, in exchange, gave control to the rest of the machine body to the human body. That is why no relational body was noticed. The design generated an overcontrolling system that, socially speaking, can also be seen as a reinterpretation of oppressive tactics. Also, the haptics became **a peripheral type of control where the**

machine body let the human body "touch" its movements, and that converted into control over the spatiality of the machine body.

3.4.4 Design Report

In "Design Step I" the design did not reach relational body and/or achieve Relational Body/Space. There was no identifiable area, no spatial area of embodiment contacts, and no negotiated self-body awareness. The only noticeable point was a real-time choreographic design, but very control-driven and stiff, with mimic feeling.

Here is the schematic design framework with the resulting Relational Body/Space map (Figure: 3.11):
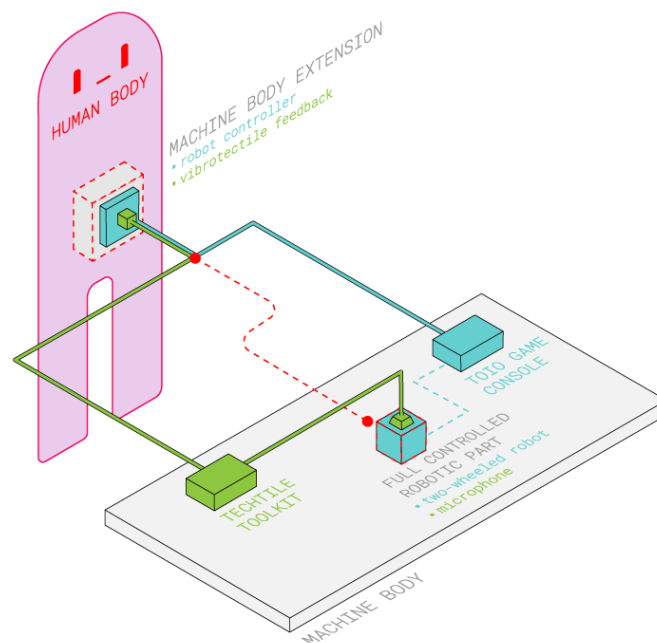
Figure 3.11: The Design Step I with Relational Body/Space flow in red.

Represented with the red dotted line, the Relational Body/Space map can be slightly noticed in the machine body extension and by the linear line connecting both bodies representing the real-time choreographic response to the toio™ game console response. The following points are the suggestive reasons for this partial conclusion:

- **toio^{TM} System:**

  - **Issue:** game console has several limitations regarding robotic parts usability.

  - **Solution:** alternative ways of controlling toio^{TM}.

- **Two systems simultaneously, but not integrated:**

  - **Issue:** Biases over embodiment perception when using Techtile Toolkit and toio^{TM} at the same time in a separate technical framework.

  - **Solution:** integrate all used technology into the same system.

- **Machine body extension:**

  - **Issue:** peripheral control over spatiality and machine body appropriation.

  - **Solution:** Do not put machine body parts into human hands.

- **Controllers:**

  - **Issue:** Increased behavioral habits, including mimic choreography.

  - **Solution:** Avoid controller-driven designs

- **Awareness of equity:**

  - **Issue:** One-on-one body part exchange.

  - **Solution:** Intentionally on equity thinking about interactive design.

- **Spatiality:**

  - **Issue:** There was no common delimited space for human and machine body coexist.

  - **Solution:** the practice of design exploration on relational space ideas.

Also, considering inclusive citation and socially aware practices, a report about the design process and its biases were created about positionality, community biases, and self-awareness. This report is under the chapter Discussion: Fields Mesh Methodology.

3.5. Design Step II – relational space

The second step of the design practice focused on improving the prior Design Step and on the design exploration of the space where the machine body and human body are going to relate to each other.

At this point of the research, conceptual foundations were better defined, such as a non-control-driven intention and calmed interactive process. With that in mind, three main issues were addressed: the lack of a delimited space for participant bodies related to each other, the need for a design exercise on peripheral and central attention, and the complete avoidance of control-driven designs such as a controller.

Considering the conceptual adjustment above, the purpose of this prototype became to improve the machine body without an extension, technical integration of separated systems, creation of an identifiable relational space, and intentionally design a relational body "moment" where a negotiation among bodies could occur.

3.5.1 Design

The prototype of this Design Step was a machine body made of an interactive surface with a detachable haptic sphere, with any type of control over any participating body. The interactive surface was composed of a toio$^{\text{TM}}$ map and a customized toio$^{\text{TM}}$ with self-driven capabilities (Figure: 3.12).
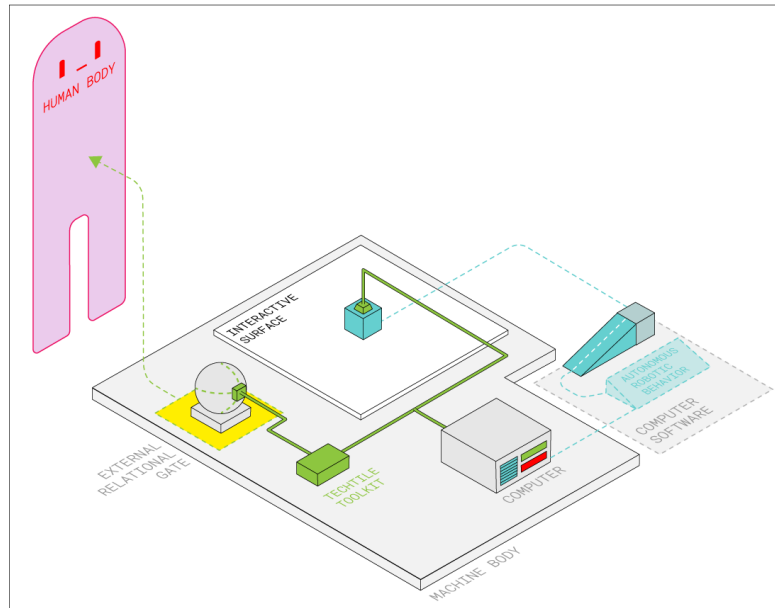
Figure 3.12: A visual schematics of the Design Step II.

The movable haptic sphere gave the design two distinctive options. One was for the human body to rest the hand over the machine body, and the other was to grab and hold the machine body part.

As part of the design exploration methodology, a radical change was implemented: the total absence of any type of control for both bodies, human and machine. Consequently, the machine body received an exclusive computational element with customized software where the robotic part could move in squared paths around the Interactive Surface and move freely with a randomization procedure.

For this design, the prototype interactivity consisted of a human body actively touching the haptic sphere with their hands while the robotic machine body part moves by itself, creating a communication channel between bodies capable of shifting from a control-driven to an active-listening-driven design.

3.5.2 Implementation

I started merging the preview design parts into a singular machine body by creating a more perceptive body for the machine (Figure: 3.13).
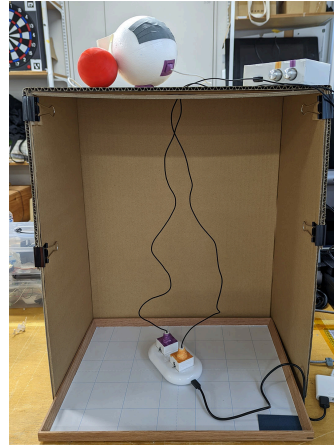
Figure 3.13: A transitional prototype using parts from Design Step I and II.

This body design had two challenges. The first one was the creation of a robust space for the robotic part using plywood and reinforced joints to guarantee an open edge-sustained tridimensional space (Figure: 3.14). Also, the lid had a wire gate coming from the top to prevent Techtile Toolkit wires from twisting, which could make the toio^{TM} stop moving.
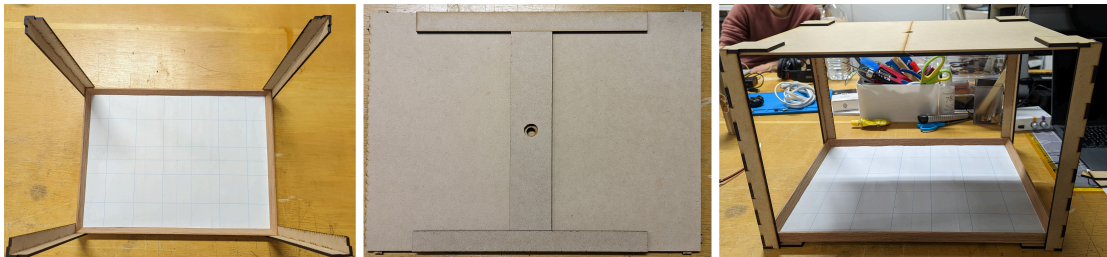
Figure 3.14: Step-by-step creation of the relational space for Design Step II.

The second challenge was to convert the machine body extension, the hand-held controller, into a resting sphere with an inviting feeling (Figure: 3.15). A combination of resting hand interface and "holding interface" was created by fixing a wooden base attached to the open cube structure with the wire from the vibrotactile feedback coming from the bottom. This led to important interactive behavior, further discussed in Evaluation and Analysis section.

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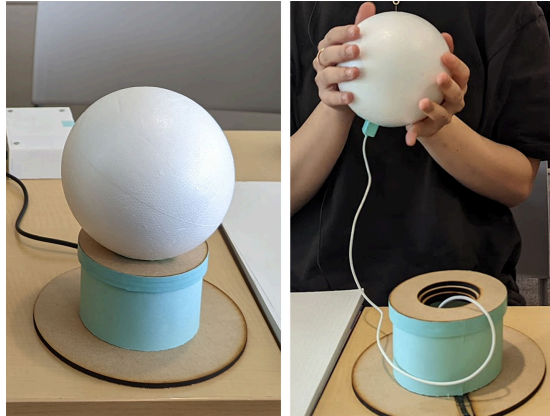
Figure 3.15: Two modes for haptic sphere: resting hand and holding sphere.

The light blue color was applied to the overall design, and aesthetical adjustments were made, such as hiding most of the computing parts, cables, and machine body parts that could reduce the feeling of a singular body (Figure: 3.16).
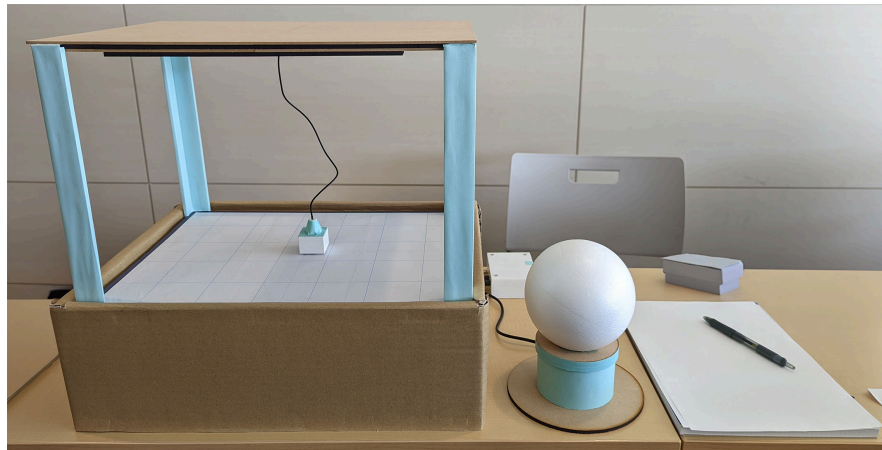
Figure 3.16: The final Design Step II prototype.

The final step of this prototype was to combine Techtile Toolkit vibrotactile signals and the toio^{TM} into a unique system capable of delivering a minimalistic yet interactive haptic language. To do that, a program in Java using Processing was created to assign simply defined paths for the toio^{TM}, making possible a design alignment with the haptic feedback.

