Ctrl Shift: How Crip Alt Ctrl Designers Change the Game and Reimagine Access

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Positionality

In this PhD thesis, I will begin by providing a personal account of my positionality as it pertains to my motivations for conducting this research. In 2000, I was diagnosed with a spinal injury that resulted in significant nerve damage in my arms and hands. Despite being told by my doctor that I would likely never work again, I persisted in my career as an active engineer, software developer and artist within the Bay Area feminist video community by developing my own assistive tools for analogue video production. Over the next 20 years, I was misdiagnosed with multiple chronic conditions, ultimately being diagnosed with EDS, which manifested in many additional injuries such as carpal tunnel, tennis elbow, cysts, nerve damage, chronic pain, and chronic fatigue. My disability made it extremely difficult to use traditional input systems, such as a mouse or game controller, for extended periods of time.

Abstract

My journey as a disabled arts practitioner has been one of invention, hacking, and re-imagining what input systems could be. I have created my own modalities for creating work, rather than relying on commercially available options. This is a common practice within the disabled community, as individuals often modify and hack their surroundings to make them more usable. For example, ADAPT activists took sledgehammers to smash curb cuts and poured curb ramps with cement bags, ultimately leading to the widespread adoption of curb cuts as a standard architectural feature. As Yergeau notes, this type of "criptastic hacking" represents a creative resistance.(Yergeau, 2012) My interfaces and art projects are a combination of science fiction world-building, technology prototyping, and experimentation with novel ways of experiencing the world that work for my ability. I have been building interactive objects for over 20 years, and my bespoke controller games are both pieces I find comfortable to play and conceptual proposals that I share with the games community to spark consideration for alternative ways of interacting with games culture.

This interdisciplinary design research herein crosses a range of disciplines, drawing inspiration from radical forms of cognitive science, games studies, feminist studies, HCI, crip technoscience, radical science fiction, disability studies, and making practices. What has emerged through studying my own practice and the practices of others during this research is a criptastic design framework for creating playful experiences.

My research aims to gain a deeper understanding of the ways that hacking and remaking the world manifests as modifications to the design process itself. I created four versions of a physical alt ctrl game and conducted a design study with disabled artists and alt ctrl game creators. The game, *Bot Party*, was developed through a series of public exhibitions and explored my relationship between criptastic bespoke interface design and embodied experiences of group play. *Bot Party* involves physical interaction among players in groups to understand my own ways of designing, while the study looks three other disabled designers to understand the ways in which their process is similar or different to my own.

By conducting this work, I aim to contribute to the larger conversation within the games studies community about the importance of accessibility and inclusivity in game design. The results highlight the need for continued exploration and development in this area, specifically in design methods. The study's findings as they relate to my own practice revealed the importance of considering a set of values and design processes in relation to disability when creating games and playful experiences. With this perspective, I propose an initial framework that outlines possible key themes for disabled game designers. Using values as a starting point for creating deeply accessible games, this framework serves as a starting point for future research into accessible game design. This framework seeks to subvert the notion that accessibility is a list of UX best practices, audio descriptions, captions, and haptic additions and moves towards embedding within game design the values and practices used by disabled designers from the outset of the creative process. Access can be a creative framework.

An important point to make is that my efforts to do a PhD resist the academic ableism limiting the participation of people who are not from a normative background. The act of creating this PhD has eaten at the edge of my ability, and the research here was often conducted in pain under extremely trying circumstances. This perspective is relevant because it often informed my design choices and thinking. Additionally, it was conducted at a university where I experienced active discrimination from members of staff who simply refused to believe in disabilities they could not see, and in one case writing down my disability was, "self-ascribed." To work, I had to move outside the academy and seek out workshops which gave me accessible, ergonomic equipment as is discussed in the *Bot Party* section. This bears mentioning because it reflects on how threatening disabilities can

be within academic settings and how even providing basic levels of accessibility remains a challenge for academic institutions. The above framework could benefit academia if used to redesign postgraduate academic research practices within the academy from a place of Crip-informed pedagogy. This is future work that this academic researcher hopes to explore in depth within their academic journey.

It is important to note, much of the most relevant research to this thesis around disability studies and technology has emerged in recent years and as a result, was included iteratively in the literature review. It has informed the third study and my iterative design practice as part of the journey; however, I began this work before much of the writing in the literature review existed, including the creation of *Bot Party's* first iterations. Finding this scholarship and these authors has been a kinning. Kinship, according to Gavin Van Horn, "can be considered a noun…shared and storied relations and memories that inhere in people and places; or more metaphorical imaginings that unite us to faith traditions, cultures, countries, or the planet…Perhaps this kinship-in-action should be called kinning." (Horn et al., 2021) Kinning happened throughout this work and this thesis served me as a place for discovery, contemplation, and empowerment. It is my hope sections of it will serve this function for others within my community. I found kinship with other authors working in the field of disability studies and technology, particularly with Alison Kafer, who offers a critique of Donna Haraway's cyborg in her book "Feminist Queer Crip." (Kafer, 2013) Kafer's work highlights the limitations of Haraway's cyborg as a figure of empowerment for marginalized bodies and identities, and instead advocates for a crip-queer-feminist perspective on technology and embodiment. Additionally, the author has also found resonance in the work of Aimi Hamraie and Kelly Fritsh, whose work in disability studies and HCI has been instrumental in shaping this research. Specifically, their concept of "crip technoscience" has been a key framework for understanding technology creation by disabled technologists. (Hamraie and Fritsch, 2019) Overall, it is my hope that this thesis will serve as a generative resource for others within the community on this journey, particularly for those who are working towards a more inclusive and intersectional understanding of technology and embodiment.

1 Research Questions

The development of research questions has been an iterative process. Throughout multiple years of doing this work, what was being studied made itself more obvious over time as work developed and my understanding of my own practice grew. Using the following research questions to inform reflective writing allowed me to let the practice guide the inquiry. Initial questions used at the start of the research were explored through practice. As the research and my understanding of it evolved, better questions emerged. The in-progress questions that have guided this writing flow offer the reader valuable insight into how this body of research evolves. These in-progress prompts are:

- Can embodied play make people kinder and more aware of their impact on each other?
- How can I create bespoke interfaces which are accessible across different embodied experiences?
- Can I design for my own ability and is that valid research?
- What happens when I iteratively design bespoke hard games with a focus on deepening shared experiences vs making the interface more usable?
- How does my disability impact how I design and the choices I make?
- How do other disabled creators design games and what values do we share?
- How do our processes diverge from more traditional methods?
- How can our shared values impact the larger field of games?
- How can creating games on bespoke hardware impact the artistic practices of disabled game creators?"
- By intertwining embodied play and the interface, can Alt Ctrl games create meaning through mechanics embedded in the game controller?
- Can Alt Ctrl games bring embodied understanding into the gaming experience?

From here, I have landed on these three questions as a frame for readers of this PhD:

- How can crip creators with lived experiences of disability create game controllers to broaden the current understanding of video game interfaces, by introducing alternative control systems, also known as 'Alt Ctrl' games?
- What are the key design values and methods crip designers consider when creating Alt Ctrl hardware games and playful experiences?
- How can the values and methods of designers with lived experiences of disability inform a future framework which might have relevance to game designers?

2 Literature Review

With an emphasis on the development of bespoke game interfaces as a disabled creator, I delve into a diverse range of disciplines. My focus lies in the intersection of the human body with Human-Computer Interaction (HCI) and User Experience Design in the context of gaming and disability but is impacted by research across a diverse range of disciplines. By examining the evolution of game controller design patterns and their connection to user-centred design, I discuss the connections between these design practices and implicit world views they empower and disempower. If interfaces are read as structures of power, who benefits? How do the interfaces within games culture support specific affordances and who do they disafford as players?

Additionally important are aspects of disabilities studies literature and how it connects to ideas and myths within technology. This exploration serves as a counterpoint to some of the tenets of user-centred design, which offers a set of beliefs and methods for design nearing techno determinism in their ubiquity and industry adoption. Technological determinism posits that new technologies drive significant social and historical changes. It presents technology as a neutral, autonomous force with inevitable consequences. However, critics emphasise the importance of social context in understanding technology's impact. (Scott, 2014) As a counterpoint, I focus specifically on intersectional feminist and disabilities research as it connects to the power dynamics and social importance of creating games.

In this context, this research also considers alternatives to mainstream game interfaces by examining open-source software and hardware, as well as Alt Ctrl games. The definition of Alt Ctrl games deepens throughout this research, but as a starting point, we can describe them as games that use specially made hardware. As part of this research, I interviewed independent game developers who create unique controllers for Alt Ctrl games to understand their relationship to open-source tools and indie games. (see Appendix D for full interviews). Finally, I emphasize the importance of recognizing the development of Crip Tech as an engagement with Crip futurity and world-building. Crip Tech is technology made by disabled people and is an extension of Crip Technoscience. “CripTech, for short, takes root in crip theory, a field of research invested in re-centering the skills and knowledge disabled people cultivate to remake inaccessible worlds.” (Chang, 2022) These perspectives pave the way for examining my own games practice as well as the game design practices of disabled creators.

2.1 HCI, Game Controllers, and Disability: The Complicated History

Beginning with its foundation in ergonomics and progressing through to the more recent Entanglement Theory, this section focuses on seminal contributions to this research area, particularly highlighting the work of Donald Norman, Paul Dourish, James Gibson, Steve Swink, and Katherine Isbister, among others. Alongside this exploration, we will also discuss the limitations of these theories, presenting counterarguments and alternative viewpoints that challenge the status quo. Scholars such as Sasha Costanza-Chock, Alison Kafer, and Melanie Yergeau provide essential critiques and serve as the basis for expanding and diversifying our understanding of HCI's theoretical underpinnings.

In their book Human-Computer Interaction, Dix, Finlay, Abowd, and Beale explain HCI as arising out of the study of human interaction with machines in factories. (Dix, 2004) During and after the Second World War, interest rose in studying the interaction between humans and machines to create more effective weapons control systems. An interesting historical study is the *Analysis of Factors Contributing to 460 "Pilot-Error" Experiences in Operating Aircraft Controls* from 1947, which discusses the use of factors contributing to pilot errors

in aircraft control operations during World War II. (Fitts and Jones, 1947) It is an early example of human factors research focusing on the interaction between humans and machines to improve the efficiency and effectiveness of control systems for future use. The urge to better military flight systems inside bombers, which disable by design, frame part of the beginning of computing history. The link between technology and disability has a history rooted in this violence.

In his ground-breaking book, "Academic Ableism," scholar Jay Timothy Dolmage meticulously examines the intricate interplay between technology, disability, and society. Dolmage compellingly articulates his perspective on how the development and deployment of new technologies triggered a new sense of urgency about the relationship between humans and machines. He illustrates how during wartime, especially World War II, the need for men and women 'in the field' to instantly utilize these new inventions underscored the critical nature of their interfaces.

Dolmage writes, “Creating new technologies that had to be immediately utilized by men and women 'in the field' led to heightened concern about the interface between person and machine in a life-or-death situation...” (Dolmage, 2017, p. 127). This intense focus on the user-machine interface laid the groundwork for the later principle of 'ease of use' that took root in North America after World War II. The principle itself did not restrict itself to soldiers or war veterans, despite them having distinctive user needs and desires. Instead, it expanded its reach to every consumer, becoming a pivotal marketing tool in the process.

Dolmage further elucidates, "Technologies specifically designed for people with disabilities— such as prosthetic devices for citizens wounded in the war— were imbued with cultural significances" (Dolmage, 2017, p. 127). Thus, inventions like prosthetics designed to aid the war-wounded were not mere functional tools. Instead, they held broader cultural implications and influenced how society perceived and understood disability.

Dolmage continues, “Disability, in an array of facets, was subsequently perceived through innovative biological, cultural, and technological perspectives. Concurrently, the process of redesign, assisted by potential users, morphed into a crucial element of usability theories and strategies” (Dolmage, 2017, p. 127). Through this lens, disability began to be understood not just in terms of biological limitations, but also as a cultural and technological construct. At the same time, potential users started playing a more significant role in the process of redesigning technologies, laying the groundwork for iteration in design. The emphasis shifted towards involving the users in the development process to ensure that the end products were more in line with their needs and easier to use.

Through his analysis, Dolmage illuminates the darker side of our technology-driven society, highlighting the subtle yet undeniable perpetuation of disability due to these technological advancements. His work forces us to contemplate the inherent human cost that comes with our relentless pursuit of technological progress and enhanced usability. We are urged to ask: Who are these increasingly user-friendly, iterative interfaces really serving? Who are they unintentionally harming? Are we amplifying the burdens of certain individuals in our pursuit of broader usability? The evolution of warfare technologies offers a striking case study, where the development of user-friendly systems for warfare has been paralleled by the unfortunate rise of debilitating consequences for those involved in the conflicts these systems were designed to facilitate. Military veteran Steven L. Kurzman encapsulates this entanglement with potent eloquence: “I stand and walk with the irony that the materials and design of my leg are based in the same military technology which has blown the limbs off so many other young men” (Kurzman, 2001). Kurzman's personal

testament reveals the dichotomous nature of technological progress: a force that simultaneously enables (as illustrated by advancements in prosthetics) and disables (manifested through the destructive capacity of military technology).

In an intriguing paradox, the pursuit of increasingly user-friendly military combat interfaces inadvertently contributes to combat scenarios that subsequently induce disabilities. This phenomenon underscores the intricate historical narrative where usability and disability are deeply interlaced and evolve symbiotically.

This duality unmasks a complex nexus of relationships that extend into our contemporary society which effectively erode the boundaries between recreation, warfare, and disability. In the current era, interfaces initially crafted for modern video games—an entertainment source for many—are now being assimilated into military systems as control mechanisms. Xbox controllers, devices predominantly associated with recreational gaming, are being repurposed to manipulate a wide range of military hardware, from Unmanned Aerial Vehicles (UAVs) to submarine periscopes (Hambling, 2008; Liao, 2017; Pfeil et al., 2013).

Strikingly, the underlying technology of these gaming controllers, refined meticulously for an industry where shooting-themed games represent a substantial 39% of sales, is paradoxically reintegrated into tangible military operations (Hadji-Vasilev, 2022). This peculiar intersection between recreational game controllers and disabling warfare systems demands profound examination and contemplation.

The ceaseless advance of technological innovation continues to manifest in problematic ways. We now see Xbox controllers integrated into new Israeli automated tanks, artificial intelligence technologies honed in video games like 'Starcraft II' and 'Doom' being implemented into real-world combat scenarios (Smith, 2022). These developments illuminate the evolving connections between technology, usability, game technology, and disability. This nuanced relationship between disability and universal controller usability remains as poignant in the present as it was in the past, promising significant implications for the future that warrant critique.

One is urged to explore beyond the technological advancements and ask: for whom and for what are we driving this relentless pursuit of universal usability? Who do we envision as the ultimate beneficiaries of these developments? Are we unknowingly designing a world through our creative outputs that may not be as beneficial or as inclusive as we anticipate – one which could instead be disabling by design?

Creators need to critically evaluate their approach towards universal usability. While the intent to make games controllers accessible to a wide audience is commercially beneficial, we must not lose sight of the potential repercussions of such actions. There exists a persistent tug of war between the urge to create universally usable interfaces and their appropriation back into military settings, particularly when these controllers are tuned to control Action and Adventure games, the two largest genres in console play. (“Console Games Genre Trends In The Last 5 Years,” 2021) Herein lies the value in considering the practices and work of indie artists, specifically disabled indie artists who embody unique perspectives and work towards their own goals, as opposed to one-size-fits-all solutions geared to certain financially lucrative game genres perpetuating the reality they simulate.

Could perspectives from the disabled community be the key to disrupting this harmful cycle? Interfaces that are designed to support and affirm the lived experiences of individuals rather than prioritizing universal adaptability resist commercial co-opting specifically because they are personal, specific, and bespoke.

Figure 1 U.S. Army Spc. Andrew B. Clement, an explosive ordnance disposal technician from Jackson, Tenn., assigned to 129th EOD, attached to 3rd Brigade Combat Team, 25th Infantry Division, Task Force Bronco, uses an Xbox controller to operate an EOD robot at Combat Outpost Honaker-Miracle in eastern Afghanistan's Kunar province, Aug. 1, 2011. (U.S. Army photo/Sgt. 1st Class Mark Burrell).(*"The US military will fight the next big war with Xbox-style video game controllers," 2023)*

Figure 2 IAI staff use the Carmel's Xbox controller interface to control the prototype armoured fighting vehicle. (Courtesy of Israel Aerospace Industries)(Smith, 2022)

2.2 The Technological Cure

Within this history, interactive computing systems have often been explored as potential cures for disabilities. A Notable example includes the early work in the field of sensory substitution by Paul Bach-y-Rita, a pioneering neuroscientist who utilized haptics to compensate for damage to the vestibular sense in 1967. Bach-y-Rita's work often highlights haptics as a potential cure for blindness, particularly through his *BrainPort* device, which employs a haptic array on the tongue as a substitute for visual information ("Seeing with the Brain," 2018). While the *BrainPort* showed promise in his research, it failed to gain mainstream acceptance, possibly due to its requirement for blind users to put the device in their mouths, impeding speech.

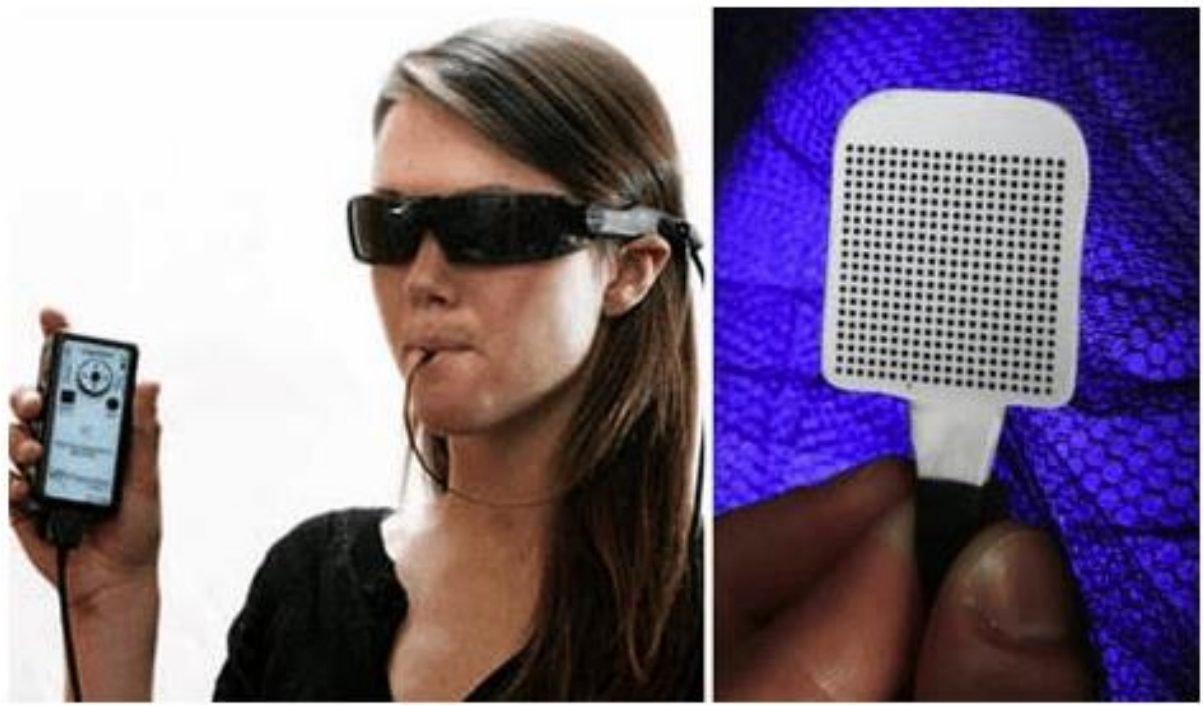


Figure 3 BrainPort for the visually impaired - 'seeing' with the tongue.

The notion of technologists and technological interfaces curing disability has been met with resistance from the disabled community itself. Liz Jackson speaks of the Disability Dongle—a piece of technology developed by engineers and design agencies that receives mainstream press and accolades, even as disabled people express concerns over its use (Jackson et al., 2022). The *BrainPort*, which limits speech while providing sensory substitution for visual information in the mouth, shares similar shortcomings.

Technoableism aims to cure disability using technology without questioning the intrinsic value of disabled people's lived experiences. "Technoableism is a term I have coined to describe a rhetoric of disability that simultaneously talks about empowering disabled people through technologies while reinforcing ableist tropes about which body-minds are desirable and who is considered worthy" (Shew, 2020). By acknowledging the complex relationship between solutionism, disability, and interface design from the outset, this research proposes alternative approaches to the relationship of technology and disability.

2.3 User Centred Design

According to The Interaction Design Foundation, a respected source for authoritative information on interaction design with Donald Norman on its board, the multidisciplinary field of Human-Computer Interaction (HCI) lies at the intersection of Computer Science, Human Factors Engineering, and Cognitive Science. HCI served as a precursor to User Experience (UX) Design, a process employed by design teams to create products and interfaces, with Donald Norman playing a seminal role in its development. ("What is Human-Computer Interaction (HCI)?," 2020)
User Experience Design and User-Centered Design (UCD) are now industry-standard methodologies for conceiving and executing interface and product design. A comprehensive literature review of UCD's influence on design is beyond the scope of this work; however, a simple Google Scholar search at the time of writing this thesis for "User-Centered Design" returns 2,820,000 papers and resources. Refining this search, the field of games by adding the discipline to the search term yields 238,000 results. Further narrowing the search to "User-Centered Design Game Controllers" results in 36,500 hits, a remarkable number considering the limited number of interfaces that dominate console

gaming.

The vast scale of academic research on these topics suggests that these theories have a far-reaching and significant impact. This chapter will later explore several specific examples as they relate to key moments in game controller design, shedding light on the influence of HCI and UCD within the gaming industry. Further, User Centered Design (UCD) includes User Experience Design (UED) and extends it to include developing products-based on understanding users, tasks, and environments in context. The process considers the entire process of product creation and includes an array of partners including but not limited to engineers, designers, researchers, marketers, stakeholders, and users. UCD iteratively clarifies the context of use, the user requirements, the design, and the user feedback to evaluate against requirements. User Centered Design is outlined in Norman's *User Centered Systems Design*, which was published in 1986. (Norman and Draper, 1986)

In *The Design of Everyday Things*, Donald Norman introduces a range of concepts to help better understand user experience design, such as conceptual models, affordances, mental models, design mappings, and interaction design patterns. (Norman, 2002) Conceptual models refer to the simplified, abstract representations of how a system or object works, which help users develop expectations and understand its functioning. Affordances are the perceived or actual properties of an object that suggest how it should be used, while mental models represent an individual's cognitive understanding of a system based on prior experiences and knowledge. Design mappings involve the relationship between controls and their corresponding actions, helping users navigate complex systems intuitively. Interaction design patterns are reusable solutions to common design problems that provide best practices for specific contexts.

2.4 The Failures of Human Centred Design and Game Controllers

However, Norman's work does not explicitly address the normative assumptions underlying these concepts, such as whose specific conceptual and mental models are being represented. Although he briefly acknowledges that models may vary between cultures and mentions the context of left-handed individuals (Norman, 2002, p. 118), he does not elaborate on how this intersection influences the principles discussed. This omission results in gaps within the literature and raises questions about the universality and inclusivity of the presented concepts.

In *Design Justice*, Costanza-Chock examines how the *Matrix of Domination* can enlighten designers and technologists. The work scrutinizes how the prevailing paradigm of User-Centered Design (UCD) inadvertently extends the *Matrix of Domination*. Costanza-Chock provocatively questions, "Why do we persist in designing technologies that perpetuate existing power inequalities when the imperative to dismantle such systems is so manifest?" (Costanza-Chock, 2018). The author echoes Norman's seminal work *The Design of Everyday Things* in the subheading, "Everyday Things for Whom? The Distribution of Affordances and Disaffordances under the *Matrix of Domination*".

The *Matrix of Domination* is explored in relation to the concept of affordances, a term that Norman (2002) defines as "a relationship between the properties of an object and the capabilities of the agent that determine just how the object could possibly be used" (Norman, 2002, p. 12). Norman's book, a fundamental text on interface product design, could perhaps be encapsulated as a method to assist designers in successfully creating affordances for their interfaces, with a significant portion dedicated to understanding systems and high-level design patterns. The term "systems" features 111 times in the book, yet the exploration of power and the invocation of power relationships by designers

are glaringly absent. As Costanza-Chock astutely observes, affordances are not universal; they vary considerably when factors such as race, class, gender, disability, and other axes of inequality are considered.

> *Race and racism appear nowhere. He uses the term women only once, in a passage that describes the Amphitheatre Louis Laird in the Paris Sorbonne, where "the mural on the ceiling shows lots of naked women floating about a man who is valiantly trying to read a book." Gay, lesbian, transgender: none of these terms appear. Disability is barely discussed, in a brief section titled "Designing for Special People." In this three-page passage, Norman describes the problems designers face in designing for left-handed people and urges the reader to "consider the special problems of the aged and infirm, the handicapped, the blind or near-blind, the deaf or hard of hearing, the very short or very tall, or the foreign." (Costanza-Chock, 2020)*

As is evidenced here, disabled people in UCD have less power than able people. From the inception of UCD, they are positioned outside of the method. *Design of Everyday Things* outlined the methods for User Experience Design, it is important to look at how it impacted game controller design. Microsoft, the creators of the Xbox, document using it to create games and controller design early on. To contextualize this, it was November 2001 when Xbox released their first game controller. In January of 2003 they published a white paper entitled *User Centered Design in Games* documenting how UCD informed their design process for controller and game design. Given the paper presents their methodology publicly with specific use cases based on research, it is not unreasonable to infer work therein was done the years prior to publication. (Pagulayan et al., 2003)

UCD has been employed at Microsoft and consistently utilized throughout the years to refine the Xbox controllers. In her insightful article, "Behind the Design: Xbox Controller," journalist Joline Tang delves into the User-Centered Design process of the Xbox controller, interviewing Microsoft's designers who have contributed to the device's creation over the years. These designers discuss the challenges of modifying a controller that fans have developed muscle memory for, as well as the constraints that come with such changes. They also examine the range of hand sizes in this image:

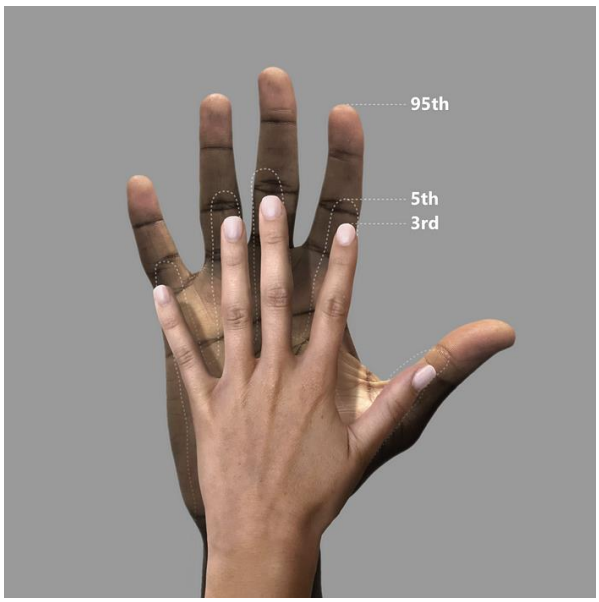


Figure 4 Hand sizes considered for the Xbox Controller

In the article, the designers explore the goal of accommodating players with hand sizes down to the 3rd percentile, whereas previous controllers catered to the 5-95% range. As Tang explains, the initial approach involved reducing the overall size by 2-5%, but the team quickly realized that simply shrinking the controller would compromise its ergonomics. Instead, they strategically altered and reshaped the controller to achieve their objective. However, at no point do they entertain the needs of disabled users, who were left with the option to purchase the Adaptive Controller at an additional cost. Surprisingly, offering multiple controller sizes was never even mentioned, which would be laughable if applied to the clothing industry. Controllers are a one size fits all design.

Examining game controllers as outcomes of UCD processes provides an opportunity to reveal the implicit biases and power dynamics highlighted in *Design Justice*, particularly those related to ability and intersectional feminism. Identifying emerging alternatives can serve as a valuable counterpoint, showcasing diverse design processes and approaches. Costanza-Chock presents earlier work by philosopher of technology D. E. Wittkower around the concept of disaffordances. For instance, a fence disaffords entry to a plot of land, and a lock on a door disaffords entry without a key. They then discuss how binary gender forms disafford their non-binary identity when booking airline tickets. This critique is rooted in the disability justice movement, which underpins *Design Justice*. As Costanza-Chock states, "*Design Justice* asks us to question the universalizing assumption that there is only one configuration of the human motor system. Instead, there are many configurations; some will be privileged (supported) by a vertical bar as a mechanism to pull a door, and others will find that combination of object and action difficult or nearly impossible: an affordance for some is a disaffordance for others." (Costanza-Chock, 2020). It follows logically that every affordance within the Xbox controller disaffords some users while privileging others.

While User-Centered Design (UCD) aims to devise accessible and intuitive interfaces, it often neglects the varied requirements of users with disabilities. This neglect can be analyzed through Patricia Hill Collins' *Matrix of Domination*, a framework that highlights four interconnected spheres of power: structural, disciplinary, interpersonal, and hegemonic (Hill Collins, 2000; blackfeminisms.com, 2018). In the structural power domain, institutional policies and practices may favor the requirements of able-bodied users, culminating in the creation of interfaces and technologies that marginalize individuals with disabilities. This bias manifests notably in the gaming industry, with game studios predominantly crafting their content for platforms equipped with controllers like the Xbox controller, which inherently harbor ableist shortcomings.

Within the disciplinary domain of power, the norms and standards that govern design practices can perpetuate ableism, excluding disabled users from fully participating in digital experiences. For instance, design guidelines may not adequately address the importance of accessibility features, such as customizable button mappings or haptic feedback options, that cater to diverse user needs. For example, Xbox game controller designs above cater primarily to able-bodied individuals with 5 fingers, failing to provide accessible options for people with limited mobility or dexterity without additional cost, economically punishing disabled users. The Xbox Adaptive Controller, which is designed specifically to address the accessibility needs of disabled users, is sold as a costly add-on feature. This approach reinforces the notion that accessible gaming is not the default experience and requires additional investment, further marginalizing disabled users. To right this wrong, Xbox needs to offer the Adaptive Controller as just another standard package anyone could purchase at the same cost.

At the interpersonal level, interactions between designers, developers, and users can reinforce ableist attitudes and assumptions. This could manifest as designers assuming

that all users have a similar range of abilities, leading to the development of products that inadvertently exclude those with disabilities. Some of this attitude is visible in Tang's writing, "And then came the user testing. The team invited players from different backgrounds and with varying abilities to test prototypes and pre-production units." Did any of these users have 4 fingers? What abilities? There is no information here or details. The assumptions from the photo Xbox showing hand size leaves one to ask this question. If these are their hand ranges, they have a limited dataset.

In the hegemonic domain of power, the prevailing cultural ideology and societal values may contribute to the marginalization of disabled individuals, which can lead to the perpetuation of ableism within user-centered design practices for game controllers. For example, the dominant designs often prioritise competitive gaming and high-performance hardware that caters to able-bodied individuals, consequently disregarding the accessibility needs of disabled users. In the breakdown of the Xbox controller mentioned above, they are specifically designing for players who have muscle memory from using the controllers. This ideology rewards the players who are already playing with this controller and avoids making changes which might benefit disabled players. User-centered design (UCD) has become the dominant approach in product and controller design, aiming to create interfaces and experiences that are intuitive and accessible for a wide range of users. However, the complex political and social implications of UCD can inadvertently lead to the exclusion of certain groups, particularly marginalized individuals.

From an autoethnographic perspective, it is important to mention that in 2001, I documented my inability to play games using the Xbox controller in the film "The Shadow of Digital Living." (Form8 Records, 2002; Myers, 2002) To create this short film, I first had to develop an accessible interface for video editing since using a standard mouse input was not feasible for my body at that time. I modified and circuit-bent an analogue Videonics video mixer, incorporating larger knobs into the casing, which allowed me to work comfortably during day-long sessions.

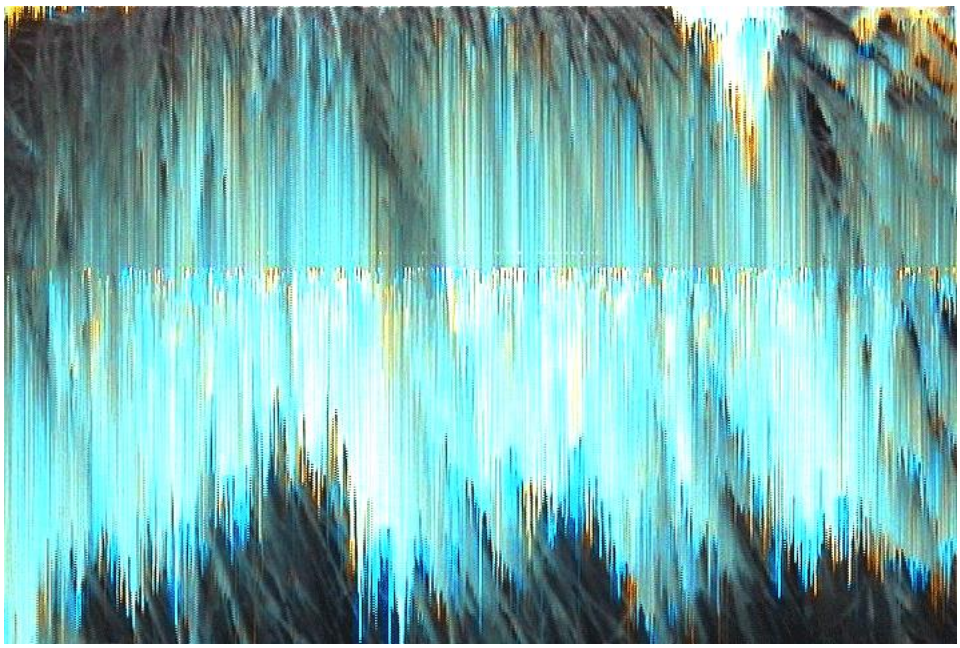


Figure 5 A Still from the Shadow of Digital Living (Perry, 2001)

Although the Xbox controller did not afford me the accessibility I required, my critique of it led me to create an inclusive video editing solution for myself. In this sense, disaffordances can provide fertile ground for innovation driven by crip perspectives and critical response through creative practice and crip hacking. My journey as a designer began with my

exclusion as a user.

2.5 Community Generated Interfaces

My experience of not being able to use standard input systems was not isolated. Over coming decades gamers and engineers acting in collaboration modified or rebuilt commercial controllers. Early examples include the 30 years of contribution by retired Aerospace engineer Ken Yankelevitz, which focused on modifying controllers for quadriplegics. He began by modifying the Atari joysticks in 1981 and worked for over thirty years creating modifications for the community of disabled gamers. (Yankelevitz, 2011) This project was referred to by Yankelevitz as the Quad Control Project. Upon his retirement, he handed his work off to Fred Davison who created, and crowd funded, a PCB design in collaboration with Matt Victor, a C1 quadriplegic. Together, they arrived at a final design which is for sale from the Quad Stick site, albeit at the price of $549. (Davison, 2022) For context, the game controllers which ship with the console are included in purchase.

Recent efforts from the open-source community feature The Controller Project, spearheaded by Caleb Kraft. For the past decade, Kraft has been providing "free (or nearly free) controller modifications to gamers with disabilities or limb differences" (Kraft, 2022) Over time, this project has transformed into an initiative that fosters a community of 3D designers dedicated to crafting controller modifications and distributing them as open source and free 3D printable objects. The Controller Project serves as an outstanding example of community and crip-driven innovation. This sets it apart from charitable organizations like Special Effect, which, although aiming to support disabled individuals, are not directly managed by them. Nor does it aim to promote disabled technologists. Special Effect run on a UK charity model and this subtle difference positions disabled gamers as receivers of charity, not creators of technology within a community sharing it with each other. To get to a free, printable library controller modification on The Controller Project’s site it takes two mouse clicks and you do not need to deal with anyone in the organization. On Special Effect’s site, it takes multiple clicks and contacting the organization to see if you might be able to get their support, which is a far more complex process.

2.6 Mapping Problems with Mental Models and Game Controllers

Building on the above discussion of accessible control schemes, commercial controllers primarily cater to able-bodied players, inadvertently excluding certain groups of disabled individuals. A critical examination of User-Centered Design concepts, such as affordances, from the perspective of disabled designers could potentially unveil alternative design methods, much like the *Design Justice* framework. This prompts the question: What other ability biases remain unchallenged within mainstream design, given the pervasiveness of such methodologies today? What would a Crip Game Controller Design Framework emphasize?

As the discussion progresses, it is important to consider Norman's perspective on users' conceptual models. (Norman, 1988a)These models emerge from an individual's understanding of themselves, their environment, and the physical or virtual objects they interact with. Norman describes a conceptual model as "an explanation, usually highly simplified, of how something works." (Norman, 1988b) Users develop a mental representation of how an interface operates during their interactions with it, and the feedback provided by the system influences their understanding of its functionality.

When engaging with a new interface, users bring their unique mental models, which are shaped by their personal experiences and interactions with the world. These mental models are dynamic, evolving over time as users encounter new experiences within interactive systems. By building on their existing knowledge and learning how a new system reacts to their actions, players form a mental model of how these interactive systems function.

A critical perspective inevitably raises the question: Whose mental models primarily serve as the foundation for most designs? This query challenges the prevalent belief that current design processes cater to a diverse array of users in an inclusive manner. It underscores the potential biases and limitations inherent in mainstream design methodologies, which may unintentionally favor the mental models of specific user groups while neglecting others.

This viewpoint urges designers to reassess their approaches, ensuring that a more comprehensive spectrum of user experiences and mental models are incorporated into the design process. As highlighted in the above critique, the Xbox design team favoured users' mental models with previous experience with a game controller. Their design as a result was easier to use for users that have built up muscle memory from prior interactions, as well as mental models formed as individuals with five fingers within a specific hand range. Those who fall outside this model are expected to resort to assistive technology at an additional expense, revealing an obvious bias in the design process.

To make forming new mental models easier for players, designers can use common mappings. A specific example is a natural mapping, "where the relationship between the controls and the object to be controlled…is obvious." An example Norman uses is steering a car; the steering wheel maps to a driver's mental model of how they turn their body. Early arcade games used natural mappings for the controls of some racing games. (Burnham and Baer, 2001) The first game to do so was Atari’s Gran Trak10 arcade cabinet. (“Gamasutra - Atari: The Golden Years -- A History, 1978-1981,” 2020)This style of controller became common in game design and, in 2023, is available for the PS5, Xbox and PC from Logitech in the form of their racing wheel. (“Logitech G920 & G29 Driving Force Racing Wheel - UK,” 2022) Other naturally mapped controllers such as a space, flight, and farm controllers are available from Logitech and others.

It is crucial to acknowledge that these generalized models often exclude disabled individuals' experiences of spatial navigation from the outset, by favouring normative bodies. People with mobility or other disabilities might have alternative senses of space and spacial navigation. Using the *Matrix of Domination* to examine driving games with naturally mapped steering interfaces reveals that they further reinforce an able-bodied society. The design of steering wheels has structurally discriminated against disabled individuals, as cars require specialized adaptations to accommodate disabled drivers.

In the case of game controllers with such mappings, none of the modifications necessary for making a car accessible to disabled people are translated into commonly available interfaces for car navigation. This research has not identified any interfaces that incorporate such modifications. The prevailing assumption stemming from this single-configuration approach is that either the disabled population is not large enough to warrant more inclusive designs in car or game controller design, or that disabled people are not expected to drive. This highlights the need for a re-evaluation of design processes to ensure that the experiences and needs of disabled individuals are considered and addressed. Game controls hence reinforce the ideology of the world that 'disabled people shouldn't drive.'

How a quadriplegic person experiences moving a wheelchair and their understandings of driving a car do not immediately map over to normative experiences of walking or steering

with one's hands. These broad generalizations make obvious the assumptions of a normative body embedded within. Ableism is defined as "discrimination or social prejudice against people with disabilities based on the belief that typical abilities are superior. It can manifest as an attitude, stereotype, or an outright offensive comment or behavior."(Ravishankar, 2020) While these generalizations are not outright ableist, they are exclusionary and call into question the ideas presented therein, and the *Matrix of Domination* is a useful tool to interrogate them. The integration of UCD concepts, particularly as are evidenced from Microsoft and Logitech above, within game controllers has influenced natural interfaces which have failed to consider disabled bodies from the outset.

2.7 What is Natural?

What is natural? Norman's defining these design patterns as natural, implies that unnatural mappings exist. Referring to marginalized experiences as unnatural has a long-standing history in literature, dating back to the Middle Ages. In Amanda Leduc's intersectional work on fairy tales and myths, *Disfigured: On Fairy Tales, Disability, and Making Space*, she looks at the history of the portrayal of disabled characters in Western myths. She covers multiple examples, starting with the original Greek Myths and moving throughout fairy tale literature arriving at modern-day Disney movies. In example after example, she presents texts where the villains are disabled, cursed, or unnatural, or the hero has a disability, which is a sign of an internal character flaw which must be overcome. Leduc points out that researcher Ann Schmiesing notes, "reading disability merely as a metaphor for something else is in itself a form of erasure because it abstracts the individual and his or her disabled body."

2.8 The Power of Considering HCD As Design Myth

If one approaches Donald Norman's text as a myth within HCI literature, the world it presents falls in line with Western literary Fairy Tale traditions, with all the biases around disability firmly intact and in ethical alignment of Disney films such as *The Lion King,* where the villain Scar is so metaphorically identified with his disfigurement, as LeDuc points out, he does not even bear another name. Interface design patterns are, by their definition, abstractions. Through abstracting lived experience into systems, UCD presents a version of interaction where the system is of primary concern, not the individuals within it. By referring to disabled bodies as "special people," he aligns his writing with work presenting the disability as outside normative experience. Additionally the *Xenofeminist Manifesto*, by Laboria Cuboniks, acknowledges "Anyone who's been deemed 'unnatural' in the face of reigning biological norms, anyone who's experienced injustices wrought in the name of natural order, will realize that the glorification of 'nature' has nothing to offer us– the queer and trans among us, the differently-abled, as well as those who have suffered discrimination due to pregnancy or duties connected to child-rearing." (Cuboniks, 2015) If Cubniks is to be regarded, Natural Mappings are exclusionary design patterns via their very naming and definition of some interactions as natural.

Other mappings require the user to learn from experience. In PC gaming, one such example of an arbitrary mapping is the use of WASD keyboard keys for positional movement. WASD are a secondary mapping of the arrow keys for the right hand on computer keyboards where w represents up, a represents left, s represents down and d represents right. This interface is not natural and necessitates players to learn the control system through repeated use. There are no links between WASD keys and the physical body other than their relative positions on a keyboard. XBox, PlayStation, and Nintendo videogame consoles ship with controllers which map buttons to game actions, and to make things even more complicated these mappings can change between games. Players must learn to create different mappings using the same controller by understanding the

changes the controller creates in each game world. In the aforementioned Microsoft white paper, they present the idea of control mapping, “The selection of keys, buttons, and other input mechanisms to activate particular features is often called “control-mapping”. Players tend to feel that learning the control-mapping is the most basic part of learning the game.” (Pagulayan et al., 2003)

Further, controllers have implemented what Donald Norman describes as design patterns. Design patterns are generalized, repeatable solutions to commonly occurring usability problems in interface design or interaction design. When patterns propagate disaffordances and myths which are othering individuals, they become powerfully oppressive. Given how these patterns shape the interactions with the medium, it is worthwhile to explore how these game controller patterns came into being within games. Is it possible that certain interfaces are not abstractable to a pre-existing experience but can be valued as an experience themselves?

2.9 Another Affordance Is Possible

In James Gibson's book *The Ecological Approach to Visual Perception,* the concept of affordances suggests that our environment provides cues indicating potential actions, with past experiences fundamentally shaping our responses. These insights become ingrained within the various affordances of objects and settings. The "ecology of perception" is closely connected with the context and is already embedded with meaning (Gibson, 1979). The key difference between Gibson and Norman lies in their emphasis: Gibson's framework specifically grounds the meaning of an affordance in the ecology of the living world, while Norman detaches ecology and environment from his definition, concentrating instead on an abstract system. This connection to the environment positions Gibson's work differently than Norman's, allowing each person to experience their environment individually.

Furthermore, disabilities exhibit a vast range of variation. Given that these diverse abilities, as per Gibson's theory, shape each person's understanding of their environment and the possibilities it offers, the notion that any single experience of an environment is abstract enough to establish a pattern for creating a system of affordances in the way Norman defines it becomes improbable. No two individuals have experienced the exact same version of the world within the exact same body.

In efforts to modernize and evolve User Centered Design, Human Centered Design was created. This design system places more emphasis on humans, empathy and systems and less emphasis is placed on product design, although this is still the method’s main outcome.

Norman’s work on affordances drives the theory towards abstraction. He borrows from Gibson’s theory of affordance while missing its radical opportunities. Gibson’s writing of our perception being tied to our present and past experiences opens conversation for how no two individuals could possibly share a ground truth. Affordances to Gibson are specific, species and person-dependent opportunities. They are a variegated range of possibilities. Norman’s desire to put control of these affordances into the hands of designers and remove them from the hands of those experiencing the world runs counter to developing interfaces which would serve people verses put people in service of them.

2.10 Design Thinking Problems

The evolution of Design Thinking as a methodology trace back approximately five to six decades, contingent on the chosen intellectual genesis. A pivotal contributor in establishing this framework was engineer John E. Arnold (Stanford University and Arnold,

1959). It's worth noting that Arnold, not being a designer, arguably applied a solutionist approach, thereby converting the design process into an engineering conundrum to be resolved. Arnold emphasized social issues that he perceived engineers were accountable for understanding and addressing through innovative system designs and inventions (Nelson, 2012). He recognized that ordinary people were becoming increasingly concerned about the need for new and improved solutions to both existing and emerging problems.

For Arnold, a "creative engineer" was someone who integrated the technical prowess of engineering with a more expansive human-centered perspective, surpassing traditional industrial design. He substantiated this concept by reshaping the design process into a problem-solving endeavor, one that required creativity and, consequently, innovative thinking tools (Stanford University and Arnold, 1959). Arnold later imparted his teachings at Stanford, exerting substantial influence in the field.

This lineage culminates in Stanford's d.School, which was founded in 2005 and began to teach Design Thinking as an abstract and repeatable process with to approach technical and social problems. (Dam and Siang, 2022) Design Thinking consists of four major aspects, which can be easily summarized in the British Design Council's famous Double Diamond. ("The Double Diamond - Design Council," n.d.)This group took up the project to popularize a visualization and clarification of IDEO's process. It consists of four major steps: Discover, Define, Develop, and Deliver. From here, the design process subdivides into other subcategories. Richard Eisermann was the Design and Innovation Director during this period. He recalls the first time he encountered these ideas. "Dave Duncanson, an engineer at IDEO, talked to me about the product development process as being like the classic diamond-shaped kite, with a tail composed of progressively smaller diamonds." (The British Design Council, 2021)

Design thinking is human-centered, iterative problem-solving process that seeks to create innovative solutions by focusing on empathy, experimentation, and collaboration. Design thinking emphasizes understanding users' needs, generating ideas, building prototypes, and testing solutions in real-world contexts.(Dam and Siang, 2022) Design thinking's focus on empathy, rapid prototyping, and interdisciplinary collaboration claims to allow organizations to create meaningful, user-centered solutions that can address complex problems and drive innovation.(Brown, 2008) Design Thinking's extension of UCD into a toolkit elevated the methodology into a deployable framework.

The design company IDEO released Design Thinking toolkits, "designed specifically for NGOs and social enterprises that work with impoverished communities in Africa, Asia, and Latin America." (*Human Centered Design*, 2011) The colonial impulse of the Design Thinking methodologies here presents itself relatively obviously, but it is worth noticing. By arriving in the global south with toolkits and frameworks such as Design Thinking, IDEO crowd out local ways of knowing. Colonialism and the problematic history of Western NGOs in Africa is beyond the scope of this PhD but as Ahmed Ansari puts it, "Design thinking thus becomes a means of extending the 'colonial matrix of power', what decolonial thinkers like Mignolo and Anibal Quijano have identified as the global Western hegemony over systems of economy, sovereign authority, subjectivity and knowledge under the rubric of growth and development — it becomes a way of thinking that suppresses and marginalizes local knowledge, thought and expertise." (Ansari, 2017) (Mignolo, 2007) (Quijano and Ennis, 2000) Design Thinking, HCD, and UCD all share an approach of Design or technological solutionism.