3.5.3 Evaluation

To evaluate this Design Step, which includes the relational space apparition, relational body apparition, and peripheral overcontrol, a second preliminary user study was designed to address haptic feedback and robotic movement mapping. The user study consists of three acts.

- **Act I:**

  - **Setup:** User rest or pick up the haptic sphere. toio$^{\text{TM}}$ moves randomly using different directions and speeds.

  - **Action:** The user touches the haptic sphere while the toio$^{\text{TM}}$ moves for three minutes. The user can choose to rest their hands or pick up the haptic sphere.

  - **Objective:** It is an interactive introduction between the user and the machine body.

- **Act II:**

  - **Setup:** The toio$^{\text{TM}}$ is restrained to a set of two types of square-shaped movements at three different speeds, generating a total of six possible outputs assigned as the following table (3.1). A visual barrier is placed between the human body and the machine body to prevent visual contact. A noise-canceling headphone is given to the user to prevent sonic contact. The user receives a checkered paper and a pen, and is informed that the machine will only make square-shaped movements from now on.

Robot/Key	1	2	3	Q	W	E
Size	L	L	L	S	S	S
Speed	30	70	100	30	70	100

Table 3.1: Table of commands for the user study regarding toio$^{\text{TM}}$ movement and speed

  - **Action:** The machine body makes a set of five movements with intervals between them, and two of those movements are exactly the same.

Using only the haptic sphere feedback, the user had to draw the most accurate possible squared-shaped paths made by the machine body.

– **Objective:** Clarify if the human body could "actively touch" the relational space in the machine body. Also, it is an attempt to quantify how much information we can transfer using haptic feedback interactivity.

- **Act III:**

  – **Setup:** The visual barrier remains, and the toio^{TM} moves randomly for two minutes. The user rests one hand in the haptic sphere while drawing the path of the toio^{TM} with the other hand.

  – **Action:** For two minutes, the toio^{TM} randomly moves while the user draws most accurately as possible the path made by the machine body.

  – **Objective:** To understand if this haptic approach could lead to peripheral control over the spatiality of the machine body.

3.5.4 Results and analysis

The study was applied to 11 participants on June 10th, 2022, during Keio Media Design Plenary Meeting, in a public presentation set. Here is some visual documentation of the study (Figures: 3.17 and Figure: 3.18):

Figure 3.17: User feeling haptic vibrations from toio^{TM}.
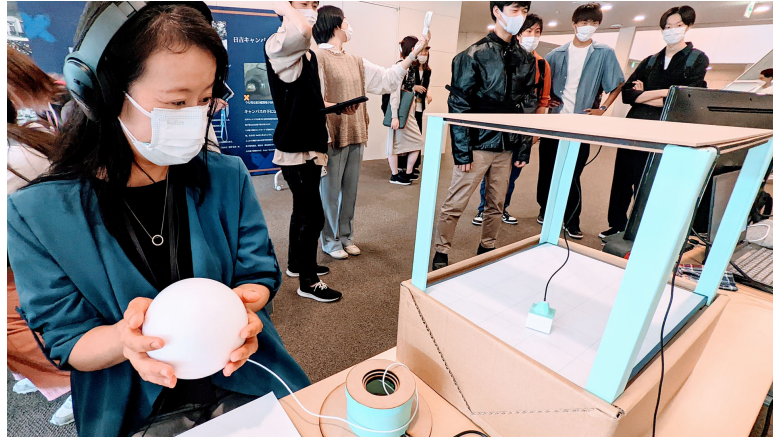
Figure 3.18: First contact between user and machine body.

For this preliminary study, I collected drawings from the users regarding the movement design of the prototype. During the five trials, each user could feels the feedback twice and draw during the feedback or after. The analysis was a direct comparison between the movement design made by the prototype and the drawing, crossing relations between spatiality and speed of the movements made by the toio^{TM}.

Here are some visual results from the study (Figures: 3.19 and 3.20) with the numbers and letters related to the actions of the toio^{TM} according to the movement table. A reminder that the referenced numbers are the 20x20cm square-shaped path, and the letters are the 10x10cm.
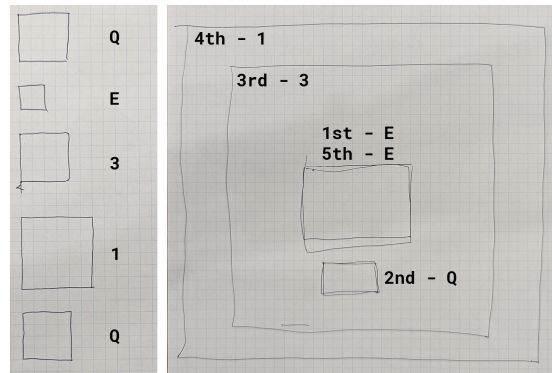
Figure 3.19: Resulted drawing from Design Step II user study.
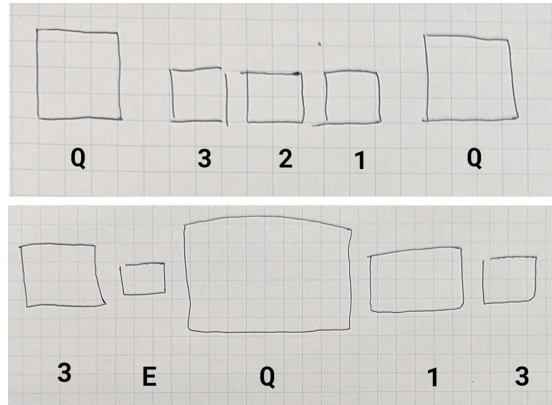
Figure 3.20: Resulted drawing from Design Step II user study.

The preliminary study revealed limitations of the relationship between vibrotactile feedback and spatial movement accuracy, pointing out flaws of haptic feedback as a cause for giving imprecise spatial information. As you can see on the resulting draws, only one user was able to establish meaningful spatial accuracy.

Nonetheless, regarding machine body design, relational space, and relational body understanding, important conclusions could be extracted from the study that led to our next prototype. About the machine body, I believe an improvement leap was achieved. Changing the extension from a handheld controller to a resting haptic sphere showed a different way that humans approach a machine body, including its intentionality of it.

Figure 3.21: Left: Design Step I gripping. Others: Design Step II gripping.

In visual documentation analysis of the human body and machine body interactive point (Figure: 3.21), it is comprehensible a behavioral change on how

the users, the human body, deals with the machine body. With the first prototype, the user held the controller with possession intentionality, grabbing the sphere in a domineering firmly way. In the next three photos is possible to see a relatively calm and communicative behavior. It is noticeable a shift in behavior towards something more aware of alterity, like holding a pet.

I believe that are two factors for this behavioral change. One is the intentionality of the design itself, the first being a controller and the second a haptic "speaker," a resting spot, giving a sharing sense instead of demanding control. Second was the user's actions towards the machine body. In the prototype of Design Step II, the initial contact was made by the users invading the machine's space and taking part of its body, a part visibly connected to the rest of the machine's body, like grabbing the hand of the machine body as initial relationship contact.

Regarding relational space, this prototype was able to achieve minimal expectations. The creation of spatiality in the machine body, where the human body could holistically interact with it by seeing, hearing, circulating around, and occasionally touching it, created interactive opportunities outside the control-driven hierarchical structure of the body. A sense of alterity towards the machine body was weakly noticed through some comments suchs as "looks like a mouse". Also, the autonomous life-like two-wheeled robot movements surrounded by the light blue edges of the relational space raised alterity regarding the boundaries of the machine body, an awareness that gave a status of an entity with its own space capable of being, and yet a space capable of being shared with a human body.

Regarding a relational body estate, I believe this prototype was not able to achieve a successful result. In this prototype, even with the successful reorganization of the machine body, the resting haptic sphere combined with the mapped movement into weak haptic feedback proved not sufficient to generate a relational body awareness. The positive feedback regarding relational body is the discovery of an important conceptual element for the creation of a Relation Body/Space. The haptic sphere brought the "holding hand feeling" one user said, with a visible behavioral change, an awareness of habits interruption towards a machine body, but not yet elaborates a contestation of the self. This could point not for a relational body contact point but a transitional instant, like a gate towards the

moment where a relational body could exist.

If the Relational Body/Space approach could help design processes with an identifiable point and moment defined by a spatial area of embodiment contact in an interactive media design that highlights the relational body status between the human body and the machine body, maybe it needs a choreographic moment of transition, almost ritualistic, like if both bodies transpose a stage, a situation, or a gate. So, this prototype design of the machine body didn't deliver a relational body experience yet, but it was able to clarify a conceptual adjustment, the necessity of a gate for the Relational Body/Space.

3.5.5 Design Report

Design Step II achieved a potential relational space existence, did not achieve relational body, but showed the necessity of a Relational Body/Space gate. Here is the schematic design framework with the Relational Body/Space analysis, including the idea of a Relational Gate (Figure: 3.22).
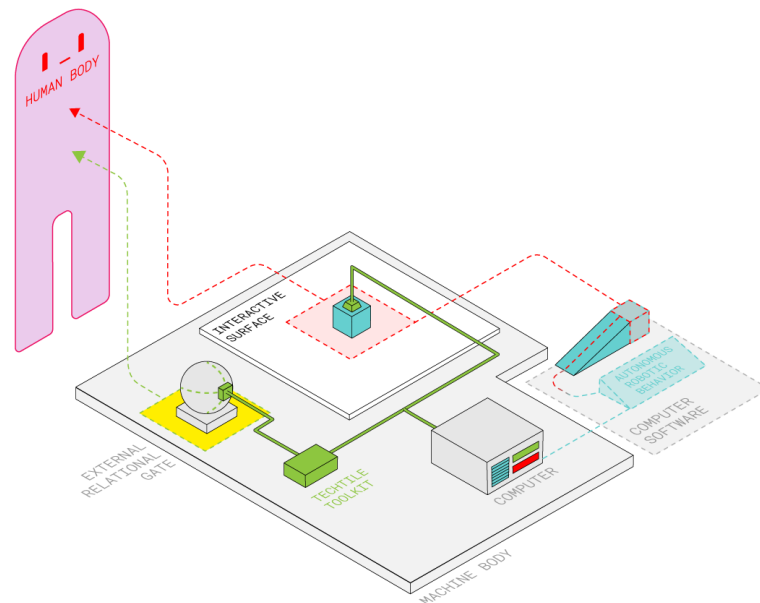
Figure 3.22: The Design Step II with Relational Body/Space flow in red.

There was an identifiable bidimensional area of embodiment but no specific point and moment. The following points are the suggestive reasons for this partial

conclusion:

- **Techtile Toolkit:**

  - **Issue:** it was a great design tool until here, but its haptic limitations made interactivity limited.

  - **Solution:** change to another robust haptic system, or discard vibro-tactile haptic feedback as an embodiment tool and look for other haptic designs.

- **Haptic sphere contact point:**

  - **Issue:** even with the usage as a point of embodiment initiation, its design restrained relational body exploration.

  - **Solution:** redesign thinking the point embodiment initiation to something that could represent the transposition of an estate, like a gate.

- **Autonomous robotic behavior:**

  - **Issue:** the random movements gave the impression of a life-like being, but it is not open to dynamics caused by the user's interactivities.

  - **Solution:** improve the software development by implementing real-time interference created by users' interactivity.

- **Equity balance:**

  - **Issue:** the toio$^{\text{TM}}$ as a life-like part of the machine body was eye-catching and brought a bodily presence to the machine body, but still too minimal compared to a human body.

  - **Solution:** put the interactive surface more centered in the final design, giving some protagonism by minimizing the other machine body parts.

3.6. Design Step III – relational body from the Hands Arcade

At this point of the research, the Relational Body/Space conceptualization concluded, as presented in the Literature Review, clearing the design needs of the project. Three main issues were addressed with that in mind: the improvement of the relational space, the construction of some kind of gate to reach it, and the craft of a body for the machine capable of being seen as an entity.