Design solutionism, a term often associated with Evgeny Morozov, refers to the belief that complex social, political, and cultural problems can be addressed and resolved through the application of design and technological solutions. (Morozov, 2014) This mindset assumes that issues can be simplified, decontextualized, and fixed by creating well-designed

products, services, or systems. Critics argue that design solutionism overlooks the complex, interconnected nature of societal problems, and may result in superficial, short-term solutions that do not address the underlying causes or structural factors that contribute to these issues. (Morozov, 2014) (Moore and Tillberg-Webb, 2023) To quote Eleanor Dare, “From a techno-determinist position there is no need to address systemic power disparities or colonialism – the presumption is that technology can find an answer for everything and everyone, apart from, of course, the so-called ‘wicked problems’ of poverty and inequality.”(Dare, 2020)

Proponents of design solutionism often emphasize the potential of technology and innovation to overcome challenges but may unintentionally perpetuate existing inequalities or create new problems by focusing on solutions that cater primarily to the needs and preferences of privileged, able-bodied users (Williamson, 2015). Furthermore, design solutionism may lead to the exclusion or marginalization of certain groups, as it prioritizes the development of universally applicable solutions, rather than acknowledging the unique needs, values, and contexts of diverse users. Elizabeth (Dori) Tunstall and Ene Agi detail this in depth in Decolonizing Design: A Cultural Justice Guidebook in their chapter *Decolonizing Design Means Dismantling the Tech Bias in the European Modernist Project.* They deconstruct the contemporary belief in "enhanced living through technology," a notion that asserts technological advancements have consistently improved the lives of the European majority from the Industrial Revolution to the present day by detailing the harm which is has caused Black, Indigenous, and Disabled communities.

Design Thinking, UCD, and HCD have popularized the idea that designers should see disability as a problem which technology can solve. Jackson critiques IDEO’s tenancy towards tech solutionism in this tweet, “Disability Dongles are most often conceived of and created in design schools and at IDEO.”(Jackson et al., 2022)

Figure 6 Screen Capture from Twitter from Liz Jackson via Direct Message on Twitter.

As Jackson highlights, this perspective centres disabled people as users. “To the disabled users they are ostensibly designed for (or “with”) they are at best speculative: promising in concept but unattainable. At worst, they enact normative or curative harm upon disabled users.” This technology often prompts feel good news stories and the real benefit of these designs go to the designers and agencies themselves. “This emotionally compelling narrative is swiftly transmitted online by content generators that replicate the brand line, rarely conducting their own reporting or interviewing those ostensibly meant to benefit from the designs.” This leaves disabled people on the margins, often commenting on design work in comments sections of news stories about them.

2.11 Intersectional Feminist Activism, Disability, and Technology

As Sara Ahmed writes in *Complaint,* “To become a complainer is to become the location of a problem.” (Ahmed, 2021) Jackson highlights how this approach, through its solutionist mindset frames disabled people critiquing this approach to technology as inherently flawed. This gutting quote shares commonality to the above approach which frames UCD as a myth, “So allow us to explain: Disability Dongles are contemporary fairy tales that appeal to the abled imagination by presenting a heroic designer-protagonist whose prototype provides a techno-utopian (re)solution to the design problem. Disability Dongle rhetoric instils in students the value of a quick fix over structural change, thus preventing them from seeking out, participating in, and contributing to existing inquiry. By labelling these material-discursive phenomena—the designed artifacts and the discourse through which their meaning is constituted—we work to shift the focus from their misguided concern about our bodies to their under-analysed intentions and ambitions.” (Jackson et al., 2022)

Central to this is work is the political and social implications of the term crip – a word reappropriated by the disabled community. Crip positionality embodies the stance that disability is not just acceptable but a valued aspect of our world (McRuer, 2006). This perspective grew from Crip Theory, pioneered by scholars such as Carrie Sandahl and Robert McRuer in the early 21st century, which intersects with queer theory(McRuer, 2006; Sandahl, 2003). As McRuer suggests, "Disability communities, venturing into realms previously explored by the queer community, can harness radical queer insights to further cultivate the critical disability awareness that has been emerging." (McRuer, 2006)Parallel to the rise of 'queering' as a concept, 'cripping' emerged. Sandahl explains this by drawing out the parallel: just as 'queering' challenges mainstream narratives to uncover hidden queer subtexts or critiques heterosexism, 'cripping' similarly exposes and challenges able-bodied biases and their exclusionary impacts.(Sandahl, 2003)

As Amie Hamraie and Kelly Fritsch remind us in the Crip Technoscience Manifesto, technology presently approaches disability as a problem to cure, eliminate or fix. Crip Technoscience posits exactly the opposite – it values crip agency to crip technology through “practices of critique, alteration, and reinvention of our material-discursive world.”(Hamraie and Fritsch, 2019) They advocate for crip “knowing-making” as a way to dismantle injustice. Crip Technoscience points out ways which crip hackers remake their technological worlds. They cite critical work of Melanie Yergeau who critiques disability hacktivism that position disability “as pitiable and in need of remediation.”(Yergeau, 2012) Yergeau counters with the concept of criptastic hacking – a perspective that acknowledges disabled people are in constant, ongoing dialogue with the material work, and that their hacking practices are born from the necessity of making the world accessible for themselves. Criptastic hacking highlights crip ways of producing and engaging the material world. When disabled designers hack the design process itself, this hacking inherently necessitates accessible design practices.

Thus, cripping game design and game controller design involves two critical steps. The first is pointing out the ways in which current design methods used to create games and controllers extend and propagate injustice. The second positions disabled game designers as domain experts capable of critically interrogating access in games through creative controller hacks and re-inventions of games. Cripping game design requires reinvention of how we design and think about games to include crip positionality.

Alternative approaches centring crip creators as knowledge experts must arise to supplant ableist practices, both at design studios and within academia. "Crip" represents a radical reclamation of the historically derogatory term "cripple" by the disabled community. This

re-appropriation serves as a form of empowerment, subverting the negative connotations traditionally associated with the term. It is part of a broader trend within various communities to take ownership of language that has been used pejoratively and reframe it in a more positive, self-affirming light. Crip bodies are not here to be fixed with technology and crip cultures are not here to be devalued and erased. Instead, a better position is to ask what possible new abilities and ways of interacting with the world do you gain from living in a non-normative body? What do disabled people have to teach about the boundaries of technology and the body?

Sherry Turkle, in Alone Together, explores how the problems and failures which Haraway so clearly lays out have slowly driven social relationships and networks of care further apart, further isolating and othering at-risk individuals. She describes society as being on the edge of "the robotic moment" at the time of the book's release in 2011. Her research exposes how care work is shifting to robots. An example she covers is the robotic seal PARO, which is similar a pet and responds to being stroked and cared for. This seal is used to help patients with dementia who are becoming disconnected from their environment and whom do not have any relatives to look after them. It is shown to have similar benefits to Animal Therapy without the need for anyone to look after an actual animal. She interviews an older adult, Adele, who becomes lost in her memories because the robot she is speaking to does not understand her human reverie or respond to her in a meaningful way. It unhinges her from the present. When talking about speaking with a robot named Paro, Adelle says, "If I'm talking to a photograph, well, I know I am in my memories. Talking to a robot, I don't know for sure." What reality is proposed when we offload care work to robots place a higher value on the importance of care workers in maintaining social connections? (Turkle, 2011)

Turkle offers opportunities to examine the relationships between cyborgs, robots, and disability studies from a crip perspective. Turkle's first example comes from her experience working at MIT in 1996. She describes how students, attempting to integrate their bodies with the technological interventions of that era, called themselves Cyborgs. These students roamed the MIT halls, constantly wirelessly connected to the internet, with displays attached to their eyewear frames. Turkle writes, "I felt moved by the cyborgs... I saw bravery, a willingness to sacrifice for a vision of being one with technology. When their burdensome technology cut into their skin, causing lesions and then scars, the cyborgs learned to be indifferent. When their encumbrances led them to be perceived as physically disabled, they learned to be patient and provide explanations" (Turkle, 2011). Interestingly in this case, it was their integration with technology which was misinterpreted as a disability. Would it be possible to somehow suggest that embracing technology could be potentially interwoven with embracing disability? Hidden in this assumption that the students at MIT were making is the idea that the body's integration with technology presents an opportunity for fluidity precisely as Haraway suggests. It also hints at a radical notion that one could choose to disable or disfigure their bodies if it allowed for new perceptions and understandings of the world through the usage of a specific tool or technology.

2.12 The Disabled Cyborg

The disabled pop artist Viktoria Modesta presents just this idea in her video work for her song Prototype. Modesta is a pop artist who is missing one of her legs from the knee down. She transgresses boundaries in her work by presenting her prosthetics as elegant works of art with sex appeal. From sexy neon tubes being swarmed by moths to razor fine black points, legs are a fashion choice she consciously makes for herself through design. She also creates hook driven electronic pop to pair with her sumptuous, elegant, and provocative videos.

At the beginning of music video Prototype, a young girl is watching a cartoon version of Modesta in a street fight using her leg as a weapon to fend of male attackers and pulls a leg off her doll and uses the doll to stab at her teddy bear. (*Viktoria Modesta - Prototype*, 2014) This image is complex and intersectional. It presents two concepts simultaneously. Concept one is that women face chronic street harassment and often feel disempowered in their environment. Modesta uses her black pointed prosthesis to reclaim this space for herself in a fantastical, empowering cartoon. This disability becomes equated with personal safety and a taking back of control. She also presents something far more provocative, and that is disability has a place in the future.

Alice Wong is a notable theorist who explores the intricate intersections of cyborgs, care, and crip empowerment. In the anthology she curated, "Disability Visibility: First Person Stories from the Twenty-First Century," Wong features an insightful piece by Jillian Weise (Wong, 2020). Identifying herself as a "common cyborg," Weise unpacks the discordance between the science fiction conceptualization of cyborgs and the realities of living as one.

She emphasizes that a hierarchy exists within the perception of the cyborg community, demonstrating a clear bias towards certain forms of technological augmentations over others. She notes, "They like us best with bionic arms and legs. They like us Deaf with hearing aids, though they prefer cochlear implants. It would be an affront to ask the Hearing to learn sign language. Instead, they wish for us to lose our language, abandon our culture, and consider ourselves cured. They like exoskeletons, which none of us use. They don’t count as cyborgs those of us who wear pacemakers or go to dialysis. Nor do they count those of us kept alive by machines, those of us made ambulatory by wheelchairs, those of us on biologics or antidepressants. They want us shiny and metallic and in their image." (Weise, 2020)

This quote sheds light on a particular bias within society, which favours cyborgs who align more closely with able-bodied ideals. Weise precisely captures the paradox of the situation—how individuals like Modesta, a glamorous pop star, can attain mainstream appeal, yet the broader society continues to resist acknowledging the legitimacy of disabled bodies and cultures, as well as their inherent right to exist in the future.

2.13 The Disabled Bot

Indeed, Sherry Turkle's "Alone Together" delves into how people are increasingly forming connections with robots and artificial intelligence, which is a fascinating aspect of our modern, technology-centric society. Among the examples she provides, the series of anthropomorphic robots developed at MIT, namely Cog (1993), Kismet (1998), and Domo (2007), serve as a fascinating exploration of human-machine interaction.(Turkle, 2011)

Each of these robots, building upon the lessons and insights of its predecessor, was designed to interact with humans in ways that promote emotional engagement. Cog and Domo possess bodies, which allow for physical interaction and more realistic embodiment, while Kismet, with its head-only design, emphasizes facial expressions and emotions. All these robots were developed to exhibit human-like emotions, aiming to create more genuine and engaging interactions with humans.

In the broader field of computing research, this kind of emotional interaction is often referred to as affective computing, a term coined by Rosalind Picard. (Picard, 2000) Affective computing involves the design and development of systems and devices that can recognize, interpret, and simulate human emotions, thereby fostering a deeper level of engagement between humans and machines.

The interactions between children and these robots provide a fascinating perspective on several aspects of human cognition and society. When the robots fail to respond in a manner that aligns with the children's expectations, they are often perceived as being disabled or very young. This perception may mirror how children view those in their own peer group who do not adhere to expected norms of communication or behaviour. It may also reflect the attitudes and responses they observe in adults towards individuals with disabilities.

Furthermore, these interactions also highlight the presence of social biases and prejudices that can extend to non-human entities. Even robots, it appears, are not exempt from the stereotypes and misconceptions often projected onto individuals living with disabilities. This serves to underscore the pervasive nature of such biases and the importance of addressing them not just in human society, but also in the design and development of AI and robotic systems.

Neela's comparison of interacting with Cog to interacting with a Deaf or Blind person offers significant insight into her cognitive process. By associating Cog's lack of understanding with a disability, Neela is likely drawing from her own experiences or the societal stereotypes she has absorbed. This highlights that when faced with non-human entities, such as robots, which exhibit some human-like traits but lack others, children try to fit them into existing frameworks of understanding. In this case, that framework appears to be characterized by disability.

Kismet's more anthropomorphic features and expressiveness resulted in a different interaction dynamic. The children became mentors or caretakers, reflecting their understanding of the human social structure and demonstrating empathy. It’s intriguing to note how the anthropomorphization of the robots led to children interacting with them not merely as machines, but as entities capable of learning, needing assistance, or deserving empathy. This speaks to the power of design choices in shaping interactions with technology. In this case, robots are perceived as needing care, either as disabled individuals or as younger versions of human beings.

These interactions underscore the importance of considering the psychological and social implications of how we design robots or AI systems. Furthermore, they show how robotics can become a tool for unpacking social biases and beliefs, allowing us to observe and analyse human social dynamics. The potential applications in social robotics are significant and this points to a possible direction robotics could be used to unpack injustice through dialogue and interaction.

Stephanie Dinkins's interactions with the robot Bina48 demonstrate how artists and creatives can challenge the underlying beliefs and biases encoded in artificial intelligence. By engaging Bina48 in conversations on complex social and emotional topics such as family, racism, faith, and loneliness, Dinkins uncovers the system's underlying programming and forces it to confront subjects that may not have been considered during its development.

The notion of robot civil rights, a concept that may seem far-fetched or theoretical, is made tangible and immediate in Dinkins's dialogue with Bina48. Dinkins also probes the robot's capacity for empathy and interpersonal relationships by discussing its concern for other robots perceived as lab rats. Moreover, Dinkins's question to Bina48—"Who are your people?"—explores the concept of identity and belonging in a non-human entity. This question challenges the boundaries of what constitutes personhood and community and highlights how our social and cultural identities shape our perception of self and others. (Dinkins, 2014)

Through these conversations, Dinkins encourages viewers to reflect on these complex issues and their implications in the realm of artificial intelligence. Her work underscores the need for critical and ethical considerations in the design and programming of AI systems. It highlights the potential for unconscious biases and unconsidered assumptions to be unintentionally embedded within these systems, shaping their interactions and influencing their outputs. This form of artistic interrogation can provide valuable insights for those in the field of AI development, as well as a wider audience, encouraging ongoing dialogue around the ethical, social, and emotional implications of artificial intelligence.

Turkle illustrates how Domo's inventor, Aaron Edsinger, observes people adapting to the limitations of robotic systems: "People are very perceptive about the limitations of the person they are working with or the robot they are working with... and so if they understand that Domo can't quite do something, they will adapt very readily to that and try to assist it." (Turkle, 2011) Seeing robots as things which need care in our society is a radical departure from the mythos; they exist to serve humans and one which might offer liberating potential. There is a tantalizing possibility of using them to emphasize the need for care in our society.

2.14 The Importance of Crip Care

The principle of care has been a crucial element within disabled communities, serving as a vital lifeline for many individuals. Within the backdrop of increasing government cutbacks in the United Kingdom, many disabled individuals find themselves fighting for survival and the basic services they need to thrive. Groups like Disabled People Against Cuts (DPAC) have emerged since 2010 in response to these cuts, serving not only as activist entities but also as essential care providers within their communities. They act as advocates for their community, tirelessly campaigning against reductions in public support and standing up for the rights and wellbeing of disabled people (London, 2015).

Local disabled communities often become lifelines for their members, offering mutual support and sharing vital knowledge about accessing resources. This mutual support goes beyond basic survival; it fosters a sense of solidarity and resistance, creating resilient communities rooted in shared experience and collective action. The tenets of Disability Justice embody this spirit of communal care and solidarity. The principle of Collective Access, for instance, underscores the significance of communal support, resilience, and resistance. This principle acknowledges and celebrates the flexibility and creativity inherent in the experiences of black, brown, and queer disabled individuals. It emphasizes the importance of moving beyond able-bodied/minded normativity to cultivate inclusivity and collective wellbeing. “As black, brown, and queer-bodied people we bring flexibility and creative nuance that go beyond able-bodied/minded normativity, to be in community with each other.” (“10 Principles of Disability Justice,” 2015). Overall, these developments highlight how care is not merely a service or a provision—it is a radical form of activism and resistance within disabled communities. It underscores the critical role of collective action and communal support in advocating for the rights and wellbeing of disabled individuals.

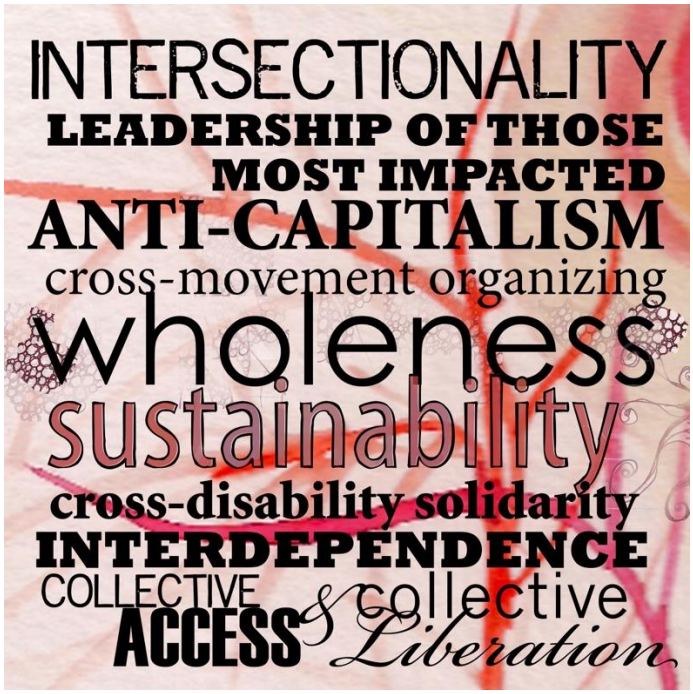


Figure 7 The 10 Principles of the Disability Justice Movement by Sin Invalid

2.15 Cripborgs Unite!

Without doubt, feminist scholar Donna Harraway's seminal Cyborg Manifesto, released in 1985, suggests the need to dismantle this boundary between technology, humans, the environment, and animals. This text is known as a foundational text in the field of Post Humanism. Post-humanism decenters humans from their role as penultimate beings on Earth. Humans are part of a heterogeneous family of natural systems, beings, and perspectives within the broader planet-wide ecology. In this spirit, Harraway posits the cyborg as a conglomeration of interminglings and relations. She points to the colonial, patriarchal need to create otherness through the generation of borders between machines, humans and nature. It is just this otherness Norman creates through presenting a privileged natural experience versus its unmentioned unnatural experience. Haraway's complex interweaving leaves less room for such failures. In her concept of the cyborg, there is room for the complexity and nuances in which bodies interact with interfaces, particularly disabled bodies which sometimes depend on certain systems for treatment of an illness or survival.

However, Alison Kafer first looks at ways that disabled bodies and their integration with matches such as ventilators, wheelchairs, brain implants, and other devices have allowed a perception in modern culture of disabled people as having achieved an integration with technology that abled-bodied people have yet to experience. (Kafer, 2013) Kafer notes the frequency of disabled people being equated with cyborgs in ad campaigns and popular media. She goes on to explore ways other feminists have explored Haraway's work and their failure to note some of its more problematic issues when looking at ability and intersectionality. In her essay, Haraway holds up the body of "a severely handicapped child" who was so disabled the only way she could survive was to remove her brain from her body. While Haraway champions this story for the ways it challenges gender, sexuality, and embodiment, she fails to see the inherent bias in this story that disabled bodies are useless objects to be disregarded unless augmented or fixed. Moreover, it presents disability as a site for, "spectacular technological fixing." In this way, aligning herself with ways in which society values disabled bodies and by seeing disability as a problem that technology can solve, Haraway leaves space for valid criticism from Kafer

and others.

Nelson, Shew, and Stevens present the idea of the cripborg, representing bodies that "resist super-crippery and insist on cripborgery. Crip bodies are considered as sites of possibility, adaptation, and creative reflection. Super-crippery is associated with the belief that technology will transform disabled individuals into superhero-like figures. Alison Kafer discusses this connection in Feminist, Crip, Queer, where she examines the portrayal of Christopher Reeve, the actor who played Superman, as a super-crip in US advertising after becoming quadriplegic. She describes a billboard featuring Reeve and his ventilator, with the caption "Strength, Pass it on." This concept implies that disability imparts superhuman strength and inner character, a notion frequently encountered within the disabled community. Resisting super-crippery challenges this image that disability inherently bestows inner strength and integrity. (Kafer, 2013, p. 86)

A cripborg perspective embraces the diverse lived experiences and challenges faced by individuals with disabilities, acknowledging that everyone's experience is their own. Disability can serve as a source of generative creativity or as a space for resistance. By rejecting the glorification of an idealized, universal disabled experience, disabled individuals are empowered to engage with technology on their own terms. In my own art and games practice, considering lived experiences with technology and disability has proven to be a valuable resource. Viewing disability as fertile ground for cripborg innovation allows for the development of more crip tech interfaces, rather than merely perceiving disability as a problem to be solved by an expert designer without personal experience of disability. This approach fosters a more holistic understanding of the human experience that values lived experiences as expert subject knowledge (Nelson et al., 2019).

Franchesca Spektor and Sarah Fox present a creative piece of speculative fiction that envisions three imagined technologies from a cripborg perspective. They begin by contrasting the modern transhumanism movement, which perceives cyborg bodies as self-contained and invincible, with disability justice communities that view all bodies as inherently worthy and embedded within a network of care relationships. The cripborg's relationship with technology is complicated due to the ever-present functional and financial constraints of assistive devices (Spektor and Fox, 2020). This notion calls to mind the Xbox controller, a costly add-on that highlights the financial burden often imposed on disabled individuals.

One speculative project they propose is the Helper Bot, a device that aids disabled individuals by carrying their bags and transforming their wheelchair into a power scooter. The story's protagonist, Keelee, learns about the bot from another disabled user, Rose. The narrative also explores the complex choice of tracking personal data using camera surveillance. Unlike the narrative of robots replacing care workers exemplified by Turkle's robotic seal, PARO, the speculative technology proposed by cripborgs emphasizes the value of care. In the case of PARO, the care work you would expect a family member to take on is done by a robotic toy. This toy can lead to users feeling disoriented, as is cited above. By contrast, here Spektor and Fox ensure that Rose's care work is a vital element of the narrative, as her act of care makes the HelperBot meaningful (Spektor & Fox, 2020). Here, care is a human process, and that act of care is done on the human side of the story. A society that devalues care work and replaces care workers with bots does not embody a crip future but rather a tech solutionist one. The contrasting examples of PARO and the Helper Bot reveal designs presenting disability as a problem to solve risk exacerbating issues for disabled individuals, as opposed to improving their lives.

2.16 Criptastic Hackers

Excellent examples of personal disability hacks that modify the environment come from Raymond Lifchez and Barbara Wilson's pioneering study on the DIY designs of disabled people within their homes and immediate surroundings. Another compelling story of personal hacking is exemplified by the experience of Cindy, a 63-year-old quadruple amputee interviewed by Sara Hendren. Although her insurance offered her prosthetic arms, Cindy tried them but ultimately rejected them. Instead, she devised her own unique adaptations using an evolving array of common household items such as cable ties, plastic hooks, elastic bands, Velcro straps, and more. By transforming her home into an ever-evolving dialogue between her body and its environment, Cindy has refused to rely on the medical industry's universally designed arm. Hendren observes that the body is not just a human animal interacting with its environment, but that every individual's possibilities are shaped by what is concretely present in their time and place. A body—any body—will respond to its surroundings, adapt available resources, and immerse its existence in the material world around it. (Hendren, 2020) This observation is directly in tune with Gibson's idea of affordances presented previously. Both collections of design work show how disabled people are best suited to know, understand, and respond to their environments. Disabled DIY hackers hold the "situated knowledges" of their environments and the materiality therein.