Considering the adjustment above, the purpose of this prototype was to redesign the machine body to its core (Figure: 3.23), shifting from an open design to a bodily close cabinet design; to include in the software development ways of the human body generate interference; utilize more robotic moving parts to bring the life-like feeling.
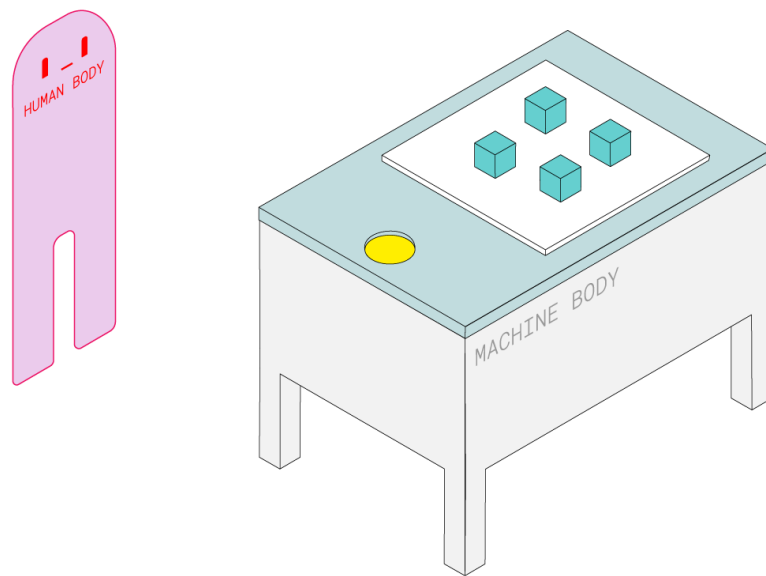
Figure 3.23: A visual schematics of the Hands Arcade.

Since the first design step, human hands and their interactivity with the machine body had a protagonist role. Because of that, targeting the final prototype, a theme of "hands" was given to the design overall, transforming the arcade cabinet into the Hands Arcade (Figure: 3.24).

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Figure 3.24: A photo of the Hands Arcade.

3.6.1 Collaborations

At this design step, three main collaborations were made for the conceptual and technical development. To improve the quality of toio$^{\text{TM}}$ usage and the human-computer interaction studies, this research collaborated with Actuated Experience Lab (AxLab) from Chicago University, Marc Teyssier and Filippo Ronco.

The main collaborator was the lead of AxLab, Ken Nakagaki, an interaction designer and HCI (Human-Computer Interaction) researcher from Japan. His research focuses on inventing and designing novel user interface technologies that seamlessly combine dynamic digital information or computational aids into daily physical tools and materials. At AxLab, he pursues research in actuated and shape-changing user interface technologies to design the future of user experiences.

Nakagaki's collaboration was on the hardware and software design development for the Hands Arcade through the adaptation of his system called Hermits System, "Heterogeneous Emergent Robotic Mobile Interactive Tiles". It is a modular system for table-top, wheeled robots to dock to passive attachment modules, defined as "mechanical shells," combined with a customized system to modify toio$^{\text{TM}}$ as "tiles," that after can be physically manipulated. It was an immense

improvement for the design overall, facilitating the achievement of life-like robotic movement design, the implementation of the hands over the toio$^{\text{TM}}$, and its interactivity. Also, to make Hermits work on the Hands Arcade, Kan Nakagaki and the AxLab students directly collaborated in developing parts of software integration between Hermits, Computer Vision technologies, and overall design.

The second collaboration came in the form of a design consultancy by Marc Teyssier from the De Vinci Innovation Center. Teyssier is a creative technologist developing creative hardware and software experiences bringing technology closer to human nature. For this project, he helped with several inputs on how design could amplify relational body awareness and its limitations. He also participated in the technical workflow of this final prototype step, suggesting directions such as exploring different hand sizes, textures, and designs.

The third and final collaboration was with Filippo Ronco, a student from Faculty of Science and Technology at Keio University. Filippo Ronco is a master's student in robotics, machine learning, and tangible/virtual interactivity. He co-developed the software responsible for mapping hand-tracking data into choreographic movement design sets.

3.6.2 Design

For this step, an arcade cabinet design as a machine body was chosen. One of the main reasons is the "mystery box" feeling, a black box design that hides everything from the user besides the top surface and its playful design capabilities. On the top of the cabinet, two machine body parts were designed: a hole named Relational Gate where human bodies could "exchange" their body part, a hand, and an improved interactive surface from the previous design now containing four autonomous two-wheeled robots working as a tile via a robust spatial mapping system. We renamed the interactive surface to **Relational Surface** (Figure: 3.25).

Figure 3.25: The top view of the Hands Arcade.

The prototype of Hands Arcade is an actuated and self-actuated machine body that has computer vision, robotics, and an empty interior space called Relational Body/Space. The highlight of the experience is that by using a wearable-free device, the human body and machine body could experience different levels of embodiment without being attached to each other.

Inside the arcade cabinet (Figure: 3.26), a big empty space was intentionally designed as an identifiable space by the limits of the inside walls of the machine body. In this space, the Relational Body/Space, a human body could interact with the machine body just by inserting its hand in the Relational Gate, while the machine body could interact by "looking at the human hand" and responding autonomously.
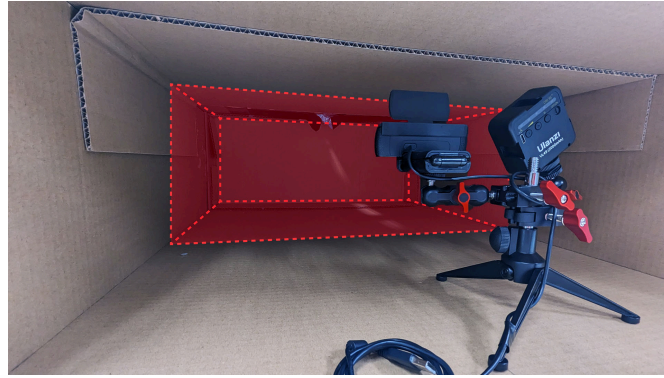
Figure 3.26: In red, Relational Body/Space inside the cabinet.

This prototype has a considerable portion of software development that must be addressed. To merge data coming from the hand in the Relational Body/Space and the autonomous robotic moving parts of the machine body, it was created a stream of data from both bodies simultaneously, cropping and mapping each one of them until a negotiation point of embodiment that it was named Negotiated Feedback Loop. The result of this negotiation is sent to a digital twin named Relation Twin, mirroring the results to the tangible Relational Surface with the four robotic hands. Here is an overall schematic design framework of the software development (Figure: 3.27).
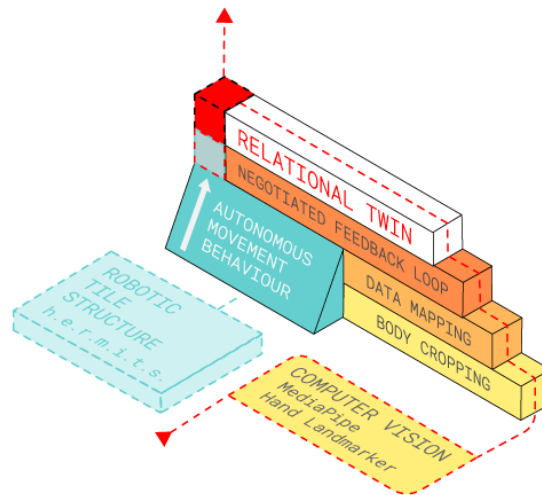
Figure 3.27: Schematics of software development for the Hands Arcade.

For the hands design part of the arcade, I decided the use of miniature hand types, including thematic possibilities such as racial types, gender types, and festive thematic designs. Also, a playful aesthetic decision was applied, including toy design aesthetics, including red wrist cut with bone exposure, and two highly customized "Halloween Hands" because the user studies was going to happened during this festivity.

To create the machine body, numerous types of systems were integrated into a unifying arcade cabinet structure:

- **Machine body structure:** Made of lightweight wood and cardboard, the prototype measures 70cm by 30cm by 90cm, with removable legs of 50cm in height.

- **Relational Gate:**

  - **The hole:** At the top of the cabinet, it is a hole of 10cm in diameter covered by a black textile to avoid visual contact with the inside parts of the machine body.

  - **The flag:** a small flag with "手↓" in red color. The kanji means "hand".

- **Choreographed Robotic Tiles:** four toio$^{\text{TM}}$ robots with two wheels, distance sensors, LED lights, Bluetooth wireless connectivity, and customized shells.

- **Relational Surface:** before called interactive surface, a fenced bidimensional area on the top of the cabinet containing a white toio$^{\text{TM}}$ mat for the Choreographed Robotic Tiles.

- **Empty Inner Space:** Right under the Relational Gate, an illuminated wide empty space of 70cm by 30cm by 60cm where the Relational Body/Space emerges during human and machine body interactivities.

- **The image capturing:** A tripoded camera facing the Empty Inner Space with 1920x1080 pixels of resolution at 30 frames per second.

- **Computer hardware:** an Apple M1 notebook with 16GB of ram, 1TB of storage, and OS Monterrey 12.5.X as an Operational System.

- **Software:**

  - **Computer vision:** MediaPipe Hand Landmarker.

  - **Autonomous Tile Structure for toio™:** modified Hermits System network, containing a minimal data receiver for MediaPipe programmed in Python, a wireless Bluetooth OSC connection for simultaneous connectivity up to 12 toio™, a program in Java to autonomously deliver a variety of movement sets for the tiles.

  - **Body cropping:** A program to crop MediaPipe data into the used-only tracking points of the human hand inside the Relational Body/Space.

  - **Data mapping:** A program to map received cropped tracking data into movement sets.

  - **Negotiated Feedback Loop:** A program to assemble the Data Mapping and the Autonomous Tile Structure, outputting sets of instruction.

  - **Relational Twin:** A digital twin of the Relational Surface that streams the Negotiated Feedback Loop data to the Relational Surface.

- **Customized Hands Shells:** simplified version of the Hermits 'mechanical shells' with hand design shape. Nine different types were produced.

- **Furry haptic surface body skin:** An extensive textile covering the entire arcade cabinet. It has a furry, touch-attractive design.

- **Minimalistic Instruction:** A small cardboard resting at the top of the cabinet with minimal figurative instructions for initial interactivity.

3.6.3 Implementation

The implementation had three main production steps: hardware, software, and finishing. Here is the exploded schematic of the entire structure (Figure: 3.28).
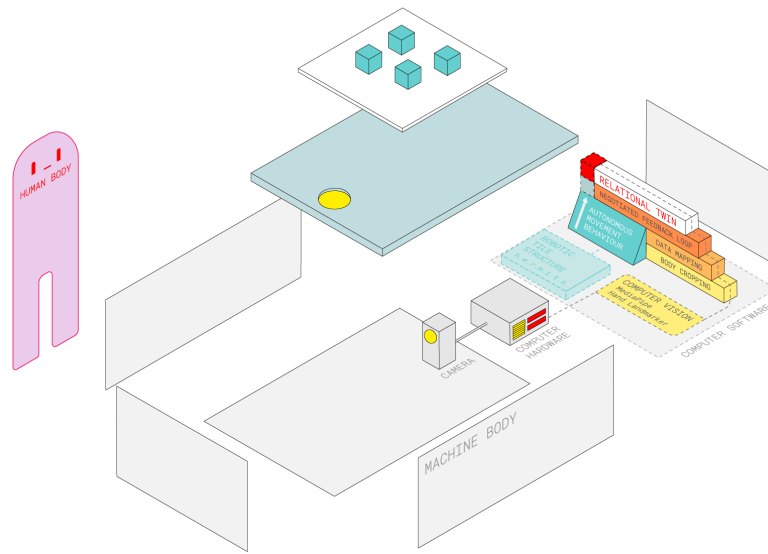
Figure 3.28: A exploded schematic of the Hands Arcade.

The **hardware** production started by cutting all the faces of the machine body's basic structure to size 70cm by 30cm by 90cm. At the top face, a 10cm diameter hole was created for the Relational Gate. A 15cm by 15cm black cloth with an edge-to-edge incision was placed at the hole to prevent it from being seen inside (Figure: 3.29).

Figure 3.29: During the process of Hands Arcade.

Inside the cabinet, on the opposite side of the hole, a tripoded camera (Figure: 3.30) was placed with a small LED light. Both were facing the direction of the hole. The cabinet was partially sealed, leaving only the back face behind the camera open for setup and maintenance.

Figure 3.30: Left: webcam and LED. Right: Relational Gate in red.

At the top surface, a 56cm by 56cm area was delimited for the Relational Surface using white miniature fences from architecture modeling. Inside the fenced area, a toio^{TM} map was placed (Figure: 3.31).

Figure 3.31: The top view of the Hands Arcade.

An important detail was designed at this point: the height of the cabinet. Aiming for a public event with a young audience, the cabinet legs were cut in half, giving an approximate 50cm height.

For the **software**, a series of programs were created, and you can see the code in the appendix. There were two main setups: the production of a streamline for data capable of representing the relational body through a Relational Body/Space, from the human hand to Choreographed Robotic Tiles. Meaning from the hand trespassing the Relation Gate, its image captured, to the toio™ robots set at the Relational Surface. This should happen seamlessly, sparking a sense of instant behavior change for both participant bodies (Figure: 3.32).
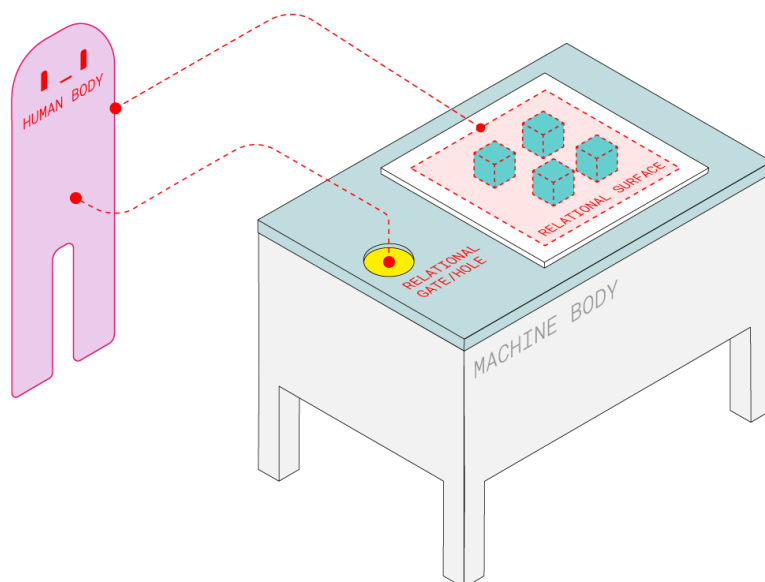
Figure 3.32: The Design Step III with Relational Body/Space flow in red.

When the camera is on, a Python program connects the captured image stream to MediaPipe machine learning (ML) model to output hand landmarks (Figure: 3.33) in image coordinates, hand landmarks in world coordinates, and handedness (left/right hand) of multiple detected hands.
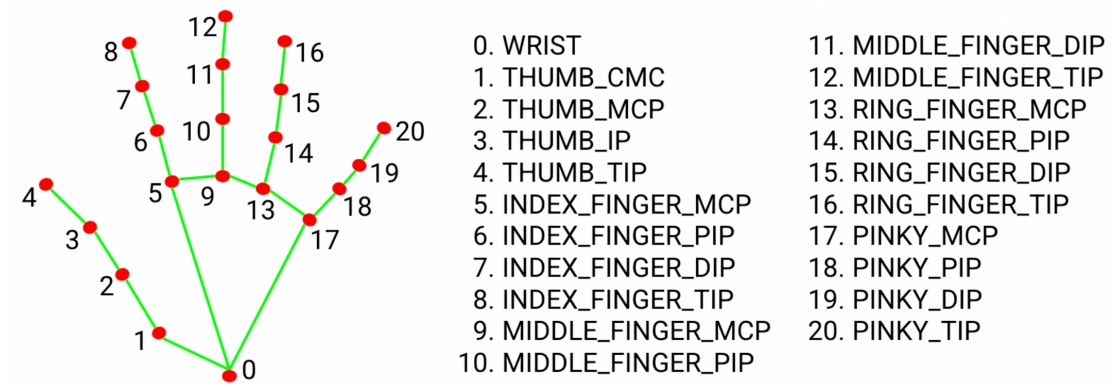
Figure 3.33: The hand landmark with 21 hand-knuckle coordinates.

(Source: MediaPipe [46])

This visual result is received by the same Python program and redirected to a Java program designed using Processing, where the data could be read, cropped, and mapped.

At the same time, to connect the four toio^{TM} robots to the same Apple M1 computer, a program in the GitHub MacTuitui [47] was used. Through that program, it was possible to receive and send data to toio^{TM} using Open Sound Control (OSC), a protocol for networking sound control. The reason is its very energy efficient and has a stable capability for Bluetooth connectivity, which toio^{TM} uses natively. From this connection, an adaptation from Nakagaki's Hermits System was made by AxLab using Java on Processing to receive this data allowing reading, writing, and data manipulation. This resulted in a closed flow for the data captured at the Relational Body/Space and data captured by the toio^{TM} mat on the Relational Surface.

After this setup, Filippo Ronco and I started the design of how both data will interact with each other. The initial editing step was to balance the amount of data to be used from MediaPipe Hand Landmark and the toio^{TM} robots. To do that, **Body Cropping** was designed to virtually crop the human body and the machine body into a restricted set of data capable of being used in an equitable and balanced way.

The first crop was on the Relational Body/Space to receive only data from one single human hand, even if a user inserts two or more hands inside the cabinet. Still, just one hand data contains 20 tracked points that can be relative to the

hand image and/or to world coordinates, which is a lot if compared with the four bidimensional displacement data. To reduce this data gap, another crop from the captured human hand data was created to receive six tracked points of the human hand. This amount was enough to create 1:1 and 1:4 movement choreography, allowing design exploration on the next step: data mapping.

The **data mapping** consisted of translating the cropped hand tracking into a set of movements on the machine's robotic parts. To do that, four tracking points were used to design cartesian lines over the human hand. This allowed the program to condense the human hand spatial movement by converting those lines into a cartesian area and use that to detect the hand displacement and rotation in the 3D space. Also, it was possible to measure the size of this cartesian graph, resulting in hand size analyses and, most important, finger articulation by calculating the distance between fingertips and the center of the hand.

This data mapping allowed the creation of a variety of movement designs correlations:

- **Relative Individual Displacement:** the displacement of the hand in the Relational Body/Space generates displacement of one toio™ on the Relational Surface using a pitch and roll system (Figure: 3.34). Moving the hand in the Y-axis generates forward and backward movements, and X-axis rotation in one toio™. To do that we design the X-axis to trigger the wheel's speed difference generating circular moves, while the Y-axis to accelerate the wheels equally without removing the X difference.
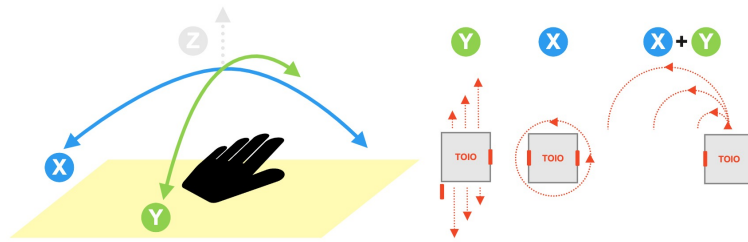
Figure 3.34: Pitch and roll design for Relative Individual Displacement.

- **Relative Multi-robot Displacement (Hands Dance):** the displacement of the hand in the Relational Body/Space generates displacement of

all robots on the Relational Surface. Each one is in a quadrant of the Relational Surface. It makes the center of the Relational Surface a center axis where all the robots are displaced around the center of the Relational Surface.

During the usage of the Hands Arcade, the set of four toios are always "on," always receiving instructions for its movements, even if the instruction is to stay still. For that, in parallel with Body Cropping and Data Mapping, a program was developed to set autonomous behavior for the four robotic parts of the machine body. The base movement design has two estates. One is a short, high-speed, four robots' all-together movement design to generate a unique "robotic" movement type. It happens at the same time or not in synchronization. The second one is a random selection of one toio^{TM} that slowly moves a longer distance, generating a "human-like" movement output.

To integrate the autonomous movement design and data mapping into a singular output, another layer of programming named **Negotiated Feedback Loop** was created. It is a minimalistic balancing input/output system where the machine body and human body establish their roles instant by instant, in real-time, creating a set of lapses, unexpected encounters, and resolutions by a choreography involving them. The Negotiated Feedback Loop lines up in an instant-by-instant output sending to the Relational Surface via digital twin named Relation Twin. Right after, this data forwards to the robotic parts.

At the Negotiated Feedback Loop, how to decide which instruction is streamed on every instance to the Relational Twin? Since the first design action of the Hands Arcade is the human body occupying the machine body with its hand, an equitable solution was to use the autonomous movement data as the main data stream. From this concept, we designed three types of negotiation:

Balanced overwriting: to completely shift from autonomous movement to data mapping by using specific hand positions. This will restrict the machine body act giving the human body total control of one toio^{TM}. To balance that, we assigned a pointing finger stand as an activation hand position because also limits the human body's actions, establishing restrictions for both bodies.

Real-time movement composition: an alternating process where on each instance there is a shift between machine body instructions and mapped

human body instructions. To balance that in an equitable way, only one toio$^{\text{TM}}$ receives these signals, while the others received autonomous movement signals also alternating between robotic-like and human-like designs.

Cooperative interactions: a single toio$^{\text{TM}}$ is occupied 1:1 by the human hand inserted at the Relational Body/Space, while the other robotic hands move based on autonomous movement design. The occupied toio$^{\text{TM}}$ uses the Relative Individual Displacement mapping type while the autonomous robotic parts use the robot-like movement design. To balance the relationship because of the total occupation of one toio$^{\text{TM}}$ by the human body, from time to time, the occupied toio$^{\text{TM}}$ changes, creating a lapse followed by an unexpected encounter of embodiments between the human and machine body.

The user, the human body, cannot decide which negotiation method will be applied, at the same time it can interfere with it by its own hand movements when applying hand and movement positions to disconnect the capturing system. This creates a balanced embodiment flow where some moments are towards the machine body, others towards the human body.

For the hand design over the toio$^{\text{TM}}$ robots, a simplified version of 'mechanical shells' was used and seven customized hand designs were made. The first attempt was to use real-size realistic hands, but after preliminary tests, the size and weight offered limited movement design, and the uncanny valley feeling was considered too noisy. Another attempt was to design as racial diversified. Due to the lack of racial diversity and gender in the Japanese consumer products market, and to avoid biases processes such as painting a white hand as black, we shift to a playful, allegoric hand design. This is analyzed in the "Discussion I: Relation Body/Space" chapter under the section "Design Limitations".

The chosen solutions were to use consumer product miniature plastic hands of several design styles. The flat surface of toio$^{\text{TM}}$ received a molded plaster to accommodate the design variety. Since the prototype was going to be presented during Halloween in a Keio Media Design public event and to give extra details to each hand, we designed the exposed internal parts with plaster, adding to the edge a "cut" feeling with flesh and bone exposure. Also, two hands received a specific design. The first was a "mummy" hand and the second was a pool of micro-hands (Figures: 3.35, 3.36).