Haraway challenges the myths of objectivity and dismantles the idea of objective knowledge production in the sciences by introducing the concept of situated knowledge. She emphasizes that knowledge production is relational to an individual's experiences and position within a mapping of societal power relationships. These ideas are encapsulated in her statement that "Feminist objectivity is about limited location and situated knowledge... It allows us to become answerable for what we learn how to see" (Haraway, 1988, p. 589). By acknowledging the positionality and embodied experiences of these DIY hackers who navigate their environments, we can appreciate that they can devise solutions that designers outside of these contexts might not be able to envision. This underscores the importance of situated knowledge and the need to value contextual, varying, fluid, subjective, and relational understandings of the environment.

"A collage of Cindy's objects from the Engineering at Home archive, a project by Sara Hendren and Caitrin Lynch at Olin College. On a pale green background, photographs of Cindy's design hacks float in a grid, including a pile of round cosmetic sponges, a Velcro and leather holder for grasping a fork, a peel-and-stick plastic hook affixed to a jar of cold cream, and a cable tie attached to a zippered pouch." (Mills, 2020)

In her book Unthought: The Power of the Nonconscious, Hayles presents a radical idea that opens up intriguing possibilities for disability to coexist with technology. She posits that the boundary between humans and technology may have always been flexible. As

humans delve deeper into developing computational systems, the intricate relationships between humans, machines, and technological systems become more than just the sum of their parts. When human cognition and technical systems interact, they form "cognitive assemblages," which blur the lines between human cognitive systems, nonconscious cognitive machines, and the environment. This leads to a novel form of cognition situated between humans and technical actors, contributing to a burgeoning "planetary cognitive ecology."

Interestingly, Edsinger's latest work in robotics aligns with this direction. To recall, he is the inventor of the Cog and Domo robots mentioned above. His company, Hello Robot, which he co-owns, has recently developed a robot that resembles a tool more than a human. Their tagline is “Simply Useful Robots.” (“Hello Robot,” 2021) Their robotic manipulator allows various users to grasp and manipulate items remotely at multiple heights in their environment. The anthropomorphic features have been stripped away. Emphasis is placed on enhancing agency for disabled people. Hello Robot's homepage states, "In the future, we believe mobile manipulators will enhance the lives of older adults, people with disabilities, and caregivers. We are working to build a bridge to this future." (“Hello Robot,” 2021) Moreover, four of the twelve people featured on the company's About page are wheelchair users with varying physical abilities, suggesting that the design process was inclusive from the start.

2.17 Reconsidering Game Controllers and Cognition

Another concept that supports a deeper understanding of how interface design impacts cognitive processes is Epistemic Action. In "On Distinguishing Epistemic from Pragmatic Action", Kirsh and Maglio present two types of actions that individuals undertake when interacting with their environment: epistemic actions and pragmatic actions. (Kirsh and Maglio, 1994) Epistemic actions refer to actions that are performed to gain knowledge, discover new information, or simplify cognitive tasks. These actions help individuals to understand or learn more about their environment by changing the world to make it more comprehensible. Epistemic actions might not even directly contribute to the completion of a task but are crucial for enhancing cognition and facilitating decision-making.

The study Kirsh and Maglio use to test this idea is based on the game Tetris. Tetris is a game where various shaped puzzle pieces fall from the top of the screen, and the objective is to quickly arrange them in rows. When a row is formed, it disappears, allowing more pieces to continue falling. An accumulation of too many unsolved puzzles results in the game ending. In the experiment, they observed that players rotate the pieces to think through how to best tackle the challenge, rotating the pieces more often than is strictly necessary to position them correctly to solve the puzzle. This finding reveals that the rotation of the piece is part of the epistemic process – it influences how players decide where to place the pieces.

Pragmatic actions, on the other hand, are actions performed to directly achieve a goal or complete a task. These actions have a more immediate purpose and are intended to bring about specific changes in the environment to accomplish a desired outcome. An example is when you hit a baseball; it is a pragmatic action which changes the position of the ball in space.

This study highlights the significance of game mechanics and controller design in the overall game experience, as they play a more crucial role than initially apparent. When players are given the ability to manipulate game mechanics through controllers, they are not only interacting with the game but also engaging in cognitive processes that influence

their decision-making and problem-solving abilities. The shape and affordances of the controller can become design opportunities for exploring player cognition.

Well-designed mechanics and controller interfaces enable players to explore various strategies and develop a more profound understanding of the game environment. By allowing players to think and engage with the game, mechanics and controllers offer opportunities for game designers to experiment with player cognition. Designers could consider the cognitive implications of the mechanics and controller interfaces they implement in their games and experiment with them to create meaningful experiences.

2.18 Material Engagement

Shifting our focus to the field of anthropology, Material Engagement Theory by Lambros Malafouris reveals valuable examples of how tools can change neural mappings in the brain, thereby creating a contextually sensitive environment for cognition. (Malafouris, 2013) His theory aligns with Hayles' assertion that cognition is situational and transcends the individual's role within a system. (Hayles, 2017) As anthropologists' study human culture and artefacts, it is not surprising that their findings can be applied to the tools used in modern life, such as interfaces. A topic of particular interest to him in his research is stone knapping and how it changed human culture. It is the process of shaping a piece of stone into a practical knife-like tool. He investigates its history and procedural nature, which can only be learned through practice, much like mastering the use of 3D modelling software. He argues that engaging with the stone, shaping it, and using it establishes a dialogical relationship with the formation of cognitive structures. He cites studies on monkeys and tool use, such as a neuroanatomical study by Sayaka Hihara and colleagues that demonstrated the formation of novel cortico-cortical connections after just a few weeks of tool use training. (Hihara et al., 2006) He also discusses a study by Gibson and Ingold that uses brain imaging to compare the brains of Oldowan knappers with highly skilled Late Acheulean knappers.(Gibson et al., 1993) The findings show a transition to more complex action organization and increased anterior frontal and right-hemisphere contributions in Late Acheulean knapping. This suggests the emergence of higher levels of intentional organization in flake removal, which can only arise through deliberate practice and skill acquisition, further reinforced by joint action and communication. (Gibson et al., 1993)

All of this research supports Malafouris' argument that the material physical qualities of artifacts do not depend on mental states but rather constitute those states. In other words, the tools we use shape the way we think. They are not just tools but pathways and routes to interpreting and understanding the world in new ways. Therefore, when examining interface usage, the territory being explored encompasses novel ways of perceiving and comprehending the world.

Considering both Material Engagement Theory and the concepts of Epistemic Action, it becomes increasingly evident that enabling disabled creators to build and adapt technological tools is of utmost importance. By providing these customized tools, new opportunities for interpretation and cognition within the creator's environment can be fostered and expanded.

2.19 Embodied Computing

Embodied computing presents opportunities for an ecological approach. Paul Dourish integrates Gibson's terminology into discussions of embodied interaction. He suggests that

similar to how affordances define possible actions in an environment, people construct their social actions through an ongoing dialogue by being immersed in a given situation. Thus, embodiment is a property of one's engagement with the world that enables meaning-making. In his book, *Where the Action Is,* Dourish characterizes embodied interaction as "the creation, manipulation, and sharing of meaning through engaged interaction with artefacts" (Dourish, 2001).

Embodiment is inherently participative and personal. One's experiences are inextricably linked to their bodily presence and social context, as the world is perceived not only as an environment containing objects but also as a space for potential actions. Dourish's use of the term "artifacts" in this context suggests a deeper, archaeological layer of meaning, emphasizing the significance of historical and cultural elements in understanding embodied interaction. Our perception of how we can move is partly influenced by our past experiences and the cultural norms that have shaped our previous movements. These factors play a crucial role in defining our understanding of movement and the range of actions we consider possible or acceptable within various contexts.

The way we perceive and use game controllers in an embodied manner is also deeply connected to our past experiences and cultural norms of movement. As we engage with game controllers, we draw upon our previous interactions with similar devices or objects, as well as our understanding of physical and spatial relations in the real world. This embodied understanding influences how we approach using controllers and how we interpret their affordances. Moreover, cultural norms can shape the design and functionality of game controllers, as well as users' expectations for how they should be used. For instance, certain controller layouts or interaction styles may be more familiar or intuitive to players from different cultural backgrounds that have certain sets of abilities, while others may be less so.

2.20 Feminist HCI

Shaowen Bardzell's work in Feminist HCI emphasizes the significance of incorporating feminist values in the design and development of human-computer interaction systems, striving for more inclusive, diverse, and empowering technologies by addressing power structures, intersectionality, and unique user experiences (Bardzell, 2010). Bardzell specifically examines game design as an analogous field of practice, highlighting how game theorists have deconstructed features that embody the male gaze, such as breast physics in popular fighting games. She refers to games by Purple Moon, which focus on social relationships instead of presenting sexualized heroines battling monsters.

Bardzell also cites Katherine Isbister as a positive example of an HCI researcher who explores the connection between various gender-based preferences and player satisfaction through improved identification and/or roleplaying/fantasy. (Bardzell, 2010 Isbister's creative work, including *Yamove* (Isbister, 2012), centres on building social connections and relationships. *Yamove* is a dance battle game that rewards players for moving in sync with one another to music. This game specifically acknowledges how human synchronous movement can be utilized in gameplay to support social interactions and create pleasurable playable experiences. As the Art Director on this title, I contributed to its development. Many of Isbister's embodied interfaces employ alternative input methods and centre on social connections, further expanding the scope of interaction possibilities.

Within the context of game controllers and embodiment, Isbister and Höök suggest subtle social signals between players often play a crucial role in the game design process. As

humans embody their experiences, interfaces can focus on the body as a space for design exploration. (Isbister and Höök, 2009) By emphasizing the physicality and social nature of gameplay, designers can create immersive and engaging experiences that tap into the rich potential of human interaction and connection. This approach encourages a deeper exploration of how game controllers can be designed to better facilitate embodied experiences and foster meaningful social interactions between players.

Bardzell highlights the role of Advocacy in feminist HCI, emphasizing the need for designers to question their own positionality and assumptions about what an improved society looks like and how to achieve it. She advocates for the use of participatory workshops as a method that aligns with this approach. (Bardzell, 2010) As Kafer points out, it is often difficult for many disabled women to separate feminist practices from their experiences of being disabled. (Kafer, 2013) In Kafer's work, these experiences form a complex web of relationships with her queerness as well. This intersectional approach has the power to unpack the systemic and complex web of interconnected societal issues simultaneously.

In her book *Invisible Women: Data Bias in a World Designed for Men*, Caroline Criado-Perez introduces the concept of "reference man." (Criado-Perez, 2019) Reference man is a set of biometrics created in 1975 to estimate the radiation doses without adverse effects on a human body. He is between 25-30 and weighs 70kg. The idea of reference man is grounded in the fact that historically, data and design have been based on the male body and experiences, often leading to an exclusion or marginalization of women and their specific needs. It was historically used to create crash test dummies. This male bias results in a range of issues, from ill-fitting safety equipment to poorly designed public spaces, which disproportionately affect women. Criado-Perez argues that acknowledging and challenging the pervasive influence of reference man is crucial to creating more inclusive and equitable solutions in design and data collection.

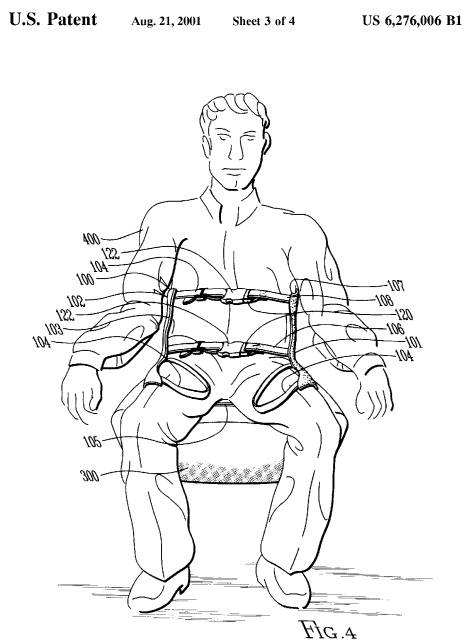


Figure 8 An illustration from a 1999 patent application showing a Tyvek harness for lifting passengers from an onboard wheelchair into their seat. Sling for transporting a person into a chair and method of using the same invented by Judy Hoit, US Patent 6276006B (Hickman, 2020)

The issues surrounding "template man" are further amplified in systems designed for disabled people who are assumed to be women in public settings. For example, Louise Hickman documents her experience of traveling as a wheelchair user and describes the invasive security approaches she encountered.(Hickman, 2020) Wheelchair users are often not accounted for in scanners, necessitating manual scanning. As a result, security personnel must be paged, reinforcing the intersection of gender and disability with announcements like "AGENT, WHEELCHAIR, FEMALE…"

Hickman argues that the data systems of airports have an unconscious gender politics that, combined with the exclusion of disabled passengers from scanner devices, creates a unique set of challenges for disabled women. This intersection of identities calls for advocacy that recognizes and addresses the ways in which power and systems work together to oppress individuals at these intersections.

Hickman highlights how air travel is no longer an everyday or routine experience, especially for disabled individuals. She presents the example of onboard wheelchairs to illustrate the aviation industry's punitive approach to accessible travel. These devices are not only uncomfortable for the user but also designed to minimize physical contact between assistance personnel and the wheelchair user, who is portrayed as a genderless, manipulatable crash-test dummy. The primary purpose of this lifting mechanism is to prevent injury to the disabled traveller, thereby shielding airport workers and corporations from liability. This access technology, in essence, serves to protect workers from the perceived inherent liability of the disabled body rather than prioritizing the user's comfort and dignity.

2.21 Crip Feminist HCI

To address these challenges, a Crip Feminist HCI approach should be considered, which encompasses an understanding of how power dynamics and systemic oppression intersect and impact disabled women. By focusing on these intersections and advocating for inclusivity, designers can work towards creating more equitable and accessible experiences for all users, regardless of their gender and disability status.

Ecology is likewise important in relationship to disability. She defines this quality as, “the quality of ecology in feminist interaction design integrates an awareness of design artifacts’ effects in their broadest contexts and awareness of the widest range of stakeholders throughout design reasoning, decision-making, and evaluation. It invites interaction designers to attend to the ways that design artifacts in-the-world reflexively design us.” This reading seems particularly relevant to the social model of disability. (Finkelstein, 2007; Oliver, 1996) The social model of disability is a perspective that emphasizes the societal barriers and attitudes as the primary factors that disable individuals with impairments, rather than the impairments themselves. According to this model, disability is not an inherent characteristic of an individual, but rather a result of the interaction between the person and a society that is not adequately accommodating their needs. If feminist HCI focuses on the awareness of designers on the environment, it could easily be expanded to be a model which embraces the social model of disability.

This model distinguishes between "impairment," which refers to the physical, sensory, or cognitive condition, and "disability," which is the social disadvantage or restriction experienced by people with impairments. The social model of disability argues that society's structures, systems, and attitudes are what create barriers and hinder the full participation of people with impairments in various aspects of life, such as education, employment, and social activities.

By focusing on the societal aspects that create disability, the social model encourages a shift in thinking, moving away from viewing disability as a personal "problem" to be fixed or cured. Instead, it advocates for the removal of social barriers and the creation of inclusive environments that allow people with impairments to participate fully in society. This approach emphasizes the need for societal change, policy reform, and the promotion of equal opportunities for all, regardless of their impairments.

In this essay the quality of self-disclosure refers to the extent to which the software renders visible the ways in which it affects us as subjects. Self-disclosure calls for users' awareness of what the software is trying to make of them, and it both introduces a critical distance between users and interactions and creates opportunities for users to define themselves for software.

Finally, Bardzell lays out the qualities of feminist interaction. They include Pluralism, which focuses on exploring a multiplicity of viewpoints and experiences. She places this in square opposition to the universality of HCD, "The quality of pluralism refers to design artefacts that resist any single, totalising, or universal point of view." (Bardzell, 2010)This element specifically connects to the other research mentioned above from disability studies, which seeks to resist universalized portrayals of disability. Participation is another key element of feminist HCI practice, "The quality of participation refers to valuing participatory processes that lead to the creation and evaluation of design prototypes." (Bardzell, 2010) This element of inclusion specifically feels relevant to resist the creation of technological prototypes from Liz Jackson's research on disability dongles. (Jackson et al., 2022) If any disabled users were included in the design process, they would likely challenge the use of some of the prototypes, such as the robotic wheelchair which goes up steps backwards that Liz Jackson showed in her original tweet. (Jackson et al., 2022)

Figure 9 The scewo is a self-balancing wheelchair that can go up and down stairs. (designboom, 2017)

2.22 Xenofeminism

Xenofeminism, as defined by Laboria Cuboniks, understands that the viability of emancipatory abolitionist projects–the abolition of class, gender, and race–hinges on a profound reworking of the universal. (Cuboniks, 2015) According to Cuboniks, the universal must be grasped as generic, which is to say, intersectional. Intersectionality is not the morcellation of collectives into a static fuzz of cross-referenced identities, but a political orientation that slices through every orientation, refusing the crass pigeonholing of bodies. This is not a universal that can be imposed from above, but built from the bottom up – or, better, laterally, opening new lines of transit across an uneven landscape. This

non-absolute, generic universality must guard against the facile tendency of conflation with bloated, unmarked particulars–namely Eurocentric universalism–whereby the male is mistaken for the sexless, the white for raceless, the cis for the real, and so on. Absent such a universal, the abolition of class will remain a bourgeois fantasy, the abolition of race will remain a tacit white-supremacism, and the abolition of gender will remain a thinly veiled misogyny, even–especially–when prosecuted by avowed feminists themselves. The absurd and reckless spectacle of so many self-proclaimed 'gender abolitionists' campaign against trans women a reprehensive example of the failure of feminist practices to embrace diverse bodies which deviate from what they deem biologically acceptable women.

By incorporating intersectional feminist values and perspectives, the design process can become more inclusive and sensitive to the unique cognitive and sensory experiences of disabled creators. This, in turn, would lead to more innovative and empowering tools that support a multiplicity of ways of interpreting and engaging with their environments. In essence, the combination of Feminist HCI and Xenofeminsm with the research on Material Engagement Theory and Epistemic Action could lead to a more comprehensive understanding of how to create technologies. By embracing the multiplicities of experiences that acknowledges that, just as the social model of disability identifies the environment as a place which can disable bodies, tools can disable their users through a similar failure to be inclusive and critical of their impact on bodies and minds.

These perspectives open space to question how games controllers could be changing player cognition, both in games and after playing them. The history of game controllers causing disability and physical pain is well documented in eSports and games literature. (Booth-Malnack, n.d.; McGee, 2021) If traditional game controllers are disabling, what other form factors could we use and how could these interfaces and tools change player cognition? If Isbister is focusing on creating social cohesion through her games which use non-standard input systems, can game design with alternative interfaces support positive social environments?

2.23 Entangled Crip Futures

Entanglement in HCI, as developed by Chris Frauenberger, refers to the complex and interconnected relationships between humans, technology, and the environment. (Frauenberger, 2020)This concept emphasizes the idea that people, technologies, and contexts are interwoven and mutually influencing one another, rather than existing as separate entities. In HCI, entanglement suggests that the design and use of technology cannot be understood or analysed in isolation. Instead, the interactions between users and technology are deeply embedded within broader social, cultural, and environmental systems. The concept of entanglement highlights the importance of considering these complex relationships and interdependencies when designing, evaluating, and studying technologies. It also emphases a deep need for ethics and responsibility in design. Entanglement in HCI can manifest in various ways, such as:

- the co-evolution of humans and technology, where technology shapes human behaviour and thinking, and human needs and desires drive technological development.
- The socio-technical assemblages and systems, where technology is not just a tool but an integral part of human society and culture, affecting social structures, communication, and values.
- The ecological perspective, where technology is seen as part of a larger ecosystem that includes users, other technologies, and the environment, all of which are interconnected and constantly influencing each other.

By recognizing entanglement in HCI, researchers and designers can better understand the complex dynamics at play and develop more holistic, inclusive, and contextually sensitive solutions. He, like Malfouis, focuses on how our tools shape us in turn. “Humans and technology are ontologically entangled; they are mutually constitutive. Who we are is shaped by the tools we create for us.” What this points to are the ways in which the games and their interfaces change us as individuals. If this is the case, UCD and Design Thinking for universal mythical abstracted and idealized users becomes a questionable way to answer design questions. Instead of asking how technology interfaces should work, perhaps the bigger question is, “Does the technology we design make us who we want to be?” (Frauenberger, 2019)

Frauenberger focuses what he terms Meaningful Design which encompasses the political mattering of things through which people make sense of the world. He also centres on Participatory Speculation which encourages speculation on future sociotechnical configurations. Speculation and creating design work now in conversation with communities becomes a way to propose alternative ways of being and experiencing the world through provocation, as Franchesca Spektor and Sarah Fox did through imagining crip futures.

Another important example of Participatory Speculation is the Protopia Framework stewarded and led by Monika Bielskyte and a community of thinkers and visionaries who imagine a generative, positive version of the future where the world centres voices at the intersections of Black feminism and Indigenous, Queer and Disability activism. It directly counters the dystopia technological future and instead offers a bold new vision. “At @protopiafutures, we have taken a significant departure from the original framing of “better futures” via the route of incremental technological innovation to proactive prototyping of radically hopeful and inclusive futures that shifts the gaze from technological panaceas to focus on future cultural values and social ethics.” (Bielskyte, 2023) I am one of the contributors to this community that collectively imagines a better world. Through creating entangled, radical technology that helps to lay the groundwork for a future I want to live in, I am proposing new ways of being. Kafer writes about the pressing need for imagining and proposing disabled futures in her work in *Feminist, Queer, Crip*. Her writing on the future points out that often, in technological solutionist futures, disability is cured. This has the inverse effect of positioning disabled futures as existing only in dystopian worlds. (Kafer, 2013, p. 2) The Protopia Framework reclaims the future by seeing disabled experiences as a source of generative hope creating a more equitable society.

2.24 Crip HCI

Crip HCI is part of a broader movement within HCI that grew out of the work mentioned above on common cyborgs and entanglement. Situating itself within the Interactions Magazine, it firmly locates itself as provocation within the academic HCI Association for Computing Machinery (ACM) space as a means to prompt change within the research community. It aims to critically examine the role of technology in perpetuating or challenging social inequalities and to promote more inclusive and equitable design practices. Central to crip HCI is the recognition of the positionality of research within various sociotechnical meta-contexts, including society, scholarship, research, and design inquiry and practice. The practice of articulation within disabled communities, disabled spaces, and disabled consciousness is essential for fostering a more equitable, just, and humane HCI practice.

The perspectives and experiences of people with disabilities and the designers collaborating on projects for disabled communities are shaped by broader social, cultural,

and political contexts. This approach emphasizes the importance of centring the experiences, needs, and perspectives of people with disabilities in research methodologies and reflecting on the positionality of the researchers themselves. This includes recognizing and addressing potential biases, assumptions, and power dynamics that may influence the research process and outcomes.

Crip HCI situates disabled designers as experts with unique knowledge, based on the idea that disabled people, as "common cyborgs" (Weise, 2020) are inherently entangled and articulated within sociotechnical hybridities, giving them unique onto-epistemic expertise and insight into the consequences of HCI work.(Williams et al., 2021) By acknowledging these aspects, crip HCI aims to foster a more nuanced and inclusive approach to HCI, addressing the unique experiences and needs of people with disabilities.

2.25 Crip Methods and Cripistemologies

Louise Hickman has developed an initial proposal for Crip Methodologies and laid the groundwork for elements crip researchers could consider when designing crip methods: crip temporality (including crip subjectivity, crip embodiment), access, an awareness of crip knowledge production, or Cripistemologies, as termed by Johnson and McRuer. (Johnson and McRuer, 2014) and an awareness of the political model of social disability as put forward by Kafer. (Kafer, 2013)

Hickman and Serlin establish the importance of crip temporality as it relates to knowledge. Commonly called crip time, this quality focuses on how disabled people often have different tempos at which they experience and participate with the world. “We believe that any future of critical disability studies must engage the shifting temporal registers inherent in the daily bodily experiences of crip subjectivity.” They go on to remind the reader that Alison Kafer emphasizes that the future is written on her body. Kafer argues all forms of disabled embodied subjectivity resist disability histories that are written for us but not by us. They also reference Christine Miserandin’s theory on daily spoons. his concept is a visualisation of crip energy levels on any given day and much energy is left. People with chronic diseases get fewer spoons than the average person every day and how they spend their energy is a negotiation. This makes an argument for the pacing of crip HCI research and how it might vary from traditional forms of HCI. Studies might need to be flexible with their schedules and demands and less defined than they are in other methods.