Figure 3.35: The four main designed hands used in the user study.

Figure 3.36: Nine simplified "mechanical shells" with hand designs.

For the finishing of the entire machine body, a furry haptic surface skin was applied to bring a balanced haptic and visual attraction to the cabinet (Figure: 3.37). Using an extensive textile, the cabinet was completely covered, giving a feeling of furry skin.

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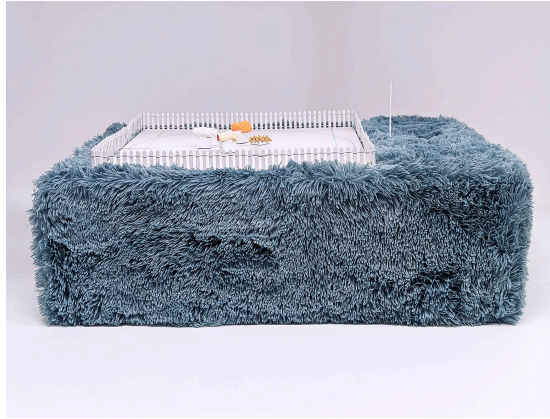
Figure 3.37: A side photo of the Hands Arcade.

Another part of the design is the minimalistic instruction (Figure: 3.38). Micro golf toy elements were customized as an iconographic instruction for the Japanese audience: "手↓"- the kanji means "hand". The flag was applied in front of the Relational Gate, the hole. Also, a minimalistic instruction of the Data Mapping types was displayed.

Figure 3.38: The set of minimalistic instruction, including The Flag.

The last design decision was to make all non-interactive machine body parts hidden inside its own body. The machine body became a compact playful arcade cabinet achieving a mysterious and instigating design (Figure: 3.39).

Figure 3.39: Final prototype of the Hands Arcade.

Here is the exploded visual schematic of the Design Step III, Hands Arcade. The schematic shows the path how human body and machine body connect to each other, and identifiable point and moment where the Relational Body/Space and the Relational Surface are active (Figure: 3.40).
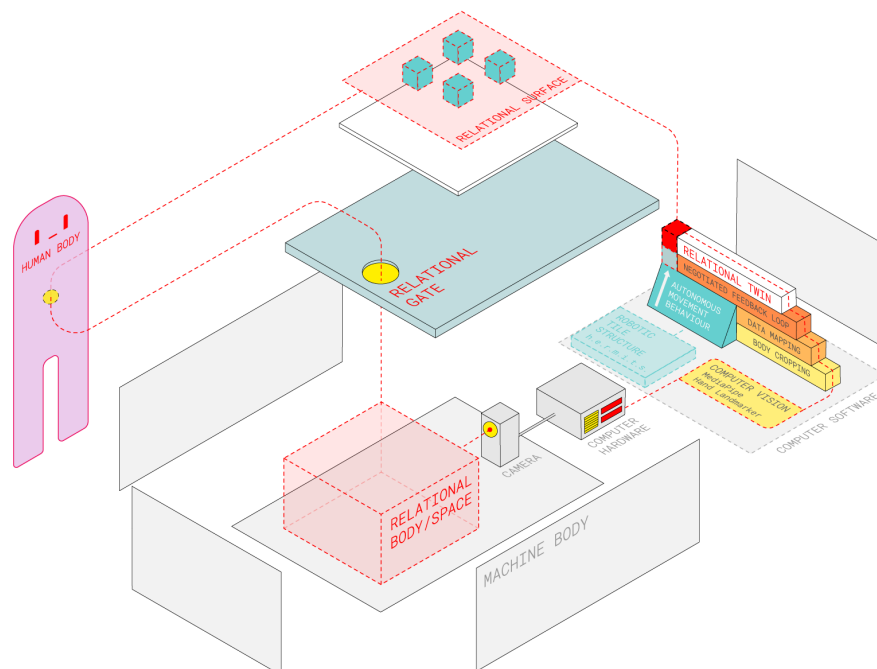
Figure 3.40: The final visual schematic of the Design Step III, Hands Arcade.

Chapter 4

Evaluation

To evaluate the potential existence of the Relational Body/Space apparition, relational body apparition, negotiated embodiment and playfulness, a user study in a public set was designed. It happened during two days at "Wonderland", the KMD Forum 2022 during October 29th and 30th of 2022.

The study consists in three acts:

- **Act I:**

  - **Setup:** with the Hands Arcade always on, the machine body was exposed in public without any direct instruction or particular invitation to use. If the public stayed in front of it with interest without interacting with, the observer behind the cabinet invited to use it without any conversation or explanation, only a gesture to insert the hand in the hole.

  - **Action:** The user spontaneously approaches the machine body and crosses the Relational Gate. The user interacts with the machine body for about two minutes.

  - **Objective:** Analyze initial empathy and curiosity triggering.

- **Act II:**

  - **Setup:** an observer analyzes the embodiment process and asks if the user can identify which parts were embodied. Visual documentation is made during this act.

  - **Action:** the user with the hand inside the Relational Body/Space intentionally tries to define which machine body part is embodying,

generating a diversity of movements by robotic tile and the user's body itself.

– **Objective:** to push the user to explore other body movement habits and challenge the potential embodiment process by the Relational Body/Space leading to a possible relational body.

- **Act III:**

  – **Setup:** A questionnaire in English and Japanese about the experience with the following questions:

    1. How well do you feel that the robotic hands are part of your body? (Feeling of agency) 1-weak, 7-strong.
    2. What aspect of the interaction do you think made agency? (Multiple choice: Shape of the hands, Mystery box design, Robotic hand speed, Toy-like design, Robotic hand movements, Wearable free experience, Other).
    3. Which of the control modes did you like and why? One-Hand, Hands Dance.
    4. What could be improved to increase the feeling of agency?
    5. Do you think in the future this type of device could help us to understand ourselves more?
    6. Any other comments?

  – **Action:** The user answers the questionnaire, and if wants to, receives conceptual and technical explanations. If the user wants to, it could try again the Hands Arcade.

  – **Objective:** Gather quantitative and qualitative data from the experience.

Wonderland KMD Forum 2022 had approximately 1,500 visitors and the Hands Arcade was presented to approximately 100 people, half of it being children from 5 to 15 years old. Here is some visual documentation of Hands Arcade in action (Figures: 4.1, 4.2, 4.3):

Figure 4.1: A group of children interacting with Hands Arcade.

Figure 4.2: A child interacting with Hands Arcade by himself.
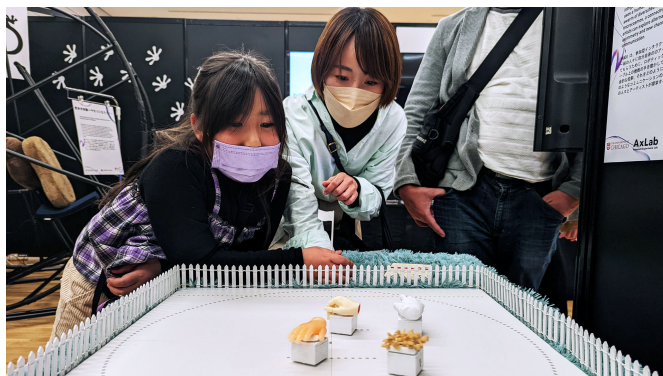
Figure 4.3: A woman and his daughter interacting with Hands Arcade.

Chapter 5
User study data analysis

The user pool was composed by 39 visitors of the Wonderland KMD Forum 2022, with 37 leaving comments and impressions besides the multiple choice answers. The analysis of the results consists in three procedures. Qualitative, quantitative, and visual documentation analysis combined with the observer commentaries.

5.1. Quantitative data

Based on the questionnaire we could extract three major quantitative data. The first one (Figure: 5.1) is the embodiment and/or feeling of agency resulting in 14 users declaring "a bit strong" and 11 users declaring a "strong" feeling, 62.5% of the participants. It is possible also to see that 13 users pointed out as "more or less" and "weak". There was no "very weak" answers.
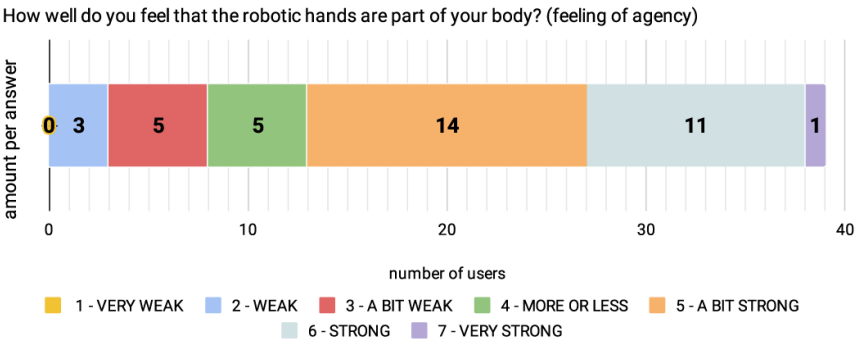
Figure 5.1: Data for: "How well do you feel that the robotic hands are part of your body?"

The second quantitative data extracted from the questionnaire was which

part of the design the user thought was responsible for the embodiment feeling (Figure: 5.2). Because of the multiple-choice option, the result was a pool of 85 answers, with the user choosing from zero to four options.
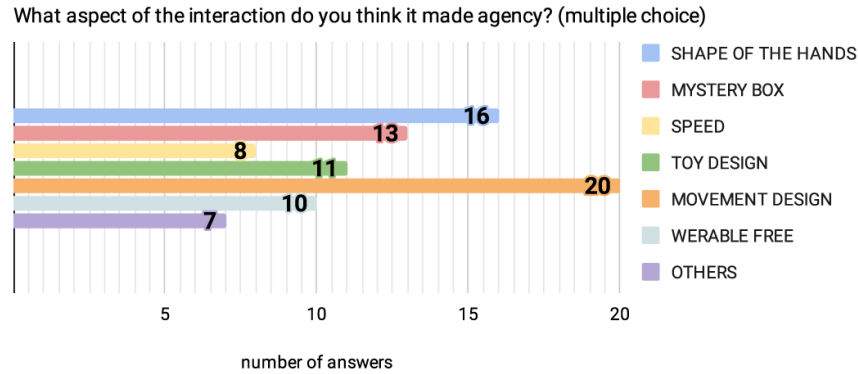
Figure 5.2: Data for: "What aspect of the interaction do you think made agency?"

The most chosen answer was "movement design" with 20 answers, followed by "shape of the hands" with 16 answers, and "mystery box" design with 13 answers. The least chosen one was "speed". The "others" pool of answers had only two direct complementation, "sounds of the motors" and "the pattern and unexpected interaction of the hands". The last one could also be understood as "movement design".

The third quantitative data is the amount of robotic hands usage simultaneously (Figure: 5.3). Most users, 25, pointed out their preference for "control all hands together".

Which of the control mode did you like?
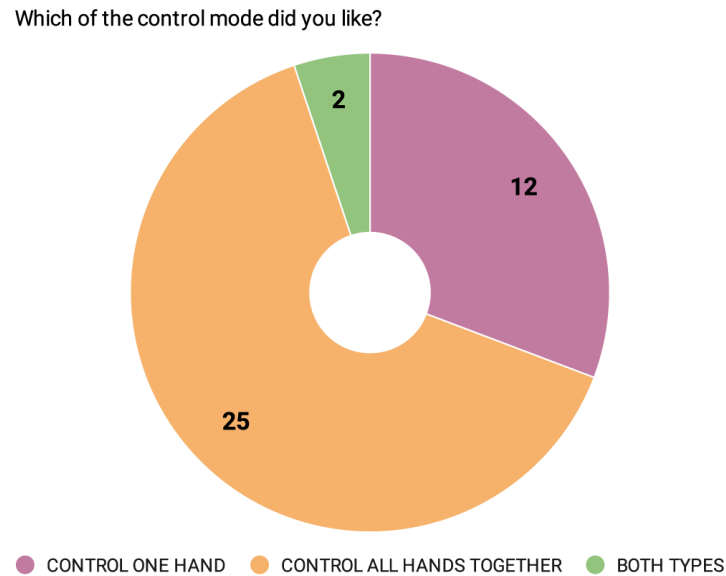
Figure 5.3: Data for: "Which of the control modes did you like and why?"