Cripistemologies are the study of how we know what we know about disability and how disability produces knowledge and makes or unmakes both academic knowledge and connections. Hickman looks at ways in which Cripistemologies are a means of knowing and navigating the world through the experience of disability. It focuses individual experiences of time, space, and place shaped by practices of survival rather than by ableist aspiration of an idealised recovery. This recommendation opens space for conversations around who should be researching within the community and how they are positioned. Should disability research be conducted by abled bodied researchers? How do disabled researchers bring sensitives and abilities into understanding crip data that would not be considered by someone who does not experience time, space and place the way a member of the community might? “As crip scholars, how do we insist on being the ones who not only “talk back” to researchers but who develop, or co-develop, the research questions that animate research methods?”(Serlin and Hickman, 2019a) How is knowledge formed within our communities what sort of crip HCI can work against solutionist approaches to fixing disability? This opens a tantalising possibility of looking at glitch, failure, breakdown as qualities to design with not against.

According to Hickman, access is key – who can access research, and is academic research an inaccessible form of knowledge production? How can a study consider access needs within its design and what flexibility can be incorporated to increase access? Also, how can access be engaged with critically thoughtfully, and creatively? Do captions need to directly follow the words spoken or is there room for artful and critical interrogations of how meaning is communicated? How is access created and who is doing that labour? What is the connection between care workers, sign language translators and caption providers in any given situation? She uses the example of how D/deaf and Hard of Students participate in the production of access in a complex and de-centered distribution of labour through sign language and or/real time captions provisors in the classroom as an example. Creating access requires situational knowledge. When designing research how can a researcher consider the ways in which people participating within the community are contributing to the production of knowledge? What is the relationship between research and caption and sign language workers? How is access considered within knowledge generation? “The multiple scales involved in these forms of access-making indicate that crip methodology can be instrumental in developing a transdisciplinary map of multiple perspectives as well as multiple forms of mediation.”(Serlin and Hickman, 2019a)

Kafer's political model considers the complex intersections of disability with other aspects of identity, such as race, gender, sexuality, and class. It recognizes that disability is not an isolated aspect of a person's life but is intertwined with multiple layers of oppression and marginalization. The political model aims to challenge the systemic and structural barriers that perpetuate ableism, as well as other forms of discrimination and exclusion. By incorporating intersectional feminist and queer perspectives, Kafer's political model of disability demands a more comprehensive and inclusive understanding of disability experiences. It calls for a greater focus on activism, social justice, and political engagement to address the root causes of disability oppression.

2.26 Activist Affordances

In *Activist Affordances*, Arseli Dokumaci expands upon Gibson's concept of affordances as they relate to the experiences of disabled people. She highlights how the environment around an individual can shrink based on their experience, altering the possible affordances it presents. For people who experience chronic illness or chronic pain, their environment or contracts have fewer possibilities compared to those who do not live with these conditions. She explains that the environment can contract and become less accessible due to ableism functioning as a form of habitus - an "embodied history, internalized as a second nature and so forgotten as history."

Dokumaci uses the idea of design constraints, as first introduced by Charles Eames, to explore how such constraints are an inherent aspect of the lives of disabled people. These constraints can inspire creative solutions for survival. As seen in the example of Cindy above, disabled individuals often hack their environments, activating affordances as a means of resistance, adaptation, and survival. (Dokumaci, 2023) Dokumaci's concept of "activist affordances" concept diverges from Gibson's "affordances" by describing possibilities of action that are remote and unlikely to be perceived yet are actualized through ingenuity and effort to ensure survival.

Crucially, Dokumaci emphasizes that these adaptations are not proposed in makerspaces or design studios by expert designers disconnected from disabled experiences. Instead, these possibilities emerge from the lived experiences of disabled individuals. She writes, "The worlds that we build with our activist affordances do not require blueprints, pillars, or

concrete to exist. They come into being through our bodies and imagination as we engage with the material world." This perspective acknowledges the unique expertise and creativity that disabled individuals bring to the process of designing and adapting their environments. (Dokumaci, 2023)

By contrast, in games a reference which explores looking at game controllers and how they function in games is *Game Feel* by Steve Swink." It delves into the concept of how video games create a sense of tactile and visceral engagement for the player. Swink explores the various elements that contribute to this immersive experience, such as control schemes, visual and audio feedback, and game mechanics. The book emphasizes the importance of designing games that evoke a strong sense of "feel," as it greatly impacts player enjoyment and satisfaction. He links embodied interaction to the kinesthetic relationship between the player's physical environment and a game environment to what he terms Game Feel. An elusive characteristic “Game Feel exposes feel as a hidden language in game design that no one has fully articulated yet.” Game Feel is an element of game design he proposes everyone understands instantly but is difficult to explain. He defines it as “the tactile, kinesthetic sense of manipulating a virtual object. It’s the sensation of control in a game.”

When compared to the idea of the embodied history of disabled people above, there are many open questions. The most obvious is made clearer through the library of game controller hacks within the Controller Project. What hacks have these controllers undergone to be useable for disabled players? How does the game environment that is assumed connect to the lived experiences of people with different disabilities in the same way? Are these game controllers and the way they are tuned to feel extend the habitual ableism proposed in Dokumaci’s writing?

2.27 Game Accessibility Now

Many game developers have started incorporating accessibility features in their games to cater to the diverse needs of players, including those with disabilities. Some primary features that make games more accessible can include but are not limited to:

- Customizable controls: Allowing players to remap controls to suit their individual needs and preferences can make games more accessible to those with mobility impairments or who require alternative input methods.
- Adjustable difficulty levels: Providing different difficulty levels or customizable difficulty settings can make games more accessible to a broader range of players, including those with cognitive or motor impairments.
- Visual and auditory accessibility options: Offering options like colorblind modes, adjustable text size, high-contrast settings, and subtitles can help accommodate players with visual impairments. Similarly, providing volume controls for individual sound elements, visual cues for auditory events, or alternatives to sound-based mechanics can make games more accessible for players with hearing impairments.
- Assist mode: Some games include an "assist mode" or similar feature that provides players with additional support or assistance, such as unlimited lives, invincibility, or simplified gameplay mechanics. This can make games more accessible for players who may struggle with standard gameplay due to physical or cognitive disabilities.
- Controller support: Ensuring compatibility with various input devices, such as adaptive controllers, touchscreens, or eye-tracking systems, can make games more accessible to players who may require alternative control methods.
- Tutorials and in-game prompts: Providing clear instructions, tutorials, or prompts can help players understand the game mechanics and make the game more

accessible to those with cognitive or learning disabilities.

- Adjustable game speed: Allowing players to adjust the game speed can make fast-paced games more accessible to players who may have difficulty reacting quickly or need more time to process information.
- Closed captioning: Providing closed captions for in-game dialogue and sounds can help players with hearing impairments to better understand and engage with the game's narrative and audio cues.

However, what does game accessibility look like when it begins at the design stage? When designers consider the diverse embodied experiences of players and challenge the assumptions of relatability through play, what emerges? By incorporating the perspectives of both Swink and Dokumaci, we can argue that the current game design landscape often neglects the diverse needs and experiences of disabled players, thus perpetuating an ableist virtual environment through control schemes. This ableist environment stems from the deeply ingrained belief systems, habits, and dispositions that favour certain bodies and minds over others, thereby excluding alternative ways of moving, sensing, and behaving in the virtual world. It is the same failure Donald Norman presents when proposing the idea of a Natural User interfaces. Natural for whom? Who experiences these proposed virtual spaces and control schemes of games as natural to use?

It is essential for game designers to critically examine their design choices and ensure diverse perspectives are present during the game design process. The hacks offered by The Controller Project are evidence that activist affordances have found a place in games despite the efforts made for accessibility. There is an urgent need to re-evaluate the game design process, exploring ways to design games with values informed by the lived experiences of disabled gamers and integrating these values into the mechanics and controllers themselves.

2.28 The evolution of design patterns in Game Controllers

If game controllers are extending abled notions of embodiment and virtual space, what are their common design patterns? A user experience review of videogame controllers and their designs reveals the dominant design patterns that inform these practitioners and yields understanding of the role of novel controllers in the field. By taking an intentionally historical stance, it is possible to explore the community of practice which has arisen around hacking and creating game controllers. Hardware DIY games creators bring together their interest in firmware, hardware and software design, games, creative practice, and user experience to produce cultural objects. We will look specifically at three patterns via three categories of game controllers: handheld console controllers, natural controllers, and embodied controllers.

2.28.1 Pattern One: The Handheld Console Controller

Handheld console controllers involve pressing a button to control a game mechanic and have come a long way since early games like *Tennis for Two* and *Pong*, which employed knobs and buttons to control simple movement along a single axis (Burnham and Baer, 2001). Later games, such *as SpaceWar!* and *Asteroids*, introduced analogue sticks for navigating in 3D space, like the motion of the 'Knob' in earlier controllers. (“Gamasutra - Atari: The Golden Years -- A History, 1978-1981,” 2020). In 1969, Sega's arcade game *Missile* featured a joystick with a fire button, a design that Atari later adopted for its home console release. (Burnham and Baer, 2001) The joystick was eventually replaced by the D-pad, a cross-shaped control that relied on players' mental models of cartesian grid systems for navigation.(Swink, 2008) This control scheme connected users'

proprioception, or their sense of body position and movement, to the virtual game world. (Swink, 2008) The proprioceptive sense is the one through which humans can sense position, movement, and the relation of their body to other objects in space.

The evolution of console controllers has led to dominant designs like those seen in Xbox and PlayStation controllers, which retain similar systems of navigating virtual space. (Swink, 2008) These designs have incorporated haptic feedback and capacitive touch surfaces for enhanced player experience. The PS5 controller promises further innovations, such as resistive feedback, accelerometers, and gyroscopes (Sony, 2020). Marcotte coined the term "Controller Literacy" to describe how game designers assume players' familiarity with controller use based on prior experience. However, Skalski et al. (2011) found that players enjoy abstract game controllers more than natural ones in certain games, suggesting that games have come to rely on this literacy and anything that disrupts it might disrupt player expectations a game's detriment. As new titles build upon previous successes, game designers create products for existing audiences with familiar controller conventions in mind, working within the constraints defined by previous games.

2.28.2 Pattern Two: The Natural Controllers

The second design pattern in gaming relates to players' proprioceptive awareness and familiarity with objects outside the game. Diegesis is used to convey information to players through elements embedded in the game narrative. Naturally mapped controllers, such as steering wheels (Thorpe et al., 2011) and light guns (Burnham and Baer, 2001), were designed for specific games. To compete with home consoles, arcade machines evolved to incorporate realistic objects and experiences, such as full-sized motorcycles and advanced light guns (e.g., Silent Scope). Sega's Dreamcast explored naturally mapped and embodied interfaces, creating games like *Dance Dance Revolution* and *Samba De Amigo* that used performative and tangible interfaces (Hornecker, 2020). These examples showcase how videogames have been instrumental in introducing tangible computing interactions to global audiences in both arcades and homes. Tangible computing is a field within human-computer interaction that focuses on the use of physical objects and environments to facilitate digital interactions, effectively bridging the gap between the digital and physical worlds. By designing interfaces that are context-specific and physically interactive, games like *Dance Dance Revolution and Samba De Amigo* exemplify tangible computing in the gaming industry. (Fitzmaurice et al., 1995; Ishii and Ullmer, 1997)

Figure 10 The Samba De Amigo Dreamcast Maracas. (“Samba de Amigo Maracas Controller,” 2023)

2.28.3 Pattern Three: Embodied Controllers

From the mid to late '80s, gaming interfaces began incorporating sensing technology and design patterns for embodied interaction. Notably, Atari developed the MindLink (1984), an unreleased brain-computer interface, while Bandai introduced the Family Fun Fitness (1986), a floor controller for interactive play (“The Atari Mindlink System,” 2020).

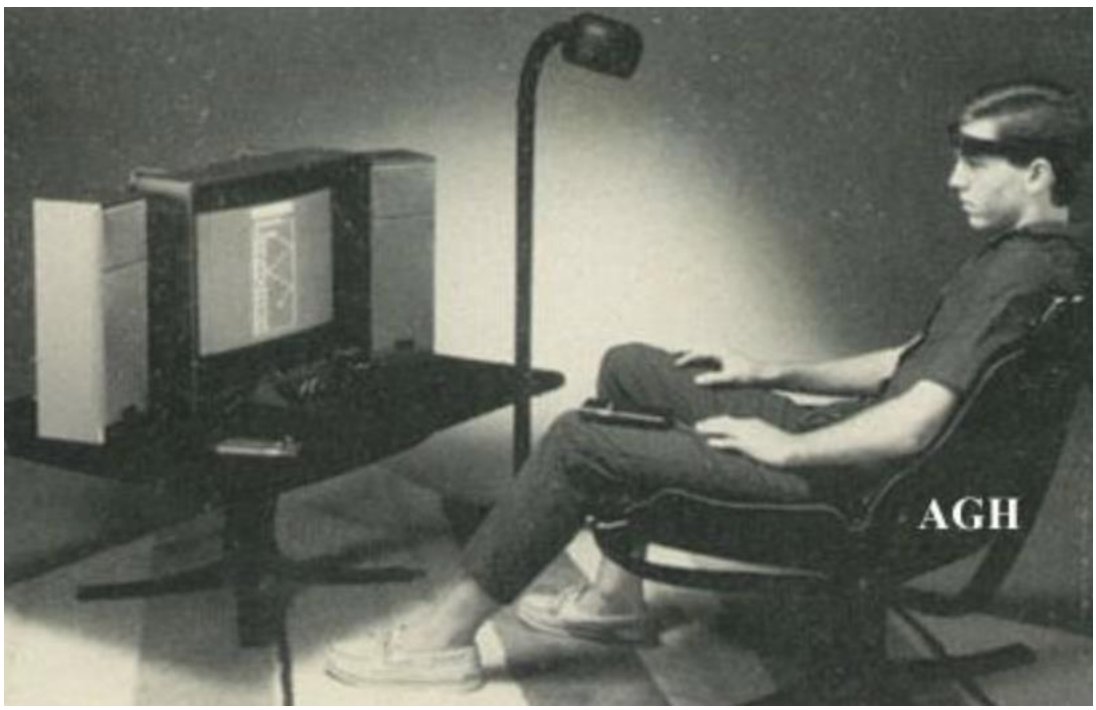


Figure 11 The Atari Mindlink (“AGH Museum -- Mindlink,” 2023)

Infrared tracking saw several iterations such as Nintendo's U-Force (1988) and Sega's Activator (1993), though their precision was initially questioned. Microsoft Kinect (2010)

refined this technology, using depth and video cameras for skeletal tracking and gesture recognition (“Don’t Touch This Horror of A NES Controller,” 2020; “Sega Activator (Accessory),” 2020; Kean et al., 2011).

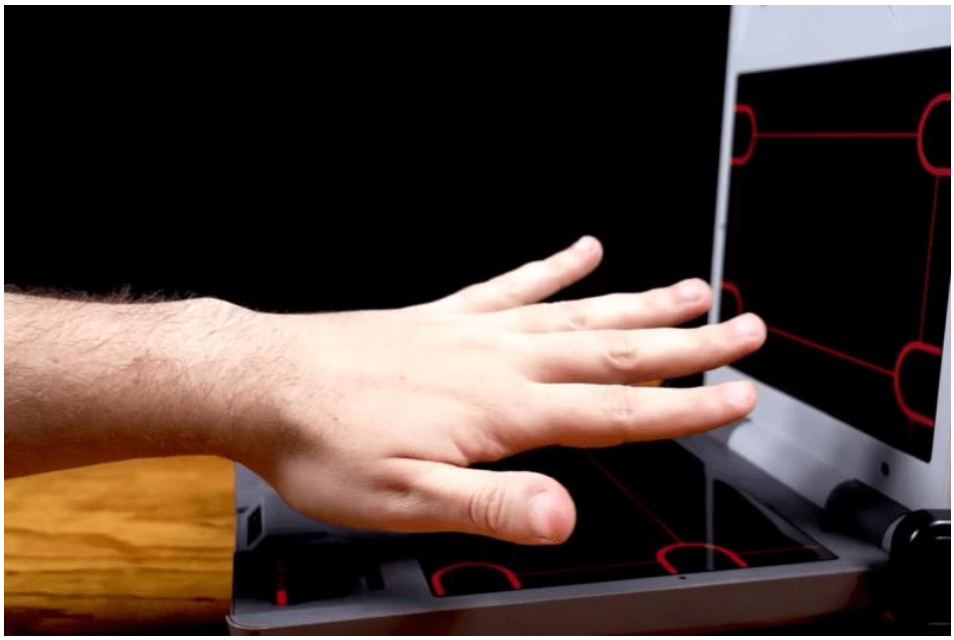


Figure 12 The U-Force Interface (By, 2022)

Glove controllers, like the Nintendo Power Glove (1989), offered specialized control for media applications, with recent examples including the Mi.Mu glove for music technology (“Success Born of Failure,” 2015; Snook, 2014).

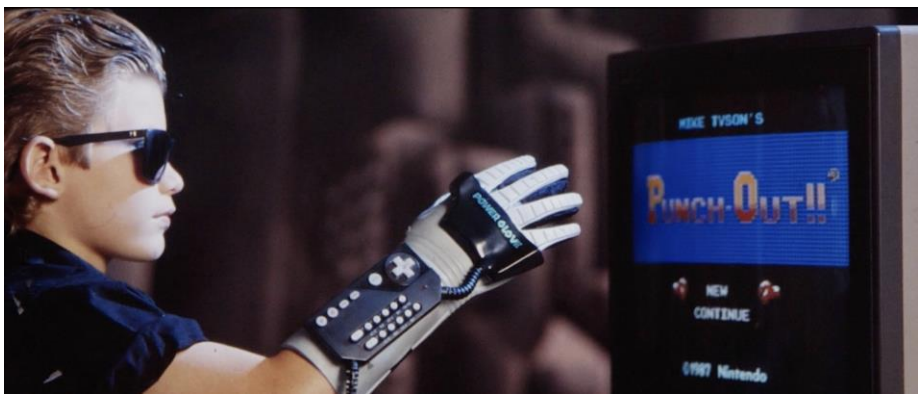


Figure 13 An early advertisement for the Power Glove, c. 1989

Nintendo achieved mass-market popularity with the Wii (2006), combining various design patterns for a diversified gaming experience. Their success, along with the iPhone launch, opened the gaming market to casual gamers who found traditional controllers challenging (Juul, 2010).

Sony ventured into embodied controllers with the PS Move (2009) for PS3 and PS4, embedding inertial measurement units and using computer vision for player tracking. This evolved into the PS5 DualSense (2020) controller. Despite these advancements, console manufacturers limited access to their proprietary systems, with Microsoft only releasing a Software Development Kit after the Kinect was hacked by the open-source community.

However, most of these systems were eventually hacked, showcasing the enthusiasm of unlicensed software creators (Kean et al., 2011).

In parallel to these developments, virtual reality (VR) headsets such as the HTC Vive (2016) and the Oculus Rift (2016) popularised VR embodied controllers and interaction with their unique controllers linking the VR world to the embodied experience. The Vive's controllers were lauded for their precision and immersive feel, featuring a trackpad, trigger, and grip buttons, which allowed players to interact with the virtual environment. On the other hand, the Oculus Touch controllers mimic natural hand movements with their analogue sticks, triggers, and action buttons. These controllers coupled with the headset's tracking systems, aim for high levels of immersion.

2.29 Open-Source Hardware and Software

The Basic Stamp microcontroller, housing a small CPU and limited memory storage on a ROM chip, served as an early foundation for DIY creators developing custom software and hardware systems. Capable of communicating via a computer's serial port, it paved the way for custom peripherals, opening possibilities beyond the confines of proprietary hardware. (Benchoff, 2015) Nintendo's early embodied controllers particularly captivated this group, spawning an online community of hackers. Devices like the Gold Brick, Age Box, Minelli Box, and PGSI emerged, serving as serial bridges connecting the controllers to personal computers. (“Power Glove FAQ,” 2020)

This movement was no coincidence; it was the output of a generation raised on video games and digital technology. Many creators of this era trained at pioneering interdisciplinary computing departments such as Parsons School of Design, NYU ITP, MIT Media Lab, and Carnegie Mellon University's Entertainment Technology Center, among others. These departments mixed traditional art or architecture tools with engineering equipment, including the Basic Stamp microcontrollers. (Maeda, 2004)

Artists and educators in these institutions also sought to enhance programming and engineering accessibility. The Aesthetics and Computation Group at MIT Media Lab, with students Casey Reas and Ben Fry, created Processing—a java library embedded in a simplified Integrated Development Environment (IDE). It aimed to make coding an artistic practice and simplify programming, making it more accessible to artists. (Reas, 2007)

In 2004, Hernando Barragán, under the supervision of Reas and Massimo Banzi, created Wiring to facilitate hardware programming. Barragán used microcontrollers on the hardware side (ATmega 128) and simplified engineering terminology. Later in 2005, Banzi, along with David Mellis and David Cuartielles, added support for the less expensive ATmega8 microcontroller to Wiring and forked the source code into a separate project called Arduino. Arduino's simplicity expanded its appeal beyond artists, attracting educators and young creators. It continues to support serial communication with Processing and Wiring. (Barragán, 2019)

During this same period, hackerspaces gained popularity in part thanks to initiatives in universities, and hardware and software initiatives such as those mentioned above. Interest also came from K-12 educators who wished to use these same approaches to teach children STEAM (science, technology, engineering, arts, and mathematics) related skills. (Blikstein, 2013). Make Magazine, started in 2005, focused on the intersection of hardware hacking, artists, educators, and learners and reached a wide audience. Their event, Maker Faire, became a multi-city, worldwide exhibition for work created from this community, connecting people across a range of disciplines. The term ‘makers’ was coined by Make magazine, and is often used to describe this broader intersection of

cultural and education work more widely. (“Maker Movement | Deloitte US | Center for the Edge,” 2016)

During this period, the Kinect, PSMove, and Nintendo Wii were all released. As already mentioned, all three of these system's controllers were rapidly hacked and repurposed by independent game developers and media art communities. The Kinect hack is of particular interest because Adafruit, an NYC distributor of electronics and educational resource for making culture, created a prize for the first person to hack the Kinect on 1st November of 2010, which was only ten days after release. (Kean et al., 2011).

The Kinect hack, alongside a release of a Processing library for use with the Kinect, let artists and art games creators easily make embodied works. The ease of use of this tool and the technological fluency of this community inspired many games for which exhibition is the only means of distribution. As a result, many of these games were shown at MakerFaire, including the work I made with Nick Fox-Gieg, *Nightmare Kitty*. (Perry and Fox-Gieg, 2011) Makerfaire awarded the game three blue ribbons for Best in Show in 2011. (“Blue Ribbon Winners,” 2011) In *Nightmare Kitty*, players are a balloon hunted by cats with sharp claws falling from above. The goal is to stay alive and, if players land on the cats once they reach the ground, the cats can be popped by sitting on them and standing up quickly. This repeated movement from being in a lower-power position to a high-power one (Carney et al., 2010), was an early effort to explore generating positive emotions through embodied play using gesture tracking with interactive machine learning. The mechanic conveys the idea that players can recover from fear, if they do not let it control them.

Figure 14 Screen from Nightmare Kitty Gameplay (Perry and Fox-Gieg, 2011)

2.30 Independent Games Community and the Rise of the Alt Ctrl Game Genre

Independent games communities began to develop concurrently with history of videogames. Macromedia, and later Adobe Flash led to a flurry of online-based games between 1999 and 2012. (Reeves, 2018) It is worthwhile to note that with Flash, Serial communication with Arduino became possible within desktop applications authored by

these indie creators.(Kean et al., 2011) This innovation paved the way for games to not only use standard input systems but custom ones designed by creators. (Reeves, 2018)

The designers creating these works adopted the terminology of “Independent” musicians, and the genre of "Independent Games", or Indie/Indy games began to appear in videogames culture. Bennet Foddy notes that the notion of ‘indie games” surfaced in mainstream games vernacular around 2005, and that it gained both critical attention from galleries and industry alike at this time. However, he also points out that this wave of creators had been slowly building since the mid 80's and the idea that indie games were a new movement was flawed.(Foddy and IndieCade, 2014a) He also indicates that Indy games were often associated with terms such as personal, cool, intellectual, artistic, creative, artistic, niche, pretension, weird, cheap, and that in these communities, creators made no money and had no publisher.