5.2. Qualitative data

The questionnaire and observation resulted in a broad variety of qualitative data that is going to be organized into three categories: Embodiment Balance, Relation Body Awareness, and Technical Improvements.

Embodiment Balance: complementing the preference for using all hands together, users highlight the following reasons:

- The discovery moment it led to an intense playfulness feeling of having "**several entities** acting as one".

- The rhythmic feeling of embodying a "hands choreography" and its **overpowering feeling**.

- One user highlighted the one-hand embodiment design saying, "We can understand easily **without explanation**".

Relational body Awareness: the feedback brought insights into body education and self-awareness. Answering the question "Do you think in the future

this type of device could help us to understand ourselves more?", 18 people replied a direct "yes". Also, commentaries were extensive:

- "Understanding how **we move our body**."

- "I can see **my own movement** in a new way, pretty reflective."

- "It could definitely help with **motion enhancement**, concentration practice."

- "Grandma and grandchild remote play to **improve daily life**."

- "Help to improve our focusing to **our body movements**."

- "We could **see patterns and habits we usually don't pay attention to**."

- "It can help us understand **our bodies and how our body moves**."

- "It could be interesting to **explore** our body."

- "I think it would be useful as an **extension**."

- "I think the robotic hands move differently **making the feeling of agency unclear**."

Technical improvements: Users suggested some improvements such as adding the possibility of touching items through the machine body, improve accurate tracking technology, articulated robotic hands, and support for more gestures. Some answers also brought certain criticism to implementation. Here is the list of relevant ones that are going to be discussed in the next chapter.

- "If **I can touch** something that would be great."

- "The hand movement could be more **related as shadow**, instead the robots move against your movements."

- "**Increased control** would be nice."

- "I couldn't tell which one I was moving."

- "I was a bit **confused which one** I was controlling."

5.3. Visual Documentation

A strong visual documentation was made of the whole public exposure of the Hands Arcade. Some photos and videos showed relevant types of feedback regarding the interactions.

The initial visual documentation is about when the exact moment of a human body crosses the Relational Gate, reaching the Relational Body/Space, and creates a disturbance at the Relational Surface instantly receiving feedback (Figure: 5.4).

Figure 5.4: The exact moment user cross the Relational Gate.

It is possible to see that the user created a collision between two robotic hands understanding some connectivity instantly, making the user laugh. At the same time, the person on the side got surprised, also understanding that a relational instance between the human body and machine body happened.

The second image is about the moment when the user was able to embody the four robotic hands simultaneously, generating an immense sense of surprise

(Figure: 5.5).

Figure 5.5: A user embodying four robotic hands simultaneously.

A video taken during this moment could reveal the user's live feedback and its awareness of the variety of embodiment levels created by the different data mapping propositions.

Video link [48]: **https://youtube.com/shorts/AGPiMe5Cxig**

The video starts with the user embodiment on four robotic hands, changing at 4" its own hand's movements resulting in a seamless transition to a 1:1 interaction with a robotic hand. Right after, at the second 7, the user changes again the negotiation leading to a four robotic hands embodiment again, generating a positive response including a spontaneous voice feedback "面白い"(That is interesting). The user then starts to combine both embodiment methods, generating its own unique movement design. It is noticeable "a waiting tactic" referred to by Fiadeiro and its real-time composition practices.

Other visual documentation analyses also revealed two types of human-machine interactivity awareness. One was by self-body awareness when specific

movement designs started (Figure: 5.6).
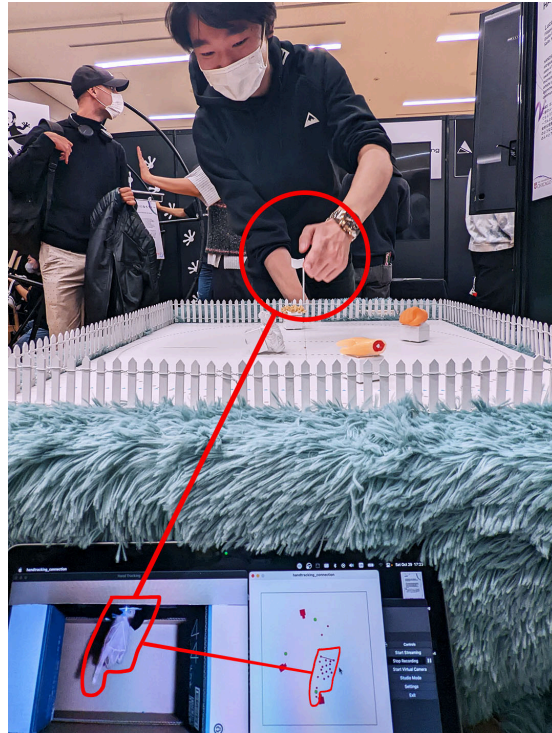
Figure 5.6: User's live feedback and its awareness of the embodiment level.

The user with the right hand in the Relational Body/Space finds out a type of mapping and immediately reproduces the same gesture outside the box with the left hand. In the photo is possible to see four instances of it: the right hand reproducing the gesture, the left hand inside the arcade by the machine vision, the hand-tracked dotted mapping, and the hand at the Relational Twin at the right side.

Another significant visual documentation comes from a sequence of photos where a child interacts with the Hands Arcade, leading to a ping-pong of body negotiations. The following sequence of frames shows the pinpoint moment of this happening (Figure: 5.7).
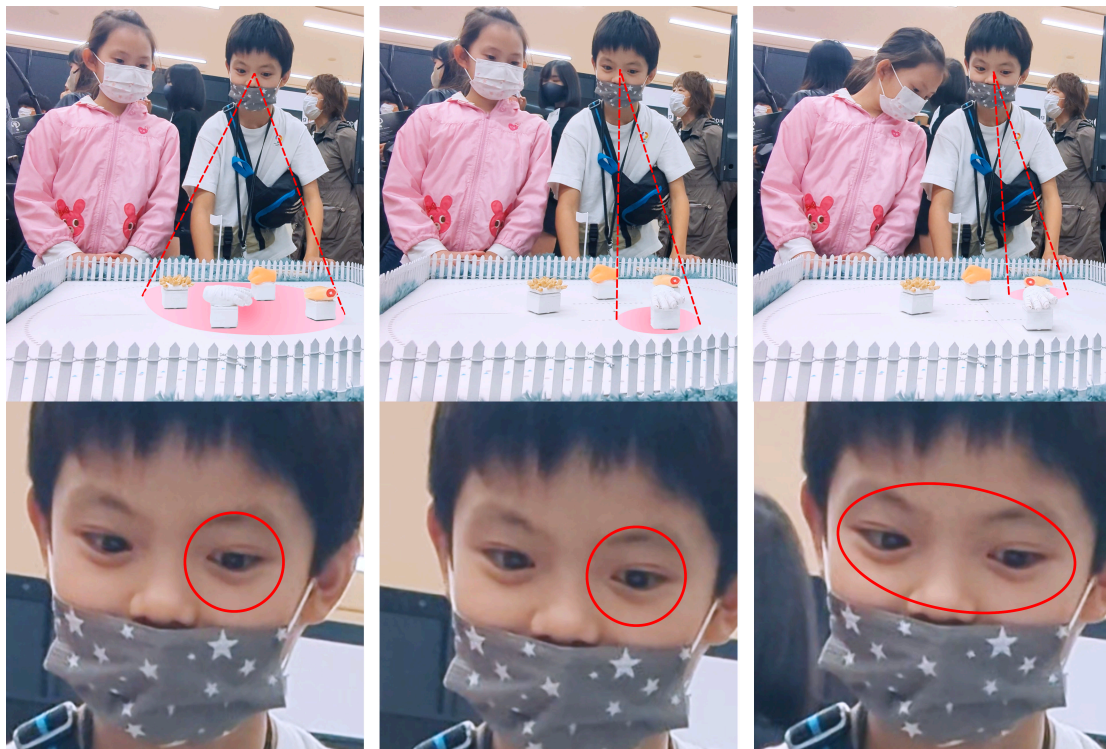
Figure 5.7: Gaze study on Hands Arcade use.

In the first photo, when the user was interacting via four hands connection it is noticeable that his attention was broad, with an overall eye gaze of the inter-activity. Suddenly, in the second photo, the child changes its hand movement in the Relational Body/Space and for two seconds negotiates with the machine body how the relational body is going to be distributed, putting him in an awareness estate, making him focus on the "mummy" hand. Right after, in the third photo, his hand movements become aligned with another, driving his attention directly to the specific robotic hand, focusing his range of attention even more. It is an improvised chorographical sequence demonstrating levels of embodiment and its negotiation.

The last visual documentation is regarding the haptic invitational design of the machine. Even though some parts of the public were not directly interacting with the Hands Arcade, the "furry haptic surface skin" could create an interactive relationship with them (Figure: 5.8).

Figure 5.8: User interacting with furry haptic surface body skin.

The red circles pointed out how users without their hands inside the Relational Body/Space could interact with the machine body, touching it at will. Also, the focused gaze of one of them on specific machine parts created a relationship between a human body and a relational body containing a human body and a machine body.

Chapter 6

Discussion I: Relational Body/Space

The intention to build playful devices from socially aware concepts such as equitability, intersectionality, and active listening was successfully achieved with minor concerns. The consequences of it, an interactive experience where users could grasp an amplified sense of social awareness was also noticed. The Relational Body/Space concept, an identifiable spatial area of embodiment contact in the design, was also achieved. The secondary goal related to Fields Mesh Methodology is discussed in the next chapter.

6.1. Relational Body via Relational Body/Space

Beyond creating embodiment, this research wanted to contribute to MD and HCI identifying in the resulting design where this happens. The resulting body relations and their interactivities from what happened inside the Relational Body/Space proved capable of its existence by three design factors: no tangible controller, mystery box, and improvisation as social choreography.

About the mystery box, we can start the discussion by bringing another snippet of what Butler said in the same speech referred to at the Literature Review [7]:

> Bodies live one, sometimes as living beings, sometimes not, and we seek to give a name to that which can never be fully or finally named. The body perhaps is the name for our conceptual humility, the limit of our conceptual schemes. Perhaps it is the site of our linguist failing.

There is a mystery, indescribable, a forever unknown part of the body that

brings liveness and empathy to it. As shown in the results of the user study with "mystery box" being in the top three choices for agency reason, the Hands Arcade body schema with "a nothing" encapsulated in a sealed vessel that becomes the Relational Body/Space demonstrates how flexible and relational a body can be. The idea of relating to a body that was intentionally designed to work on the limits of its materiality triggering states of embodiments, points to a positive direction regarding the design choices.

On the qualitative results, there are elements of reinterpretation of body awareness, most of it regarding answers that involved some type of self-proclaimed body. *"I can see my own movement in a new way,"* one participant said, even though it never saw its own movements, only the machine body movements. *"Our body movement"*, *"we move our body"* and *"robotic hands move differently making the feeling of agency unclear."* For this research, relate to the self ambiguously could be seen in another body is positive feedback. If not a relational feeling, at least, empathy and alterity. The first two replied by naming the body as "our" which also can be seen as a if not a relational body, a social one. In control-driven designs, the "unclear" word can be identified as a partial failure because the objective is to control the totality of a body. For the Hands Arcade it implies a relational body and interruption of habits that, in this case, frustrated the user.

About the lack of a controller, the design challenged the existing inadequacies between TUIs and the pixel, making them collaborators, even further, a part of the same body through the Relational Body/Space. The inserted human hand, its movements, and haptic desires, in synesthetic dialogue with the machine vision and its pixel-based technology. There was no overlap of virtual, tangible, and digital, it was a choreographed instant. The **body cropping** and **data mapping mapping** worked together to create a montage of machine vision's elements and moments of human hand moves. Also, if understood as a singular body, could point to a positive direction where interaction enables ***"to look at the interruption from the outside"*** where ***"to know"*** [44] is substituted by "to taste", which means alternative ways of self-awareness on habits. The human knew little about the machine, but tasted it and consequentially, embodied.

The user studies results showed that "movement design" was the most chosen option regarding the reason of agency. There was a sense of body contesta-

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tion [43] during the use of the Hands Arcade demonstrating the depth its social choreography, a possible choreopolitics state. That state is extremely relevant concerning the relational body containing humans and machines. Some feedback pointed out *"several entities acting as one"* and that *"We could see patterns and habits we usually don't pay attention to"*. There was no task forcing specific choreography between those bodies, but even so, both participants' bodies, human and machine, provoked themselves on do not "do nothing" [44], to break their habits, a self-awareness that most technologies drive us far from it. Both bodies, human and machine, contaminated by each other. It creates a "sentido" to both bodies, meaning, it creates a meaning and a direction and a sensation.

Other replies regarding technological improvement such as *"the hand movement could be more related as shadow"* or *"I was a bit confused which one I was controlling"* could also point to the same direction. The interactivity created a lapse [44] feelings to the point where it blurs ownership claims with some users demanding to know more types of control, and others demanding to taste the experience even more.

To finish, Hands Arcade achieved to reflections of our Media History contextualization. The gaze was a support sense, not a protagonist. The touch was aways present as a provocation towards an active sensing interaction that most users commented using a language regarding touch. The fear of inserting the hand inside another body was there challenging sanitation, but almost all tempted humans interacted with the Hands Arcade, they got contaminated by it. The use of the Relational Body/Space challenged the previews montage of the human-machine relation, and claimed attention not to itself, but to both bodies, showing a strong potential for self-awareness studies.

6.2. Design Limitations

It was detected at the Hands Arcade contradictory constraints. Even though I had the intention to develop a no-control-driven design, using most of the time term *negotiation*, and being aware of its social issues, the craft of the **Negotiated Feedback Loop** can be still considered biased by the simple fact that it was designed by me and Filippo Ronco. We tried to be impartial and to balance

the human and machine body relation not by equality, but by equity, and still is a human fabrication dictating the negotiation. The results showed potential for this design, and technical improvements over those points are crucial to reach equitability. We, humans, do not know the machine perspective, or even if it has one, and more than that, we humans are still formulating improved definitions of our bodies and who we are. Like mentioned in the "First person, why?" section in the Introduction, equality is not an option and the design practice that emerged in this research is a consequence of my perspective. The intentionality is here, and the practice was applied, but the human limitations of knowing about its surrounding will always limit the ontological, and maybe utopic, idea of total horizontality among beings. For this research became relevant the awareness of the design act, its documentation, and its thoughts toward an equitable society.

A minimalist instruction manual for the human body was directed used as a tool for initial embodiment negotiation addressing the insertion of the human hand into the machine body through the Relational Gate. Different from the historical approach on photography camera's manual documented by Iara Lis Schiavinatto [26], the body instructions at the Hands Arcade were just a provocation, and there were minimal instructions on how to behave in front of the machine body. I have strong criticism about manuals for the human body, but as part of a public event presentation, the minimalistic set of instructions was applied as a calling, not a control tool. Also, there is still biases in the Hands Arcade such as usage limitation by people without hands or people with specific disabilities regarding body movement limitations and gaze. For the machine body, the software part is a range of instructions, a limitation of today's design practices.

Not ideal, the user study in a public event generated little noise in the results, which can let to direct criticism of the analytical parts of this research. There are positive consequences simply because there is no relationship without contextual noise. It is important to design practice development that aims towards social behavior to understand its context, and that was made in this research as far as possible. Even so, it is important to register that this is design research, not a social science, ontological or anthropologic one, and the objective here was to create from the instances already out there in the world. It is obvious that noise or interference existed, but the most important is to assume the risks as

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the design exploration methodology implies, instead look for sanitized solutions towards design practices. Evaluation, dialogue, and more design explorations are the solution to identify the noisy points and develop an improved practice of the Relational Body/Space concept.

During designing the Hands Arcade a design limitation it has emerged due consumer-level products limitation. The attempt of include in the design racial discussion was strongly affected. In Japan, to buy toys and or mockups of black human bodies is practically impossible, even in local online market. The easy way out could have been to paint white hands as black, but for a project that deals with intersectionality and social awareness, that could come out as some "design whitewashing". Also, during the design process I made the decision of using human hand design as base, which exclude potential creative of non-human hand design such as animal paws. As solution, the research shifted the design of the arcade to a thematic one. Relevant to say that this also brought to light the act of resistance of this research and some fellow researchers, which demonstrate how important is to bring intersectionality topics to design practices.

Another relevant setback suffered while researching social awareness or any other fields outside engineering or design, was the need for more faculties and academic members' have interest in it. All the meetings, workshops, and group works targeted technical, design, and engineering aspects of the discussion. Questions about the multi-field research that I was bringing to the table were hardly made.

Chapter 7

Discussion II: Fields Mesh Methodology

The reasons for the results shown above come from a strong theoretical foundation built while the design practices were happening. This foundation was based on the desire to contribute to design and technological development aiming at self-awareness and community awareness for the parties involved. In the MD and HCI fields is visible violence towards social minorities and I believe the Fields Mesh Methodology is extremely relevant to develop equitable, socially aware, body aware, and collaborative, with diversity and intersectionality, inclusive processes. Because of that this chapter exists. I will present how this research approached those situations and suggests a method for interactive media design development.

This chapter has three sections:

- **Definition:** concept definition.

- **Justification:** academic reasoning showing the necessity of the methodology.

- **Method:** a set of academic actions.

- **Fields Mesh Report:** the report I made for this research based on the methodology.

Nonetheless, this Methodology suggests how to identify biased behaviors at different levels, and most importantly, how to document them to make it visible any oppressive acts in design practices.

7.1. Definition

Fields Mesh Methodology is a set of suggestive practices on interactive media design to identify and document social issues and their conflicts during academic and design practices. From Literature Review to Conclusion, the methodology delivers a self, community, and social awareness of the process and suggests methods of documentation.

It can highlight unconscious or not biased design choices, prejudices, social violence, silencing, harassment, sexual abuse, xenophobia, and racism. On the positive side can highlight potential collaborators' perceptions, inclusive citation, multi-filed research development, and self-learning.

7.2. Justification

The Fields Mesh Methodology contains three steps that are going to be justified in this section. Positionality, Inclusive Citation and Documentation.

Different from the dictionary definition where ***"positionality is the state of holding a philosophical position with regard to a particular subject,"*** [49] the definition ***"refers to the social position and power context shape identities and access in society."*** [8] During this century, to produce knowledge in any field requires the understanding that impartiality is not related to silencing. We all came from a diversity of backgrounds, and social experiences and learned from it. If we do not declare ourselves, it could bring a false prosper idea of equity, blurring relevant social perspectives, bypassing biases, and generating false conclusions.

A positionality section can settle the context of the research, bring sharpness to its ideations and solutions, and most importantly, can help the author itself understand its biases and the community that belongs. It is a tool to think about the precarious survival self-context, to understand the marginality of its own field, resulting in social values to any research.

Inclusive citation, or citation justice, is an approach to citing individuals and groups with a diversity of backgrounds, experiences, and perspectives.

Patricia Hill Collins in "Black Feminist Thoughts" [13] points out the impor-

tance of inclusive citation practices in the context of black feminists in America:

> *(...) This approach counteracts the tendency of mainstream scholarship to canonize a few Black women as spokespersons for the group and then refuse to listen to any but these select few. While it is certainly appealing to receive recognition for one's accomplishments, my experiences as the "first," "one of the few," and the "only" have shown me how effective selecting a few and using them to control the many can be in stifling subordinate groups. Assuming that only a few exceptional Black women have been able to do theory homogenizes African-American women and silences the majority. In contrast, I maintain that theory and intellectual creativity are not the province of a select few but instead emanate from a range of people.*

To reach the point where academic bodies are diverse enough to accommodate the claimed perspective, acknowledgment of social issues and their demands is not enough. To reach diversity and intentionality awareness, from theory to practice, the content of the research should be diverse and reflect its practices, and this starts with an inclusive Literature Review by having inclusive citations. By doing so, and paying attention to it during the design practices, the research can have a higher social awareness from the beginning because it diversifies itself academically from the start.

An important detail is how this citation may occur. I am not talking about a minimal citation from a different race or gender. It should be at the same level with renowned authors coming from historically oppressive social bodies and discussing differences and propositions to the point of an amalgamation of ideas, to the point of research intersectionality. To accomplish that may conflict with the final goals of the research, and that should not generate avoidance of inclusive citation use, but awareness if other parts of the research are inclusive enough [15]. Remembering what I discussed at the Literature Review when cited Anna Tsing, **"Contamination makes diversity,"** [24] and that is what inclusive citation does, it contaminates academic fields that have a false premise of purity.

One of the ways to achieve awareness of social issues is documentation [50] and that is the tool of this methodology. It seals the historical context of a specific space, moment, and social body. In the MD and HCI fields, it is very hard to

find broad documentation to analyze social context because almost all research documentation is focused on the technical and design sections of the making. It is possible to find marginal communities' documentation on epistemic violence, but for most of the productions what happened stays in the corridor talk of the academic environment [51]. How can we improve as a community if we do not leave a social history of the space for the next incomers? Who is privileged under silence? From this perspective, self and community documentation became relevant as part of the Fields Mesh Methodology.

The proposed documentation involves the creation of a report that includes descriptive information followed by personal impressions of possible violence, biases, or any kind of harassment. In the next section, a detailed description on how this should be done is presented.

7.3. Methodology Application

The creation of Fields Mesh Report consists of three sections and should be written while the design process happens, while its thoughts and conclusions should be written at the end point of the research. Here are the sections:

- **Positionality:** a descriptive section about the authors' origins and their context. It must include social aspects such as gender, racial, and social class journey. Also, a short ancestry background may fit. In the end, a contemporary context of the self should give the mindset and intentions of the period when the authors started their research. Positionality can also have negative impacts since exposed the authors. Usually authors from minorities are targeted and suffer systemic violence, which could be traumatic.

- **Contextual Analysis:** an informative, concise, factual description of relevant happenings in the community that the research has been made. Biases, unconscious or not, abuse cases in campus that changed your academic life, relationships, academic or not. The author should decide what is relevant and justify.

- **Documentation Conclusion:** A statement of the benefits and maleficence of the academic and design practices and its circumstances [52].

The writing style can or cannot follow academic standards since involves series of personal and or collective events. Also, it is very hard to express this type of context and the most important is comfortability, not format. That does not mean that was written with anger, it only implies that emotional feedback from the experience could also be exposed, bringing different content and conclusions from the rest of this research.

7.4. Hands Arcade Fields Mesh Report

This is the Fields Mesh Report of the research "Hands Arcade, Relational Body/Space and Fields Mesh: A Study on Alternative Relational Body Experiences on Interactive Media Design, Its Theories, and Practices."

During my period at KMD, much has happened regarding social violence, sexual abuse, academic prejudice, and racial and gender biases. Researching the community itself, I could not find any documentation and therefore could not track the potential epistemic structure that may support it.

7.4.1 Positionality: my body and experiences

I'm a non-binary, Brazilian Latin-American, Japanese and Angolan descendant, social class ascendant from poverty to the middle class. I was assigned as male at birth and raised as a male on an island in the State of São Paulo, at the margins of mostly white middle-class society, but centered as a subject of a predominant structural racist community.