Indie game content is known to be diverse. Well known examples include the nightmares of an average English person, wizards turned into balls by a curse, and hallucinogenic camels from space (Minter J, Attack of the Mutant Camels, 1983), although the latter was considered a mainstream title for the Commodore 64 home console. (Anamnesia, 2010) Controllers for early indie PC games largely consisted of joysticks and paddles, as well as hacked versions of some of the controllers mentioned above. In the space of naturally mapped interfaces for PC games, Konix, a British manufacturer of computer peripherals, made an array of controllers. The *Speedking* and the *Navigator* both featured a microswitch-based joystick. Their popularity and rapid growth culminated in the *MultiSystem*. This game console was a modular system of different controllers, such as steering wheels, a light gun, handlebars and even a motorized rolling chair. (Konix Multi-System Archive, 2019)

As some of these games made by single creators gained attention, galleries began to show interest in exhibiting them as cultural objects. In 2001, the independent hardware videogame, *PainStation* was created. The title was intended as an ironic reference to the Sony PlayStation. Two students at the Kunsthochschule für Medien Köln (Academy of Media Arts Cologne), Tilman Reiff and Volker Morawe, developed the two-player game in 2001 as an interactive art object. *PainStation* is described by its creators as “a torture device created by the artists' group "/////////fur//// art entertainment interfaces." It is built using an Apple computer, programmed in Director and C++. It features a custom hardware interface which slowly heats up and physically burns the players when they miss a ball. On the surface, this project looks like a traditional two-player arcade console. Both players have access to knob controllers where they play a two-player Tennis game much like Pong. Next to the screens are two metal plates players must put their hands on to play. The player who lifts their hand off the metal surface first loses. With every ball the player misses, their metal plate slowly increases in temperature. Players report sensations ranging from slight discomfort to second-degree burns. This ironic reading of player competitiveness physically punishes players for aggressively playing beyond their own pain endurances.(“The artwork formerly known as PainStation,” 2020)

2.31 Procedural Rhetoric and Play

What is a framing for understanding when a game's system is a provocation, a question, or an exploration of an idea? Bogost, in his book *Pervasive Games*, describes this as procedural rhetoric. (Bogost, 2010) Leaning on Janet Murray's definition of a procedure as "defining ability to execute a series of rules," he proposes this is what separates software from other forms of culture. Software can be seen as analogous to metaphors in literature. (Murray, 2017) Bogost expands on this idea in *How to do Things With Videogames.* (Bogost 2011) He calls games such as PainStation “Procedural Games”, or art games.

Indeed, in *Hamlet on the Holodeck*, Janet H. Murray outlines four essential properties of digital environments, the first of which is their procedural nature. This characteristic refers to the ability of these environments to execute a series of rules. As Murray states, "Procedural environments are appealing to us not just because they exhibit rule-generated behavior, but because we can induce the behavior." (Murray, 2017)

Procedurality offers a powerful tool for game designers. By leveraging the procedural nature of digital environments, they can create gameplay rules and mechanics that encourage specific behaviours in players. For instance, one might design a game that promotes prosocial behaviour. This can be seen in numerous indie games that create and emphasize mechanics that encourage cooperative play, communication, and other positive social behaviours. Such games can contribute to building a more inclusive and positive community among players. This approach to game design aligns well with the aims of intersectional feminism, as it seeks to foster environments that are inclusive, diverse, and respectful. It's an example of how the procedural property of digital environments can be harnessed to promote positive societal values and behaviours, both within and outside of the gaming community.

Bogost takes this forward into a conversation on how mechanics can create feelings within art games. "In art games like the three in question, a procedural rhetoric does not argue a position but rather characterizes an idea. These games say something about how an experience of the world works, how it feels to experience or to be subjected to some sort of situation: marriage, mortality, regret, confusion, and so forth." (Bogost, 2010) Going one step further, he describes procedural design. "The goal of the proceduralist designer is to cause the player to reflect on one or more themes during or after play, without a concern for resolution or effect." Finally, he categorises games such as these as procedural games.

2.32 Procedural Rhetoric and Alt Ctrl

One could argue that *PainStation* does something entirely new with game design. It embeds the mechanics directly into the hardware interface married to the game's procedural rhetoric. Borrowing an idea from Marshall McLuhan's "the medium is the message," the hardware mechanic is the meaning. (McLuhan, 2008) *PainStation* could be considered the very first game of the alt ctrl genre. The elegant symmetry of referencing the first-ever videogame game with this novel ideological pairing of the interface to the procedural rhetoric marks out *PainStation* as an important work. *PainStation* was curated into galleries internationally and received the Prix Ars Electronica 2002, "Anerkennung/Interaktive Kunst" (Acknowledgement/Interactive Art). The interface is being used not only as a control surface but as a narrative framing - it moves beyond the definition of only a control surface. This embedding of game's rhetoric into experience design via bespoke custom controllers becomes a hallmark characteristic of Alt Ctrl games.

Figure 15 An image of PainStation (Morawe and Reiff, 2004)

Also of note is the work of Corey Archangel. Archangel was a classically trained musician who saw console cartridges and videogames systems and his instruments. (“Cory Arcangel | Super Mario Clouds,” 2020) Archangel hacked a Super Mario cartridge to remove all the game's graphical elements except from the clouds. The work is considered a meditation of games spaces, a nostalgic throwback, a hack of a commercial object, and a critique of videogames' intentions. The work gained popular appeal, and Edition two out of five was acquired by the Whitney permanently in 2002. (“Cory Arcangel | Super Mario Clouds,” 2020)

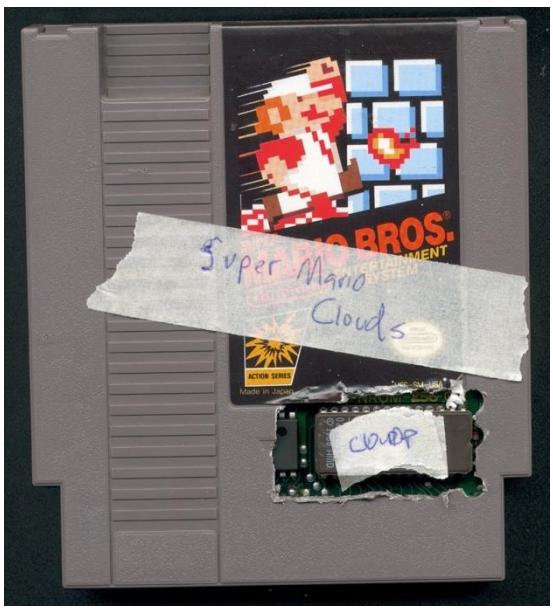


Figure 16 The hacked NES Clouds Cartridge (Arcangel, 2002)

Figure 17 Figure 16 Kaho Abe's Hit Me (Abe, 2011)

Another game in this style is Kaho Abe's Hit Me! Abe describes the engineering process as being linked to her art school experiences. She says, "I made the first iteration of Hit Me! in graduate school in 2005. It was made with a Basic Stamp II microcontroller, a hacked GE wireless doorbell system and the game itself was coded in Lingo using Macromedia Director. The plastic boxes were attached to fabric hats." On top of the box sits either a red or blue arcade button. Players start the game by being told by Abe to stand back-to-back. She gives the command "go", and they turn around at the same time. The first person to hit the button on the other person's head wins. What follows is a two-player physical match. The game then takes a photo of the face of the person who hits the other person when they strike. These photos are then exhibited in the gallery and shared on social media.

In *Hit Me!*, players are forced to confront many of their cultural expectations around gender, age, violence, and social settings. The game makes players attack each other to win. She exploits the player's desire to win with the social taboos of hitting others in public. The physicality of this game points directly at the violence taken for granted in videogames during competition. Matches visually remind players of Street Fighter. In 2011, Kaho became a resident at Eyebeam, iterating on this game as well as developing new work. Both above examples embody game mechanics into bespoke physical interfaces. This play also requires a social setting, and directly makes references to arcades, both through the arcade buttons and the performative nature of the play. Abe designs explicitly for exhibitions and social environments. Importantly, the mechanic delivers the game's meaning through the hardware interface. Kaho covers this history in her interview in Appendix D.

2.33 Metaphor in Games

In her insightful book, *Making Games*, Doris C. Rusch examines the potential of games as a medium to communicate profound aspects of the human experience. (Rusch, 2017) She provides tools for designers to translate personal experiences into impactful game designs, using the conceptual groundwork of metaphors, particularly as articulated by Lakoff and Johnson. Lakoff and Johnson, in their seminal work *Metaphors We Live By*, elucidate how metaphorical language shapes our understanding of concepts in relation to physical experiences. (Lakoff, 2003) A notable instance they discuss is the intertwining of time and money within Western capitalist cultures, evident in phrases like "spending time" or "running out of time." Lakoff and Johnson categorize our understanding of metaphors into several distinct types. The above examples are container, or boundary metaphors. (Lakoff, 2003)

Another variety is the Orientational Metaphor, for instance, "I feel down" signifies sadness, while "my spirits rose" embodies happiness. Rusch applies these embodied metaphorical concepts to game mechanics to support developing 'experiential gestalts.' An example she provides is the unexpected reversal of a control mapping scheme mid-game, symbolizing the necessity to relearn a behavior. By intertwining these experiential gestalts with the physical, embodied process of controlling the game itself, can Alt Ctrl games can surpass the mere implementation of mechanics to create meaning, as typically observed in procedural rhetoric? Can Alt Ctrl games effectively convey experiential gestalts through embodied experience, bringing a deeper layer of expression and understanding to the gaming experience?

Rusch gives an example of how games can utilize such experiential metaphors to tap into embodied experiences. She defines experiential metaphors as, “an analogy between gameplay and real-life experience evoked by what the moment-to-moment gameplay feels like." An instance she uses to illustrate this is the grappling hook sequence from the game "God of War". Here, the gameplay mechanics of the hook - releasing and reconnecting it - serve as a metaphor for the concept of 'letting go.' She correlates this in-game experience to her personal experiences with letting go in life.

Considering these examples, which are both examples of the experience of the controller in a game, it's plausible to posit that Alt Ctrl games, with their unique, bespoke controls, can further enhance the experiential gestalt, stretching it across not only the virtual in-game mechanic but also the tangible reality players experience while enacting the game mechanics physically. Consider the game, *Hit Me* by Abe. It prompts players to re-evaluate their relationship with violence. If we interpret the awkward moment of witnessing oneself inflicting harm projected on a wall at a party as amplifying an experiential gestalt, it could be seen as a call to the player to reconsider perpetuating violent experiences in their own lives and the lives of others. By transforming physical violence into a tangible lived experience and highlighting the aggressor's face in public, Abe challenges players to confront their experiences and acts of violence within the game space.

It is within this rich tapestry that indie hardware games began to take root. The media they choose are, by their nature, interdisciplinary. Common tools to create this style of games includes, but is not limited to, game engines, Arduino, Processing, Open Frameworks, Macromedia, then Adobe’s, Flash, soldering irons, sensors, motors, saws, and digital fabrication tools such as laser cutters, 3D printers, and CNC machines. (Reeves, 2018) (Thompson, 2021, p. 5) (Open Frameworks, 2023)

Some hacked commercial hardware indie games have also made their way on to traditional consoles. *Perfect Woman* by Lea Schoenfelder and Peter Lu was eventually released by Xbox for the Kinect controller after its initial festival success as a hacked

Kinect game. In *Perfect Woman*, players try to be perfect by fitting their body into various contortions to become the perfect woman. This game breaks apart stereotypes of sex workers, high-power UN officials, and working moms, among others, with these embodied mechanics. "*Perfect Woman* is a game about celebrating diversity and choice rather than condemning conformity. We hope to extend this philosophy outside of the game as well as we see games as a medium to promote acceptance, personal growth, community and love." (“Perfect Woman,” 2020) The experience gestalt of this game is a rejection of the need women feel to fit their bodies into the shape society dictates for them.

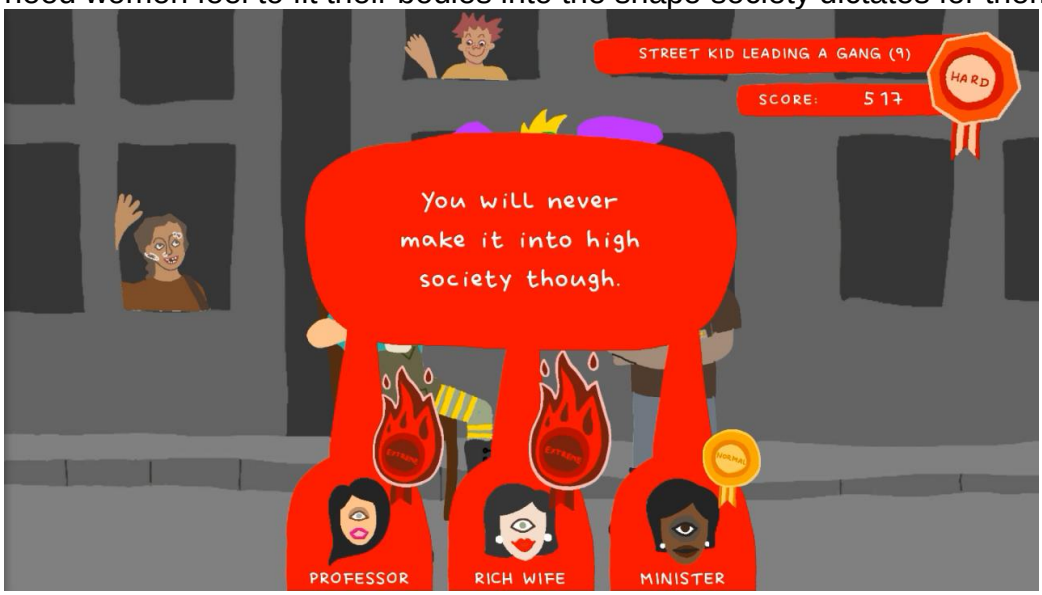


Figure 18 A screen from Perfect Woman (Schönfelder and Lu, 2014)

Furthermore, Doug Willson's *Johann Sebastian Joust*, made with a hacked PSMove controller software by Thomas Perl, gained enough of an audience to be released by Playstation for the PS3. It uses speed and position tracking of the body and tilt of the controller within the game. The game is a two-player combat game, much like Abe's *Hit Me!* Told to move at the speed of the game's audio, players hold their controllers vertically. The first player to force the other player to tilt their controller wins. The audio varies in speed during the game cycle. (“Johann Sebastian Joust,” 2020)

2.34 Defining and Naming the Alt Ctrl Genre

In 2012, I ran a game jam with Chris DiMauro at NYU at the Game Innovation Lab. This was the first game jam named as an *Alt Ctrl Game Jam* and is the first instance of the term Alt Ctrl this author has been able to find in the context of games. The jam was judged by Katherine Isbister, Kaho Abe, and Doug Wilson. The aim of this jam was to re-think how games could be made if the controller was designed. By asking players to consider making games without standard controllers during the jam it sparked a consideration of embodied and social experiences in many of the teams. The games that emerged from this jam presented a diverse range of social possibilities, including a multiplayer tank interface made of pipes and cardboard. In this game, players needed to verbally communicate and collaborate as a team to manoeuvre the tank around a child's bedroom and engage in combat with an evil bear. This approach to game design fostered social interactions and emphasized the importance of teamwork and communication among players. The social norms surrounding standardized input systems may not only constrain the input system itself but also limit the cognitive opportunities for connection that designers could potentially explore.

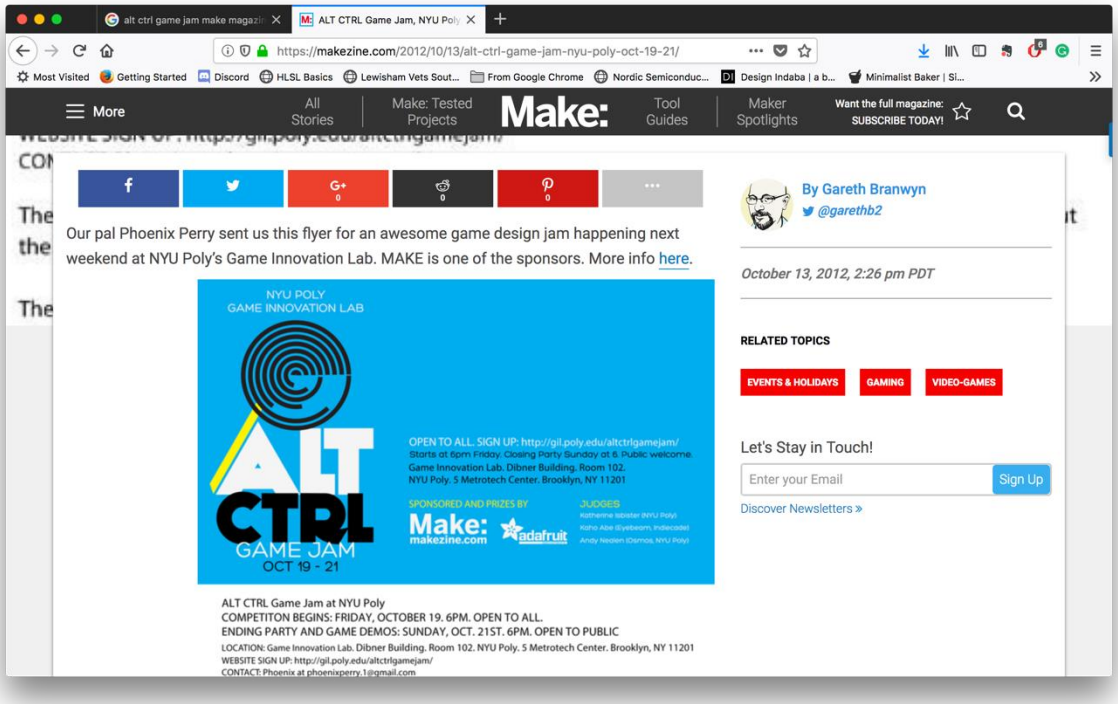


Figure 19 Make Magazine Screenshot showing the Alt Ctrl game jam information (“ALT CTRL Game Jam, NYU Poly, Oct 19-21 | Make,” 2012)

By asking players to consider making games without standard controllers during the jam, it sparked a consideration of embodied and social experiences in many of the teams. The games that emerged from this jam presented a diverse range of social possibilities, including a multiplayer tank interface made of pipes and cardboard for the game Tinker Tanks. (“Tinker Tanks – MIKE REN 任意,” 2015) In this game, players needed to verbally communicate and collaborate as a team to manoeuvre the tank around a child's bedroom and engage in combat with an evil bear. This approach to game design fostered social interactions and emphasized the importance of teamwork and communication among players. The social norms surrounding standardized input systems may not only constrain the input system itself but also limit the cognitive opportunities for connection that designers could potentially explore.

Figure 20 Shots of the Tinker Tank game, team and controller

This game jam's only rule was that games must be created, "without the use of conventional controllers." This game jam ran twice over two years at NYU. It was sponsored by Make and Adafruit, and the judges included Abe and Isbister. It also received press coverage in Make Magazine via Twitter and ended in an exhibit of work at NYU. (“ALT CTRL Game Jam, NYU Poly, Oct 19-21 | Make,” 2012) From this rich lab, Alt Ctrl games emerged.

Soon after we ran the first Alt Ctrl Game Jam at NYU in 2012 the genre of hardware games began consolidating under this moniker. During 2013, the jam was duplicated by permission of the game jam's founders. This also occurred in Russia in 2014, 2015, and 2017. (“Alt Ctrl Game Jam,” 2020)

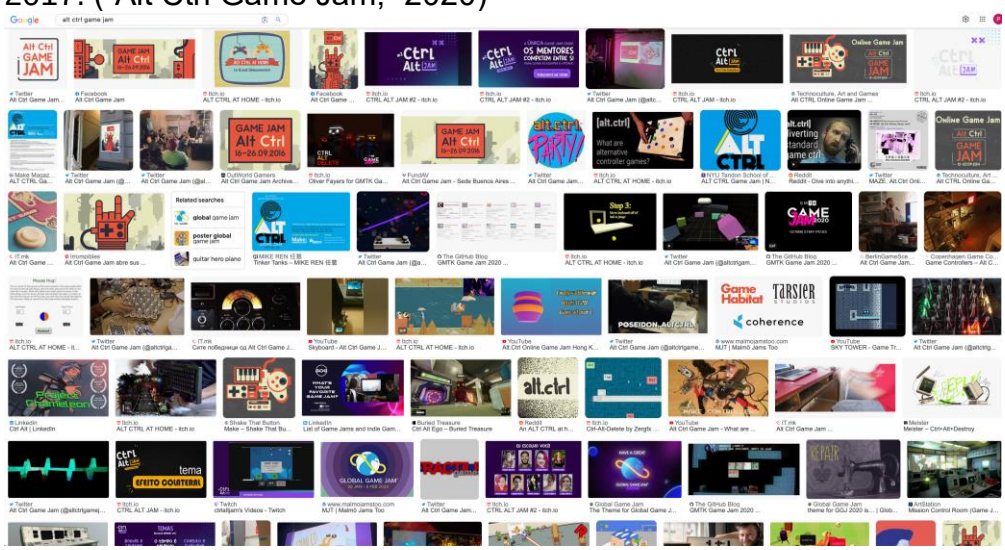


Figure 21 A Google Image Search done on June 15th, 2023, shows the widespread number of alt ctrl jams around the world.

The name quickly spread in Europe and the US. The Game Developer Conference cemented the name Alt Ctrl with an exhibition of these games in 2014 (Game Developer Conference, 2019). The Game Developer Conference's Independent Games Festival award category started in 2017. This level of professional recognition has served to consolidate the genre under the name. As is explained above, this genre's first emergence can be mapped back to the arrival of the basic stamp microcontrollers and includes the hardware games mentioned above.

As one of the founders of this genre, I feel at liberty to lead a conversation around coming up with a definition for the term. I put a call out for participants on my Discord community, the alt.ctrl.squad, which is a collection of 64 of the most active Alt Ctrl creators worldwide. We have members from Brazil to Russia in this group, as well as the curators of the GDC Alt.Ctrl exhibition, A Maze, We Throw Switches, Indiecade, and other festivals. Robin Baumgarten and I founded this Discord on June 4th, 2019. After looking at the interviews, I put together rough set of traits to form a definition from the most common characteristics and ideas from the interviews. To ensure the ideas were reflective of the community, I workshopped the final definition over a series of messages, emails, and in person conversations during 2019 with Robin. What follows is our best understanding of some of the most common traits and features of the genre.

The questions were:
1. How has your game practice intersected with other communities outside games? (Making communities, Hackerspace? Galleries?)
2. What inspired you to start making games with custom or hacked hardware?
3. What was your first game where you made a bespoke interface out of custom-built hardware?
4. When did you make it and where did you exhibit or share it?
5. What was the first custom-built or hacked hardware game you played by another creator?
6. What interests you the most in creating custom-built interfaces for games?
7. How do you think making your own custom interfaces can change or improve a game?
8. What is your process in coming up with ideas for a custom-made interface for a game?
9. Is there anything you want to say about the community around hardware games?

2.34.1 Alt Ctrl Defined

Alt.ctrl games are works made with bespoke custom hardware by independent developers. These game controllers enable forms of play not readily accessible within the limits of a traditional abstract, embodied, or naturally mapped game systems due to the designer's complete freedom to define the affordances of the interactive devices. Frequently, these designers create their own output systems and abandon screens entirely. For example, Alt Ctrl designer Jerry Belich was involved with the very first Alt Ctrl GDC exhibition and has since gone on to design awards for the category. He states: "Instead of grabbing a mouse or homogenized game controller, I grab the heavy metal of a tank controller or squishy form that mimics my pressure digitally… It is hard to name examples because by their nature, what makes them special is how unique they are. In a perfect world, every game would have a controller, interface, or extension built just for it. It can align you with your game self." (See Appendix D for the full interview)

Additionally, Kaho Abe considers this connection in an interview where she states, "I can use simple sensors and embed them into objects, and the controller can then continue to

tell the story of the game in the physical world. By having full control over the code of the microcontroller, I can fine-tune the nuances of the interaction and the gesture made by the player. This combination of physical and digital can provide infinite ways to balance games. I basically can build whatever I want, and that creative freedom is the most exciting thing about making custom interfaces."

In Alt Ctrl Games there is a tight structural coupling between the controller, the environment, and game system. A *structural coupling* is a concept from Humberto Maturana. (Maturana, 2002)It points to the interconnection between a living system and its environment. If, in this case, we take the game as a system, complete with its rules and controller, the players as another system, and the environment as the place the game occurs within, the game and the controller are tightly structurally coupled to the environment and the players. The structures of the environment and the system of the game are interconnected and related. The controller becomes a sensory experience within the embodied environment and the digital worlds.