I believe that until this day, even if I want to, I cannot say that I'm a trans person for social structural awareness and to respect the parts of the trans community that I am not part of it. Still, I struggled until my thirties to accept that my gender is not male or female, that is why now I self-declare a non-binary person. I have layers of intersectionality that are not in the binary standards of social behavior.

I will briefly pinpoint some events in my life. A Japanese descendant mother who has been working from 14 years old to retirement at 65 years without one single sabbatical year. An Angolan descendant black father, a musician by the family carrier, became a late audio techno artist while working as a driver. For

a period of my life, I lived in a two-room apartment with 14 people. There were moments when I didn't have enough money to eat as an undergraduate student, but I also had the first Japanese video game in my poor community during the early nineties because an uncle that lived in Japan gave to me when he came back to Brazil.

I witnessed capitalist enrichment from illegal activities and meritocratic legal processes. I saw close black friends dying from police violence and white friends being released, while as a mixed race and non-binary person, I was held on the spot to witness barberries. During teenagerhood, I suffered extreme prejudices for not being white and for not having a stereotyped male body, but I also was falsely privileged from actions such as passing on a failed math test because "you are Japanese, I know that you just forgot to write the answer". I am not Japanese and even I wasit should have not affected the results of the test.

In my twenties, I lived among majority white middle-class students in a town designed for a public university with a student body composed of middle and high classes, experiencing less gory and individual violence, but amplified structural aggressions. I also had the privilege to experience being an ex-pat in Japan, noticing other types of biases and violence in a conservative Asian country. As an adult I had the late privilege of becoming aware of intersectional and structural oppression, to understand intersectionality, social critical theory [5], gender studies, media, and art relevance. From that, I produced awarded films, TV shows, and internet content that had intersectionality topics as the main theme.

Today, at 40 years old, I considered myself more self-body aware, and conscious about intersectionality, with an improved sense of alterity and active listening. I have a lot to improve, but my life experience gave me relevant tools to do so. Is at this moment in my life that I am writing this research and report.

7.4.2 Contextual Analysis

I'm at Keio Media Design, Japan, a conservative, predominantly wealthy, male-driven, and heterosexual faculty team, fixed in a patriarchal structure, poor on gender awareness to the point where sexual harassment scandals are privileged by laws. As a marginal community, and this includes women, Gay, Lesbian,

Bisexual, Transgender, Queer, Intersex, and Asexual (LGBTQIA+), and non-white foreigners, talking about those oppressions is a must and is part of creativity. Unfortunately, confirming what Bell Hooks points out [6], we are more silent and more silenced because of the acknowledgment that we are not only sites of oppression but also sites of resistance. That is why this thesis and section are so important, even though sometimes resisting in daily life is a death threat. It is a tangible result of the community's margin as a site of resistance.

At the interactive media design community, HCI, and KMD, there is a structural deficiency of awareness on major social issues including gender, aging, sexuality, violent social tools, work methods, and communication. The students joke that is like "to live in the 90's". Particularly at KMD, the most concerning point is the distance between the education proposition and the factual daily life. KMD claims on its website that its mission ***"is to develop 'media innovators' who are capable of innovating on their own initiative to create social value. Media innovators will go beyond the confines of specific disciplines and national borders to perform on the global stage and play a leading role in shaping a creative society in the post-pandemic world."*** The good intentions of the mission can be seen diluted around the community with some instigating classes, some bold professors, and its presentations. Unfortunately, the gap between this and daily basis design practices at KMD diverge in some specific points that affected my mental health and this research to the point where it was relevant to be in this document.

First, I would like to make it clear that this report does not have the intention of being disrespectful or fighting against the community and the school. Some faculty members and veteran students at KMD advised that I am writing this at risk of retaliation, but I believe in dialogue as a social tool, and communication at this level in a design school should be seen as act of novelty. This report is a document to register and archive the social context in which I lived during the period of my master's thesis and directly affected the results of this research.

Gender awareness: Since the beginning, there were little sense of gender awareness at KMD. There is a visible patriarchal hierarchy, with female secretaries and most of the faculty members being male. There is also gender differentiation between students and research assistants. It follows the same pattern as the faculty

team where female assistants fall into a secretariat or producer role, while male assistants take part in more protagonist roles. There are no open conversations about these issues, and there were no conversations or questions about gender and its contemporary awareness tools such as pronouns and gender-friendly spaces.

The community officially does not allow discrimination or any kind of prejudice, but the tools given to the students in case of any violence happens are very limited and that directly affected me. During the introduction of the KMD community by the faculty, the gender topic did not receive any specific attention, and harassment issues were addressed with just a few slides during a more than an hour presentation.

In my case, one fact directly disturbs the research. Around mid-2022, during a meeting to attempt a collaboration with a researcher, a harassment case occurred to me. Knowing my gender preferences, because ironically the researcher was one of the few that asked about which pronoun I preferred, this researcher went to an online meeting using a drag queen face filter and attacked me regarding the possible collaboration, demanding ways of do and ways of behaving, including sexist claims involving gender stereotyping such as *"you are acting irritational."* [53] The collaboration ended at that moment, and I started a report about the harassment. Without any official protocol announced or method discussed with me, three faculties mediated the issue via Slack, a community tool used at KMD. One of them treated seriously the case including concerns about my health estate. One didn't manifest at all, and the third asked me questions regarding the research. I was unofficially informed that my private messages on Slack were analyzed. One of the faculties officially informed me that a faculty team was taking care of it, but I didn't hear any official response to the incident.

The harassment case that occurred to me directly affected my mental health condition and research timeline. I was not able to work for about two months. Research-wise, the attempt to build a community based on a specific technology collapsed, and the solution was segregation. Two Slack groups were created, splitting the lab community that was using the same tech into two work groups that did not talk to each other.

Structural language segregation: this topic regards not an individual fact, but a structural bias involving the research environment. The KMD community

is a bilingual community, and the barrier language is something surrounding researchers and students. At first, it is proclaimed that there is integration between Japanese and foreigners, but in fact, there is almost none. The labs and activities are separated in a way that Japanese speakers and English speakers isolate themselves. During my period at KMD, there was no intentionality among faculties to connect us. Talking to Japanese speakers and English speakers, I could notice that the issue and the will to integrate exists and affects both groups, but structurally KMD works in the opposite way. Once, one faculty during the Real Projects presentation openly said that English-Speaking students were not welcome. Even though there are English classes and Japanese classes, the issue is not language learning itself. It is a structural avoidance with false positive outcome. The positive results that could improve the community overall fade away. One faculty member said to me that is "because of the Japanese students, they are silent", which in fact is not true because talking to them about the subject showed me the opposite. Even knowing the Japanese language, and having Japanese friends outside KMD, I will graduate without any Japanese-speaking friends from KMD.

Sexual Abuse: it is public knowledge that sexual abuses at Keio University exists. There are lists on social media, and communities documenting it, and at first seems KMD was a bit apart from that. In 2022, a case between researchers at KMD emerged and even though the case by itself traumatized the English-speaking community part of KMD, what it followed is the point of discussion concerned to this research. Until the moment of the case, and I do not know if now has, KMD has no clear protocol about sexual abuse or any type of harassment. Following the Keio University guideline, the recommendation is to report to KEIO University Harassment Prevention Committee, an outside KMD committee. The abuse received the protocolar attention and it was confidential. Despite that, the fact was known by several students and faculties (and they should not know), and conversations were constantly happening in the corridors. Many times, I was asked by several colleagues to go with them to KMD because they were scared to be there. Six months after the happening, conversations about the case re-emerged, leading to direct consequences for the community. The students were traumatized with no will to participate in KMD events anymore, fragmenting the community to the point where the subgroup from the lab that I am part of

was directly affected with project cancellations and activities suspension. Official communication between some students not involved in the case and the faculty happened to gather information and to try solving the community issues (not the case). Right after, a Town Hall was made with two sessions separated by language. At the English-Speaking session, the entire 30 minutes was used to ask questions regarding the issue and all the answers were protocolar, with no specifics about what was happening at the moment. They again, showed same weblinks as before. A request for a monthly Town Hall to deal with the issue was made, but not accepted. Until the writing of this report, the involved researchers in the case were still around KMD on a daily basis, some students still ask me to accompany them, and there was no announcement on improvements in sexual harassment or any type of harassment at KMD.

7.4.3 Documentation Conclusion

With its ups and downs, the social experience brought by the media design practices at KMD generated a mixed feedback.

Community-wise, it was a struggle. Not that I didn't have positive moments, good English-Speaking friends, learned about design, and had fun. But the bitterness of unsolved issues such as the harassment case, the sexual abuse academic consequences, and the language segregation moved me away from KMD to find support and social tools in other spaces like the queer community of Tokyo, the Latin-American research community in Japan, and the international research community that I ended up directly collaborating after the failed attempt of collaborating internally due harassment in KMD. It seems to be predictable that a rich conservative environment would have patriarchal behaviors about social minorities, gender, and race. But for a place that declares itself as a place for an innovative future, its core is still much embedded in social sources from the last century.

Research-wise, it showed how even in biased and unprepared spaces there is a marginal part of the community that can support your ideas and help to prosper your design intentions. I learned how to sustain critical thinking in design debates, identify structural issues in the academic design field, and be socially aware during inflamed conflictive moments. It was a design journey in which I could exercise

some level of creativity and shift the perception from a small space of oppression to a little bit broader space of resistance.

Chapter 8
Conclusion

After design practices, user studies, and discussion, the contributions of this research are aligned with its initial goals and intention, with minor changes. It was possible to identify the Relational Body/Space during the design practices and in its results. It was consequence of a research practice socially aware and committed to diversity, intersectionality, and equitability. The idea of a relational body between humans and machines was also identifiable, but different from what was expected, its appearance is very subtle and time-limited, but very strong regarding punctual awareness moments.

The Relational Body/Space could become a protagonist tool in interactive design regarding embodiment, by generating moments of awareness during a relational body state between humans and machines. Like the human body and the bacteria inside of us, both bodies worked together trying to reach a survival moment of this brief instant. During the interaction between the machine body and the human body, self-identification was mostly present via a cluster of moments created by body confusion, an increase in awareness, and a synesthetic relationship. It was possible to assume that Hands Arcade via Relational Body/Space created relational body moments.

Hands Arcade's design results were able to point towards a direction where ***"it is not altogether right to conceive of individual bodies as completely distinct from one another,"*** [7] and that is a positive achievement. The results not only embedded the theoretical ideas from a multi-field theoretical research framework but converted them into a tangible design that could amplify the research field of MD and HCI in the direction of its marginality.

This research was able to connect distant marginal conversations and strengthen them into a cohesive proposition capable to stand by itself and contribute from where it stands, not trying to dominate or antagonize existing research fields. It

was a journey of reinvention, self-analyses, and media craft that devoured the conservative society constrains about body materiality and gave it back to the community if not solutions, the possibility of existence to its marginality.

> *It's funny you looking me like this*
> *With a poker face*
> *Now that you know, you're afraid of me*
> *But if I were you I'd fear me too*
>
> *I wanted to write a beautiful song*
> *But there was no pen, there was no paper*
> *All I had was bread paper bag*
> *And the only blues, a piece of sky*
>
> *Goodbye blue sky*
> *World in disharmony*
> *I go to the city*
> *Closer to the good ego*
>
> *Goodbye blue sky*
> *Don't rip the skin, it hurts the heart*
> *Give me, give me intimacy*
> *To lie down and dream on your floor*
>
> *I'll warn the street dogs*
> *That my raw wound is better not to lick*
> *That for the poor people*
> *Revenge can be honey and pleasure*

Céu Azul (Blue Sky)
Thaís Dayane da Silva, MC Tha

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