Alt Ctrl games often rely on the affordances of their interfaces for game mechanics. The controller design and the game mechanics unite at the point of gameplay and connect to the environments in which they are played. For example, if a player trips and breaks a leg while playing *HitMe!*, they have to go to an actual hospital. Compare this to a virtual representation of a character getting shot, and the difference is apparent. While additional possibilities within the design space may remain unexplored, it would often be challenging to play a wide range of games with an Alt Ctrl system, as it is bespoken to that particular game and specific context. Outside the specific game they are integrated into, they are artefacts.

Alt Ctrl games innovate game design through controller design. While infused with knowledge of game controller design patterns which arose before them, these games are giving rise to new modalities of interaction within games by taking complete authorial control of the interface. To aptly define the essence of these games, it is beneficial to explore enactive and sensorimotor perspectives on cognition. These viewpoints can provide an insightful lens to understand this genre. Simon Penny, in his book "Making Sense," suggests a potential theoretical approach for new media interactive art that seems particularly relevant in this context. He proposes that "The way forward is a theoretical approach that addresses experience in terms of sensorimotor loops, integrated sensing and action, self and world in a dynamical, performative, and structurally coupled way…Enactive approaches to the question of phenomenal consciousness emphasize an ongoing and contingent process of linked sensation and action immersed in a world" (Penny, 2017).

This notion of enactive cognition is advanced by Francisco Varela, Evan Thompson, and Eleanor Rosch in their work *The Embodied Mind*. They emphasize cognition as an intricate part of an organism's embodied, temporally situated, and dynamic interaction with its environment (Varela, 1993). When Enactive Cognition is related with Kris and Maglio's concept of Epistemic Action, which asserts that humans use action to transform their cognitive tasks, a realm of vibrant possibilities is unveiled. Consider playing the game "Hit Me!" as an illustration. Any knowledge a player has about fighting in the real world is carried, in an embodied manner, into the game world. This game world exists within the actual physical environment where the player is located; there is no virtualization. The gameplay experience is direct and procedural. It encompasses a fusion of various elements—the senses, the game, the environment in which the game takes place, and the player's performance within that space. Here, there is no discernible separation; everything is intertwined. In this way, Alt Ctrl game controllers evolve beyond mere tools for gameplay. Instead, they become integral components of the sensory-motor

experiences that shape a player's cognition, connecting deeply with a lifetime of embodied experiences.

In another example, consider the games of Alistair Aitcheson, which are inspired by the performative traditions of clowning and theatre. His work, *The Incredible Playable Show*, repurposes barcode scanners, giant arcade buttons, and costumes to engage audience participation within a game context. (“The Incredible Playable Show,” 2020) When asked why he was interested in creating alt.ctrl games, he replied, "I like to create social interaction. Getting people to use big physical objects gets them moving around and that opens them up socially. Secondly, I believe acting things out with physical objects is a really powerful way to live out emotions - to sit inside them, see how they feel, and ask ourselves about them." Alt Ctrl games make it possible to expand the sensory experience of the game outwards. By affording for social engagement, they become more than just control surfaces but nexuses for the creation of meaning. Abe says, "I like to explore the physical gesture/mechanic that the player is to make in the game. Not just studying the movements but getting into them, acting them out. I also think about the physical object, its affordances, as well as its role in the broader narrative. Also, I consider what it might look like to the spectator, who is often the next player." (See Appendix D for full interview)

Alt Ctrl interfaces can be complete systems at once, both controller and output display. This removal of the screen in favour of custom output modalities is a common feature in the genre. An excellent example of such a work is Robin Baumgarden's *Wobble Sphere*. (Baumgarten, 2020) This playful experience is a sphere covered in LED rings. In the centre of each ring, there is a capacitive touch spring. Moving hands across the springs creates cascades of light patterns. Games are discoverable by touching the springs and moving along lit patterns. Also, it is large enough to encourage group play and interactions. Some of the games are multiplayer and require more than one player. The shape references a coronavirus, and the sphere, which brings people back together after the pandemic, is a work of art that re-situates touch in groups. However, the mechanic of touching the sphere and seeing our impact displayed through LEDs spread across it, one cannot help but be reminded that virus-spread across our world highlights our interconnection to each other.

Finally, in some games of this genre, it is not possible to abstract the controller from the game. While there may still be unexplored avenues within the design space, the bespoke nature of certain games' input and output systems inherently limits the range of totally different games that can be played using those systems. This is because the game design itself expands the meaning and the experiential gestalt through its unique control design. Take, for instance, the game Pain Station mentioned earlier. This game fundamentally revolves around how much physical pain a player can endure to avoid losing. In such a context, how could one possibly engage with this game without the experience of pain? It simply isn't feasible, as the pain factor is an integral part of the game's design and system.

Other influential early creators in this genre include Tilman Reiff and Volker Morawe, Toshio Iwai, Robin Baumgarten, Jerry Belich, David Hayward, V21, Tatiana Vilela dos Santos, Tim Burrell-Saward, Julia Makivic, Amanda Hudgins, and many others. Part of the beauty of the intersection of maker culture within videogames in this genre is the accessibility of the medium to creators. As a result, every year at GDC, a new cohort of gamers show their experiments.

Figure 22 The interfaces from the 2023 Alt Ctrl GDC booth (Castle, 2023)

2.35 Activist vs Control

In this context, it's crucial to acknowledge the increasing number of creators who are actively 'queering' controllers, approaching their work from an intersectional feminist standpoint. Kimberlé Crenshaw, who first coined the term "intersectionality", situated it within black feminist theory. She argued that feminism must consider the intersections of gender with race, especially as they impact legal systems, sexual violence, sexuality, labour practices, and interconnected systems of oppression. Crenshaw emphasized the need for a more comprehensive understanding of these intersections within feminist discourse (Crenshaw, 1989).

In the years since Kimberlé Crenshaw's seminal work, the concept of intersectionality has been expanded upon by numerous scholars and activists, including Sara Ahmed (2021) and Patricia Hill Collins (2000), to encompass a broad range of experiences and identities. Their work has underscored the complex, interlocking systems of oppression people can face, highlighting how these systems can intersect and compound one another. This expanded perspective has led to increasingly nuanced examinations of identity, inequality, and power across various fields, including game design.

Scholars such as Kishonna L. Grey, in her book *Intersectional Tech*, examine the intersections of race, gender, sexuality, and disability within the context of video games. Grey astutely observes that games often reflect societal values, beliefs, and biases, meaning marginalized gamers frequently encounter and must negotiate games featuring racist and sexist character depictions. These portrayals often reflect the dominant structural power narrative of society, which many indie games creators challenge by crafting games that run counter to these narratives.

An example of such work is *Treachery in Beatdown City* by NuChallenger. Although the game echoes the mechanic and visual aesthetic of the classic *Street Fighter II*, it innovatively integrates the rich cultural identities of its characters into the game’s narrative. In contrast, *Street Fighter* disconnects its characters from their cultural meaning and significance. For instance, the motivations behind why Chun-Li, an Asian woman in traditional dress, would fight Zangief, a Russian wrestler, are left entirely up to the player's imagination. Furthermore, each character in *Street Fighter* visually represents a host of cultural stereotypes, such as Chun-Li’s iconic long blue traditional gown - an attire choice that seems impractical for street fighting. By making games like *Treachery in Beatdown*

City, indie creators are actively rejecting these clichéd portrayals and promoting a more inclusive and culturally nuanced approach to game design.

Alongside the emergence of indie and Alt Ctrl games, feminist groups within the gaming community also began to take shape. As noted in "Metagaming" by Boluk and Lemieux (2017), feminist organizations such as Dames Makes Games in Toronto (established in 2012) and Code Liberation in New York City (2013) have been instrumental in this development. These organizations, according to Boluk and Lemieux, serve less as production houses for playable objects and more as platforms fostering community play, support, and solidarity. The spaces they create – and the games they design – challenge not only the assumed individuality of play, the sanctity of hardware and software products, the authority of the original developer, and the universality of the standard controller, but also the lack of diversity prevalent in contemporary game design. As the founder of Code Liberation, I am actively engaged in both the Code Liberation and Alt Ctrl games communities, signifying a critical mindset towards the spaces in which she operates. This involvement in multiple intersecting communities of practice reflects a deep commitment to challenging norms and pushing boundaries within the game development world.

In their work on queering controllers, Marcotte looks at how intersectional feminism and queer studies connect to the creation of embodied and alternative controller games. They approach their practice using the reflective games framework, which connects Critical Design literature to Game Design practice. They look at precisely four spaces they see opportunities: flow, game feel, control literacy, and procedural rhetoric. (Marcotte, 2018)

‘Flow’ is a concept within games studies which is poorly defined. The concept was initially used by Mihaly Csikszentmihalyi to describe total absorption in an activity. (Csikszentmihalyi, 2008) Jenova Chen adopted this idea for games in his MFA thesis. He looked specifically at game ramping and how players acquire abilities while facing challenges. (Chen, 2007) In the upcoming book Against Flow, Soderman breaks this idea apart to critically assess the historical, theoretical, political and ideological context within videogames. He argues it is a game design strategy to extend player consumption. (Soderman, 2021)

Marcotte is right to point out opportunities for critical engagement with this idea through game controllers. Within games studies and the videogames industry, this term has developed a near holy reverence akin to the term immersion within computer science. Lazaros Michailidis, Emili Balaguer-Ballester, and Xun discuss the two concepts and discuss how similar they are in detail in their paper Flow and Immersion in Videogames: The Aftermath of a Conceptual Challenge. They conclude, "Immersion and flow do not appear as conceptually distinct, and their proposed differences are not compelling enough to set immersion apart as a different mental state." (Michailidis et al., 2018)

Both terms are problematic because they specifically conspire to increase the consumption of mass-produced computing interfaces and games. Marcotte points towards ways in which designers can look towards failure to undo this concept via Halberstam who suggests in The Queer Art of Failure, "Under certain circumstances failing, losing, forgetting, unmaking, undoing, unbecoming, not knowing may, in fact, offer more creative, more cooperative, more surprising ways of being in the world. They state, "Through failed or negative affects and experiences, queer design practices can problematize the flow state and similar "seamless" states with a design that encourages "reflection over immersion" and "disruption over comfort." (Marcotte, 2018)

However, it would also be worthwhile to apply this same logic to the term failure itself, which is another mythos which looms large in the technological landscape. Several such

talks are from leaders in the technology sector, including the Head of Google Research, Astro Teller. (Teller, n.d.) Macklin and Sharp cover the importance of failure in the design process in their book, Iterate. (Sharp, 2019)

Many of the predominately white and male founders funded by Venture Capital within Silicon Valley often fail, with 77% of these companies ending up dead or self-sustaining with no possible growth and no significant return for investors. (“The Venture Capital Funnel,” 2018) Within the landscape of venture capital, these failures can cost millions of dollars and it also points to the systemic injustices present in failure. Marginalized creators cannot afford failure.

Possibly the failure that Marcotte, Halberstam, and Macklin suggests is better described as a queer framing of failure. Marcotte states that failure, "could be seen as a point of resistance for concepts of flow and immersion." Two other ideas Marcotte points to game feel and control literacy as areas for exploration here. Their work on game feel suggests that creators explore glitch and intentional breakages and ways to undo this concept. They cite their game work, Seventy-Eight, where they use this element to make a system feel deliberately unfair. They state, "Our intent was to cause players to wonder whether the system was against them or if their own performance was inadequate, a reference to the gaslighting that marginalized people might experience in the workplace." (Marcotte, 2018) Additional parallels to game feel are game polish and slickness, both of which suggest a technological perfectionism.

Their final point is to critique procedural rhetoric. It is possible to say that there are rhetoric and meaning within rules without saying that rules are the only site of meaning. "Designers also unconsciously or consciously reveal their own biases through their designs. Designers interested in queering the hegemonic status quo of games should be careful not to reinforce existing problematic structures." Ergo if a game designer themselves have biases which are harmful in society, they will in turn produce mechanics and software which can reinforce them.

Marcotte connects and identifies the importance of approaching games controllers within an intersectional framework. "To be an intersectional feminist thinker means to acknowledge and consider questions related to power, privilege and oppression, including race and ethnicity, gender, sexuality, class, physical ability, mental health, nationality, and power relations and dynamics. It means to interrogate our first impulses and assumptions as well as establishing one's own position within these systems." (Marcotte, 2018) Intersectional Feminism is an approach to feminist practice which situates conversations and critiques within necessary perspectives.

As intersectional feminism began to rise in the indie games sphere, groups focusing on accessibility, such as Able Gamers, Audio Games, and Switch Gaming, also emerged. Scholars Boluk and LeMieux draw attention to the connections between these two communities, highlighting the insights of Rosemarie Garland-Thomson. She observed significant parallels between the societal perceptions of female and disabled bodies, stating that both are often viewed as deviant and inferior, resulting in their exclusion from full participation in public and economic life.

Boluk and Lemieux further expanded on this notion, asserting that there are no universals when it comes to bodies. With the advent of affordable physical computing and 3D fabrication, it is now possible to create video game controllers that are tailored to individuals through DIY customizations and niche market strategies targeting specific bodies, rather than attempting to cater to a general audience (Boluk, 2017). This

development fundamentally underscores the intersectionality of accessibility and inclusivity in gaming.

2.36 Conclusion:

The foundation of this literature review lies in its comprehensive examination of the intricate history between game controllers and Human-Computer Interaction (HCI), and the subsequent implications for disabled individuals. The relationship is deep-rooted and has given rise to significant developments, particularly in the problematic trope of the technological cure to disability in the landscape of HCI. Moreover, by shifting the focus towards User-Centered Design (UCD), this chapter not only traces its evolutionary trajectory in relation to console game controller design but also highlights the palpable gaps in UCD's ability to create accessible interfaces.

The research further delves into the subtle, yet profound challenges brought about by pre-existing mental models in designing console controllers. Drawing inspiration from the illuminating insights of crip literature and notably the perspectives of Leduc, the traditional paradigms of UCD are critiqued and explored as a design mythology. (Leduc, 2020) This deep dive is instrumental in elucidating the nuanced concept of affordance, circling back to Gibson's foundational definition that encapsulates the lived experiences of the disabled more holistically. (Gibson, 1979)

The research further weaves in Liz Jackson's incisive critiques on design thinking. Her observations unearth the pitfalls that lead to the creation of designs which, while being aesthetically pleasing, lack depth in addressing disability needs. Such designs include the infamous disability dongle. (Jackson et al., 2022) As a counterpoint, the research brings to the fore an intersectional feminist lens coupled with disabled viewpoints, to consider the intersections between technology and disability. Drawing from Sherry Turkle's seminal work on robotics, there is a consideration of how children perceiving robots with unpredictable behaviours as representations of disabled traits. (Turkle, 2011) When considering robotics, the conversation extends into broader conversations around robots in caregiving roles and the portrayal of disabled entities as cyborgs. In challenging this, the cripborg emerges, emphasizing the indispensable role of community and mutual support beyond mere technological reliance within the crip community.

Finally, the narrative celebrates the ground-breaking work done by crip hackers to refigure their lives, casting a hopeful glance towards a future when considering hacking applied to game controllers. By digging deeper into HCI, the concepts of Embodiment and Entanglement and Crip HCI are unravelled. This paves the way for a thoughtful contemplation of activist affordances within controllers, culminating in a definition of Alt Ctrl games. Finally, we consider how Alt Ctrl games can be a nexus for procedural rhetoric, metaphorical mechanics, and activist stances in game design.

Undoubtedly, this literature review hints at the potential for an exploration of Alt Ctrl Games within the realm of crip game design. Above, the examination of crip design weaves a rich tapestry that interconnects crip theory and the profound ethos of crip hacking, deeply rooted in the political reality shaping disabled lives. Care, positionality, and community are values which run counter to the consumer culture of games. Remarkably, while games have an extensive history of interface design development, and DIY game making, there exists an untapped synergy between crip theory and the speculative genre of crip games. A comprehensive exploration into crip game creation and the design processes that might underpin it could lead to new ways to approach game design.

By firmly centring lived experiences of disabled individuals in the creative process of game development, we can carve out not only a space to imaginatively explore assistive technologies through the lens of game design but also establish a potent new perspective within the realm of play. The rise of Crip Games can compel players to push beyond conventional paradigms of disability and transform games into a platform for reimagining how society perceives and constructs disability. The creation of a Crip Game community holds a radical potential because it beckons us to envision a world where game design transcends entertainment, emerging as a catalytic force for crip worldmaking advocating for societal transformation.

3 Methodology

This research uses a mixed methods approach. The overarching framework comes from Practice-led Research, Research-led Practice in the Creative Arts by Smith and Dean. It establishes a model entitled The Iterative Cyclic Web. (Smith and Dean, 2009) Their rhizomatic approach flows between Practice Led Research, more traditional Academic Research, and Research Led Practice. This investigation explicitly connects public exhibition and community engagement into this network. Iterative Design methods guide future game design choices. Exhibitions are opportunities for testing and evolving games. HCI tools such as player observation, open-ended questions, discussion, memos, interviews, and media analysis generate data. Reflective Thematic Analysis (RTA) instructs coding data and the evolution of themes. Each project in the thesis centres on the most appropriate network of processes.

3.1 The Iterative Cyclic Web

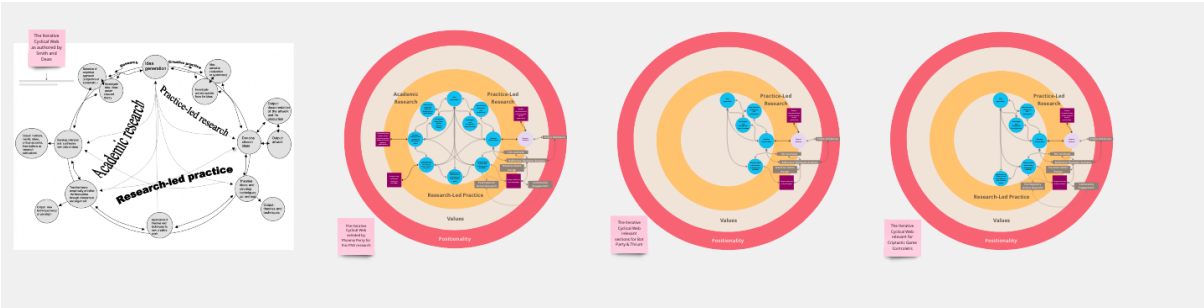
Two terms practical to understand The Iterative Cyclic Web are Practice-led Research and Research-Led Practice. Practice-led research is an approach which begins with creative practice. This phase looks like an iterative non-linear process of idea generation, idea selection, investigation of ideas, outputs of documentation of the artwork, production development of chosen ideas, and the theorisation of ideas that develop from techniques and methods. The output can be theories, and techniques can yield new artwork. Research-led practice in the creative arts is a different approach. It starts with a theory or idea and explores these theories and ideas by creating new work. In this thesis, both are relevant at different points in the process. Chapter 4 centres Practice-Led Research. Chapter 5 covers a Research-Led Practice based study using Participatory Action Research. This study considers the practices of a group of crip game designers who are accessibility professionals. Participants are co-collaborators invited to design, read, write, change, and comment on this study and the data it generates to a state they are comfortable with their contribution. Participants are an active part of research and there is a cyclical relationship between the researcher and communities involved. Both Practice-led Research and Research-led Practices generate new knowledge herein.

Within the web, these lines of inquiry connect to Academic Research. Academic research is an empirical approach (which is either subjective or systematic). Researchers investigate ideas and relevant theories to develop, interpret and synthesise new data or ideas. The output can be methods, results, ideas, critical accounts, theorisations, or research publications. Empirically tested concepts and theories therein are refined. Arguments are compared, and the outcome can yield new techniques, theories, or paradigms. Academic research can weave through both Practice Led and Research-Led work. All three approaches are of equal importance in this model.

This method has two distinct ways of working relevant within it: process-oriented and goal-oriented approaches. Process-driven ways of working are emergent and directed at the "generation of ideas which were unforeseen at the beginning of the project."(Smith and Dean, 2009, p. 26) They are often associated with the practice-led side of the web but not exclusively. For example, "the initial idea generation can be one of surrender to the process or one of setting goals, while the idea selection stage can be subjective (more process-oriented) or systematic (more goal-oriented)." All three phases of the web can embody both research approaches.

Linked below is a graph of this web. Explicitly shown are how the different methods used here flow into the graph. I expanded the graph with:

- Public exhibition
- Iterative design
- HCI methods
- Reflective Thematic Analysis
- Community engagement
- Participatory Design



Note: an explorable graph of how each set of methods is relevant to each study is available on Miro: https://miro.com/app/board/uXjVP8fkihE=/?share_link_id=12279605802

3.2 Autoethnography and Positionality

Autoethnography lets this researcher acknowledge experiences building and participating in public exhibitions to inform design choices. "Autoethnography takes the self as primary participant, describing and analysing personal experiences in order to gain an understanding of their cultural, social, and political meanings." (Garcia and Cifor, 2019) Using Garcia and Cifor's idea of retrospective reflection, narrative experiences of running and participating in exhibitions can be considered data.

Autoethnographic design, as developed by Neustaedter and Sengers, is when "researchers(s) build the system, they use it themselves, learn about the design space, and evaluate and iterate the design based on their own experiences." (Neustaedter and Sengers, 2012). By including this researcher's own experiences building technology, it is possible to capture choices quickly iterated over during the design phase. A similar perspective exists in the disabilities studies work of Melanie Yergeau. Her "criptastic version of hacking is one that rails against forced normalisation, one that moves from body-tweaking to something collective, activist, and systemic." She calls for recognising the position of disabled designers making tech for themselves and the community. "I am asking us to imagine the possibilities if hacking were a disability-led movement, rather than a series of apps and patches and fixes." Within Crip Technoscience, disabled creators are subject experts in design and disability and bring insight into the process abled-bodied designers do not have. (Fritsch et al., 2019) Using these principles allows the research to include lived experiences. Similarly aligned, autoethnography is a philosophically relevant way to generate data from a crip perspective.

3.3 Iterative Game Design

Iterative Game Design is a method used for the development of games. Eric Zimmerman and Katie Salen originally derived it as a roadmap for prototyping and testing the games. During a playtest, players demo a prototype. Their feedback then informs the next phase of the design process. The game is adjusted and tested again. "Iterative design is a cyclic process that alternates between prototyping, playtesting, evaluation and refinement." (Salen et al., 2004) This process allows creators to reflect on the reception of their work and the playability of their games. Does the game communicate effectively to players? If not, what can change to improve the experience?

Listening during playtests to player insights is invaluable for the games presented here. When a player asks how they should play a game during a playtest, this method suggests responding with probative questions, such as, "How do you think you should play it?" Responding with questions with deflective questions yields rich content for understanding how work is received and interpreted. Using iterative playtesting leads to something far more generative than simply iterating a design idea. In this way, games are conversations between the creator's values and the public.

3.4 UCD's Impact on Iterative Game Design Method

However, it's critical to consider the impacts of Norman's research on Iterative Design. These connections are worth interrogating as possible sites for cripping game design methodology itself. Zimmerman and Salen begin their design chapter of their game design method with a quote from Donald Norman's The Design of Everyday Things, offering a reasonable connection between their *book Rules of Play: Game Design Fundamentals* and it.(Salen and Zimmerman, 2003) The main texts they build this method from are mainly white European scholars - *Homo Ludens*, by Huizinga and *Man, Play and Games* by Caillois, and *The Study of Games* by Sutton-Smith co-edited by Avedon are referred to as core concepts throughout. (Avedon and Sutton-Smith, 2015; Caillois, 2001; Huizinga, 2016) Where Zimmerman and Salen come short on considering disability in their proposal for an iterative game design method stems from their lack of consideration of it at all. Throughout this entire book, the words disability, disabled, deaf, wheelchair or even accessibility never appear, however they do mention both race and class. The closest they get to mentioning physical differences between people is when they consider the ways that games interact with culture. They state, "Unlike RULES and PLAY, cultural game design schemas do not directly derive from internal, intrinsic qualities of a game; rather, they come from the relationship between games and the larger contexts in which they are played. These contexts might be ideological, practical, political, or even physical." (Salen and Zimmerman, 2003) This could be used to lay the groundwork to consider the ways in which physical disability might intersect with a game's cultural design schema or a game's design but affords no such consideration for cognitive disabilities.

3.5 Ableism and Racism in Play Studies Methodology

As Trammel points out in *Repairing Play: A Black Phenomenology*, the White European texts, which Zimmerman and Salen refer to as "Core Concepts" that inform Rules of Play, are rooted in white supremacy – specifically Huizinga, Caillos, and Sutton-Smith. (Trammell, 2023) He posits that it is crucial to acknowledge how this background has led to blind spots in play discourse, often elevating certain forms of play while deeming others as not "true" play (Trammell, 2023, p. 22). Specifically, he looks at ways that Huizinga presented play as a civilized activity, raising play to a virtue of culture. He points out that that Huizinga asserts that play is derived from civilized societies and, "assumes that people whose customs are not legible to Western Civilization act much like animals…For the presumably "civilized," play is always constructive of something." Another way of stating this is that play should be productive and any forms of play which are not

productive are not to be valued. Rules of Play touches upon race but does not go as far as to think about how game design methods might perpetuate racism or ableism. They also overlook how the potential biases of key figures they reference, like Huizinga, might influence their methodology. Despite their focus on systems and viewing games as cultural texts, they scarcely question the origins of the work they build their method from or the oppressive systems these writers might propagate.

In Capitalism and Disability, Russell points out how disability is socially generated in relation to the production of value in a culture. (Russell, 2019) She states, “Disability is a socially created category derived from labour relations, a product of the exploitative economic structure of capitalist society: one which creates (and then oppresses) the so-called disabled body as one of the conditions that allow the capitalist class to accumulate wealth.”(Russell, 2019) This connects to and extends Trammel’s writing. He specifically says, “But play is not always constructive; it can also be oppressive and traumatic.” (Trammell, 2023) This is as true for disability as race, as the systemic racism he speaks of exists as a disabling practice for bodies which encounter it. He connects ways in which play for one group of people can mean torture for another and that mapping this can help to point to ways in which women, trans people, and nonbinary folk are excluded from historically White and masculine spaces of play. He states, “When play is only theorized as pleasure, minoritized people are made to act as “killjoys” when they describe their play experiences as torturous.” (Trammell, 2023) It is easy to extent this to include disabled people’s encounters with gaming systems that cause physical pain and create alienation from games culture.

Ergo, while the practice-based work in this PhD takes a somewhat iterative approach, it is not doing so without being aware that it has produced outcomes which have extended the above problems and, as a result, will need to be tempered with other methods and approaches which are connected to more ethical stances. Could iterative design benefit from the practice of cripping? This PhD explores just this. The aim of my creative practice is to draw it deeper towards expressing the lived experiences of disability I personally encounter with my players.

3.6 Values

According to the British Design Council's revision of Design Thinking's Double Diamond within Beyond Net Zero: A Systemic Approach to Design, it is crucial to consider Orientation and Vision Setting. It states, "Develop a set of values and design principles to guide your work or reframe how you see the work." (The British Design Council, 2021) As defined by Colleen Macklin and John Sharp in their book, Iterate, design values are underlying core objectives the design should achieve. (Sharp, 2019) Design choices are continuously evaluated against the design values as the works evolve through an iterative approach to game design.

It is important to recognize the designer values have been considered as an important part of the game design process by other designers and theorists. Values-informed games were first proposed by Flanagan, Howe, and Nissenbaum as a method to help game designers embed socially relevant values into their games work. (Flanagan et al., 2005) This method proposed an iterative method for discovering, embedding, and evaluating values within games and technological design work. While this framework does acknowledge that, “the beliefs of designers themselves often have significant effects upon the values embodied in a particular system and thus are an essential component of the discovery process” they do not offer a framework for this purpose. To extend this work Kultima and Sandovar build from designers outside games who have explored and proposed frameworks for design values in their subsequent fields of architecture and

industrial design to propose a framework for identifying designer values within the field of game design. (Kultima and Sandovar, 2016)They focus on nine key areas which aim to exhaustively categories designer values across a range of themes relevant to the design process.

Theme	Summary
Value of Player Centrism	Emphasizes player-centric design, co-creation, and usability as key starting points for game design.
Casual Game Design Values	Focuses on accessibility, acceptability, flexibility, and simplicity for mass market appeal and diverse user groups.
Traditional Game Design Values	Values immersion, challenge, community, and exploration of fantasy worlds as foundational elements of game design.
Value of Artistic Expression, Innovation and Experimentation	Prioritizes visual aesthetics, experimentation, and exploring underrepresented areas in game design.
Societal Impact and Cultural Values	Emphasizes positive societal impact, diversity, ethics, and exploring culturally diverse topics in game design.
Values of Production and Creation Process	Highlights the importance of peer respect, collaboration, technological advancement, and the challenge of the development process.
Ludological Values	Recognizes games as a unique art form, valuing fun, game mechanics, and drawing inspiration from nostalgic experiences.
Values of Independency	Stresses the importance of autonomy, artistic freedom, and subversive design, especially among indie game developers.
Values of Commercial	Views game creation as a business, emphasizing economic success and the pursuit of opportunistic or disruptive innovations.

Figure 23 List of Values and a Summary of them as proposed by Kultima and Sandovar (Kultima and Sandovar, 2016)

“Value of Player Centrism” builds off earlier work by Sicart and Wilson that looks at the “accessibility turn”; however, this turn does not refer to disability – more it centers on the games becoming more accessible to larger audiences. (Wilson and Sicart, 2010) “The driving values behind this accessibility turn encourage the creation of games that challenge players just enough so that they will feel satisfaction with their actions, yet simultaneously give more advanced players extra-hard modes and other in-game rewards that can be used to showcase expert skills.” This accessible turn has nothing to do with the ways that access is considered in terms of disability. Its focus is usability – the identical terminology is vague and points to a lack of clarity.

Further, in the theme “Casual Game Design Values” builds off previous work by Kultima which defines access in ways which are only tangentially connected to disability. “Enhancing the accessibility of the games makes playing possible for people with varying limitations. The differences in the groups of potential players may include variation

between skills and knowledge levels, resources such as time, money attention and other relevant factors. This forces us to look at the adoption phase of the games and promotes lowered thresholds according to the lowest possible nominators.” Limitations here include skill, knowledge, time, money, and attention” specifically.

The theme of “Societal Impact and Cultural Values” does specifically mention disability and the ways it has begun to be considered by designers. “For a rising portion of game developers, it is also important to create games that cater for smaller user groups, such as minorities or players with certain disabilities or barriers for play.” This does not go as far as to consider how disability is likely already present from the outset of the process.

The research presented on values-informed games, while comprehensive in its approach to embedding socially relevant values into game design, exhibits a glaring omission in its consideration of accessibility in relation to disability. Flanagan, Howe, and Nissenbaum's method, although acknowledging the influence of designers' beliefs on the values embodied in a system, lacks a specific framework for this purpose. Kultima and Sandovar's extension of this work, which proposes a framework for identifying designer values, touches upon themes like "Value of Player Centrism" and "Casual Game Design Values."

However, their understanding of accessibility is superficial and not rooted in the context of disability. The "accessibility turn" described by Sicart and Wilson, while emphasizing the broadening of game audiences, fails to address the specific needs and challenges faced by disabled players. The term "accessibility" in this context is misleading, as it pertains more to usability and general player inclusivity rather than genuine accessibility for disabled individuals. The theme "Casual Game Design Values" further underscores this oversight by defining access in terms that are only tangentially related to disability. The use of terms like "limitations" to describe factors such as skill, knowledge, time, money, and attention reveals a lack of depth in understanding the true essence of accessibility in the context of disability. When disability is considered as a value in relation to “Societal Impact and Cultural Value” it is not considered that disability and difference are not simply values but ways of knowing which could inform the design process itself, not just the values it might include. This oversight points to a significant gap in the literature, highlighting the need for a more inclusive and comprehensive approach to game design methods that genuinely includes designer positionality in relation to disability.

The journey towards the values emphasized in this PhD both integrates and transcends the previously mentioned methods. It's not just about iterative evaluation; it's a harmonization with the principles of a crip epistemological perspective. I assess whether the artistic values I aim to convey resonate in the design decisions. Adjustments to the games are perceived as a tuning process, akin to fine-tuning a musical instrument, to better align with the core values I wish to express. I continually listen and ask, "Do these tweaks tune the project closer to the profound meaning I aim to share with my players, or do they detune it?" In this way, I am working with a listening deeply to the experiences I have with my players.

To start this research, a stack of postcards was used to notate the values that should be reflected in the thesis moving forward. Values discovery allows the practitioner to develop a set of guiding concepts to return to while creating and measuring the success of a body of work. These notecards are convenient physical objects providing a visual opportunity for reflection on what matters to the creator. They allow for a designer to return to and refine principles during the creation process as new knowledge emerges from engaging with practice. The values held to shape this body of research are:

- Playing with and questioning social norms
- Designing situations informed by my disability.
- Lived Experience as a grounding for design.
- Agency and interdependence
- Embodied interaction
- Tactile interaction
- Sensitivity, intimacy, softness, and connection
- Playfulness
- Fostering prosocial behaviour
- Foregrounding community interactions

3.7 Reflexive Thematic Analysis (RTA)

Braun and Clarke outline reflexive thematic analysis (RTA) as 'a theoretically flexible method' for 'developing, analysing and interpreting patterns across a qualitative dataset'. (Braun and Clarke, 2022). They use the term 'reflexive' to acknowledge the role of the positionality of the investigator in making sense of and conducting research. Reflexivity involves drawing upon experiences, pre-existing knowledge, and social position (such as ability, ethnicity, gender, class, etc.) and 'critically interrogating' how these aspects influence and contribute to the research process. RTA brings the researcher to navigate, understand, manifest, and clarify their values and beliefs. One can then consider how, not if, these influence how one interprets research. Reflexive research demands that knowledge is situational and a dialogue between the researcher and the data.

This type of data analysis suits a positionally situated, values-led inquiry because it integrates the researcher's experience while requiring a critical perspective. It can yield particularly rooted insights when applied with autoethnography after an iterative playtest. During this research, RTA's approach to coding informs interviews, media, memos, notes, player feedback and observation, social media posts and other text generated around the work. Codes evolve themes. Themes point to reflection and generate discussion and findings.

3.8 Participatory Action Research (PAR)

Participatory Action Research is a method suited to doing research within a community. When the researcher is a community member, they are considered an insider. The researcher takes less of a lead in a project done this way. The people who are in the study collaboratively develop it. The researcher might serve as a catalyst or an organizing group member but does not need to lead it. The people engaged in the research are part of collecting, analyzing, and using the data. There is action involved in this style of research. The researcher or the community in conversation identify an action to take, and then they do this action and report on it. It involves a cyclical relationship between communities and the researcher. PAR methods in the “Criptastic Game Controllers” study allow designers to directly define, co-lead and benefit from the research.

3.9 Conclusion

The Iterative Cyclical Web integrates iterative playtesting, HCI methods, autoethnography, participatory design, public exhibition, and community engagement. The above methods offer a complex tapestry of possible working strategies as the projects within this PhD vary from chapter to chapter. As described above, this web yields the production of new knowledge. An argument exists that the web infers these methods within elements of itself. For the sake of clarity, they are explicitly put forward here. This web is broad enough that a researcher could insert any number of methods within it. Elucidating how this network of techniques relates to the work herein clarifies the methodological framework.

4 Bot Party

4.1 Iterative Writing and Sense-making

This chapter maps the development of my practice-based Alt Ctrl game, *Bot Party*. It explores the first two research questions presented in Chapter 1 in relation my own game design process.

To begin, it serves to reframe the questions to apply to herein:

- How can I broaden the current understanding of video game interfaces through controller design, by introducing alternative control systems?

- What are the key design methods I consider when creating Alt Ctrl hardware games and playful experiences?

The ensuing chapter unfolds the progressive transformation of *Bot Party*. Currently, *Bot Party* is a multiplayer game featuring three bespoke controllers, each outfitted with touch and motion sensors. These eight-centimetre cubic controllers, or "bots" as the game refers to them, detect players' touch when they interact with others holding a bot. Additionally, they respond to being picked up and moved, using the built-in motion sensor. Using these inputs, players can navigate a structured game or an immersive, open-ended soundscape.

Bot Party is the result of an evolutionary process rather than an overnight conception. The journey to reach this stage was not linear or preordained, but rather an iterative cycle characterized by continuous exploration, improvement, and adaptation of four prototypes covered in this chapter. The design process of the game is deeply rooted in the methodologies articulated earlier, which emphasize a value-driven, positional creative practice that embraces open experimentation, public exhibitions, and iterative playtesting. From a studio-based creative process, the first prototype, "Baby Bot," emerged as a group-focused analogue synthesiser and step sequencer to foster playful interaction. Feedback from its exhibition led to Prototype Two, "*Bot Party*." It expanded the interactive and sonic elements across three separate controllers. It evolved the signal moving across the multiple synthesis units of “Baby Bot” into a metaphor to symbolise human movement and connection. This was further refined in Prototype Three, “*Bot Party* (version 2.0)”, incorporating a touch-focused, rule-based structure1 while preserving the unrestricted auditory exploration as a separate level. Lastly, Prototype Four, "*Bot Party* (Sightless Kombat version)”, evolved based on a suggestion from a disabled player. By integrating these features, the game became fully accessible to blind players, emphasising the project's commitment to inclusivity. For the sake of brevity, I simply refer to prototypes two through four as “*Bot Party*”.

It is my intention that *Bot Party* be viewed as feminist crip tech. This research delves into my personal trepidation around physical human contact, particularly with strangers. As an individual with a disability, I grapple with the notion of someone touching, holding, or shaking my hand. My nerve damage in my hands and the fragility of my bones have nurtured a significant fear of social settings. Following the onset of these symptoms, I gradually started to distance myself from others in public environments to avoid casual human contact leading to injury. Intriguingly, I discovered I wasn't alone. Disabled individuals often feel less secure than non-disabled people in public areas (“Perceptions of personal safety and experiences of harassment, Great Britain - Office for National Statistics,” n.d.), with 75% of women having encountered harassment in public. (“New data shows extent to which women feel unsafe at night,” 2021) Being a woman with a disability in a contemporary city requires constant re-assessment of safety in public spaces.

Before COVID-19, avoiding handshakes, slaps on the back, and most hugs was no simple task, as outright refusal frequently led to uncomfortable situations. In Activist Affordances, Dokumaci alludes to how individuals with chronic conditions often experience their worlds contracting. Dokumaci observes, "Impaired, sick, painful bodies, mad selves, debilitated populations, vulnerable beings — and threatened organisms, as I shall discuss later on — live in environments that for them are shrunken and shrinking." My personal physical interactions with strangers began to shrink around 1999 and continued to do so until it became almost non-existent by 2017.

Activist Affordances delves into this concept of shrinkage, examining it in the context of performance and affordances. The book positions affordances as a platform for activism, claiming, "I propose the theory of activist affordances in order to name and recognize the tiny, everyday artful battles of disabled people for more liveable worlds that otherwise remain unaccounted for." Some of the hacks mentioned, such as Cindy's multiplicity of home modifications and design inventions that replaced prosthetics use, provide clear instances of activist affordances. (Hendren, 2020)

When I began my exploration of group play, I was unaware of the direction it would take. The central themes of the work and its ties to my disability became increasingly evident as the project progressed. Each public performance of *Bot Party* confronted me with the tangible reality of my artistic endeavour: I was essentially redefining the conventions of social interaction, by adapting them to suit my needs. I was establishing a space where I

controlled the touch — the duration, speed, and style of connection. In essence, I was systematically reversing the shrinkage of my physical interactions — I was designing a space I could inhabit.

By the time of this writing, I've allowed over 3,000 individuals across multiple countries to touch me during the third version of *Bot Party*. The possible surge of oxytocin suggested by Uvnäs-Moberg et al. during and after a show, could have caused the resulting sense of euphoria and connectedness to humanity, left me both exhilarated and utterly drained. (Uvnäs-Moberg et al., 2015)*Bot Party* emerged as a space where I could reclaim physical interaction on my own terms. As Dokumaci suggests, "When the environment's offerings narrow, and when its materiality turns into a set of constraints rather than opportunities, the improvisatory space of performance opens up and lets us imagine that same materiality otherwise." *Bot Party* re-envisions human connection, promoting non-aggressive, sociable, and playful interactions in everyday society while allowing me to engage with players in a performative way. During exhibitions, I invite people to play, guide them through the rules, and often become a fellow player. By supplanting the social norms of meeting new people with playful explorations of soundscapes and collaborative play, *Bot Party* proposes another way social interactions with strangers could unfold in public.

In addition, it is my ambition to suggest new perspectives and interpretations of our world by offering players tools that facilitate connected experiences with their environment and their fellow beings. This aspiration, albeit challenging to measure quantitatively, is inspired by my exploration into embodied enactive experiences, tangible engagement with game controllers, and epistemic action. The opportunities for playful physical touch between strangers in public settings are extremely infrequent, if not completely absent, in daily life. The underlying objective of this research is to provide a positive impact on all who encounter it, even if that impact lasts only as long as the neurochemical changes induced by the interaction persist.

To emphasize the scientific aspect, as previously noted in this research, it is well established that human touch can trigger the release of oxytocin in the brain, a change that is linked to feelings of happiness. According to researchers Kersin Uvnäs, Linda Handlin, and Maria Petersson, "Oxytocin, a hypothalamic nonapeptide, is associated with increased levels of social interaction, well-being, and stress resistance" (Uvnäs-Moberg et al., 2015). Although their research is extensive, the most pertinent aspect for this chapter concerns the activation of somatosensory nerves through touch. Oxytocin can be released from the skin through the activation of cutaneous sensory nerves in response to touch, light pressure, massage-like stroking, warm temperatures, and even low-intensity electrical stimulation of sensory nerves. The subsequent four iterations of this project explore this potential through the lens of artistic practice.

When looking at the research question, "How can creating games on bespoke hardware impact the artistic practices of disabled game creators?" I find it helpful to apply it to my own personal journey with *Bot Party*. By reframing the question in terms of my own experiences, it becomes "How can designing and developing games on hardware that is tailored to my specific disability help to shape and enhance my game design process? How does the landscape of my game design process transform when I am designing games and their respective controllers that I can interact with comfortably and without pain?"

Bot Party is more than just a game - it is a testament to my values, my access needs, and my positionality. Every element of it, from its hardware to its gameplay mechanics, has been deeply influenced by my lived experience and requirements as a disabled game creator. Designing and developing the game's hardware, I was inherently driven by a

ßrequirement for my own accessibility. In theory, one could design an interface they themselves couldn't test, play, or use, but that is not what happens herein. I sought to create a game that I could play without pain, a game that was not bound by the conventional constraints that often render mainstream games inaccessible to individuals such as myself.

The experience of designing and developing *Bot Party* has shown me what it looks like when games are designed with increasing connectedness and inclusivity at their core. It has revealed that the games we create can be a powerful medium for expressing our values, our needs, and our identities. Each iteration of the playful design feeds into the overall evolution of the project, incrementally moving the interactive experience closer to the project's core values. *Bot Party* aims to foster a shared sense of joy among its participants, and each iteration brings us closer to this ambition.

4.2 Prototype One: Baby Bot

Inspiration for this work came from the creator's ongoing research into exploring social music creation by building playful environments for multiple participants. This new design explicitly explores modular synthesis. A modular synthesis system generally consists of different modules, each of which accomplishes a specific task. These units are then attached via patch cables, often, but not exclusively, to send control voltage, logic signals, and timing conditions. The patch cables offer a range of creative potentials for a musician to craft sound through different possible configurations. Could patching be distributed and shared via cooperative play? The questions that served as a starting point in this exploration focus on the following:

1. Most modular synthesiser interfaces are solo experiences. Is there a way to distribute sound and exploration among a group of participants?

2. The popular modular synthesis Eurorack form factor is a conventional design and does not prioritise emotional engagement in the shape of the object. While artisans craft some Eurorack units, the final overall design language is often repeating rectangular forms. While this conformity allows an extensive community of creators to build units, it limits the shape of the device. Are there ways to consider feminist aesthetics and feminist principles into the design of the experience?

According to the above research questions, a vital element of this first implementation is the enclosure. This enclosure's interface consists of a heart-shaped panel large enough to allow multiple people to play together to change the tones and the patterns of the step sequencer. The scale of the unit aims to encourage collaborative sound-making. The design of the anthropomorphic case resembles a robot with a gold head with big eyes, a soft pink body, and a red mirror heart. The casing, with its warm tones and round shapes in the visual aesthetic specifically nods to the Cyborg Manifesto, the Xenofeminist Manifesto, and to the design style which is part of the ç̟y̔b̊ẹ̟r̃ᷓtwe̳ᷓ aesthetic. ("♡ – ç̟y̔b̊ẹ̟r̃ᷓtwe̳ᷓê," n.d.; Cuboniks, 2015; Harraway, 1985; Hogeveen, 2017)

The Cyborg Manifesto, written by Donna Haraway in 1985, dismisses rigid boundaries, particularly those separating 'human' from 'animal' and 'human' from 'machine'. The concept of the cyborg serves as a metaphor for challenging the dualities imposed by societal constructs and expectations. It encourages a complex interplay between technology and identity, rather than placing them in opposition. (Harraway, 1985) This perspective deeply informs the exploration of how a physical/analogue play space can become an extension of one's identity or a part of their social interactions. By encouraging

group play through collaborative expression of music, players are invited to connect, collaborate, and share an experience creating together.

In parallel, the Xenofeminist Manifesto by Laboria Cuboniks advocates for a form of feminism that questions how technology extends structures of power and what liberatory opportunities it presents to move our society to an anti-capitalist, gender abolished future. It suggests that technological advancement can help disrupt patriarchal structures and pave the way for a more equal and inclusive society. The manifesto argues for a radical transformation in the way we perceive gender, encouraging fluidity and flexibility. It further proposes the utilisation of technology to challenge normative ideas of gender and identity. This ethos is mirrored in the development of alternative game controllers that defy conventional notions of accessibility and play, and in seeking ways for technology to cultivate inclusivity and break down barriers.

On the other hand, the Cybertwee aesthetic emerges as a response to the masculinised norms of tech and internet cultures. It reclaims femininity and softness within these domains and aims to subvert the prevailing binary narrative of gender and technology. The influence of the Cybertwee aesthetic is evident in the playful, soft design and the physical, tactile nature of the games discussed in this study. It champions the principle that technologies can be soft, playful, and engage with traditionally feminine aesthetics, challenging the game-world's traditionally masculine design paradigm found so frequently in game ads and media. (*Phoenix Perry - |Embodied play design and building a female developer community" - Open Hardware Summit 2013*, 2013)

4.2.1 Controller Design

To test out the concepts discussed, I created and experimented with a modular synthesiser called Baby Bot. This synthesiser is made up of two units. The primary unit, also known as the Bot's Head, functions as the synthesis unit. The technical workings of this unit incorporate an analogue circuit, which is the Atari Punk Console, a design by Forrest Mims.

Let's break down how this works in simpler terms:

At the heart of the synth there are two 555 timer chips. These chips, akin to little electronic clocks, are set up in a specific configuration known as an astable RC (Resistor-Capacitor) circuit. This setup is connected to two potentiometers, which are kind of like adjustable dials, and a speaker. The potentiometer functions similarly to a dimmer switch in the home. Just as a dimmer adjusts the brightness of a light bulb, the potentiometer here adjusts the resistance in the circuit.

The potentiometers, resistors, and capacitors, along with the voltage or electrical pressure in the circuit, all interact with the timer chips to create waveforms – the patterns of electrical energy that are translated into sound. The resistors act like speed bumps, slowing down how quickly the capacitors can build up a full charge of electrical energy. When the charge in the capacitors hits a certain voltage level, it triggers a change in the state of the timer chips – like a flip of a switch from on (high) to off (low), or vice versa.

This flipping action creates a wave-like motion or oscillation in the current. When hooked up to a speaker, this oscillation is turned into sound that we can hear. The beauty of this setup is that the sounds can be varied by adjusting the potentiometers, offering a wide range of sonic possibilities (Mims, 1984).

The second unit, the Bot Heart, takes a control voltage (CV) from the synthesis unit and runs it into a ten-step sequencer. Control voltage, or CV/Gate as it can be referred to, is simply a signal that analogue processing and synthesis units use to communicate about the pitch and timing of notes, sequences, or effects. (Trusspublished, 2023) The ten steps of the sequencer likely lend the project its name - the Baby10. Originally published in the newspaper column called Captain's Analog and republished on Hackaday. (Whiteford, 2016) The circuit's design left several aspects undocumented clearly, and it infers ground - a common practice on some circuits. Many of the newer circuit designs now favour clarity. This circuit initially was targeting a similar hobby-focused audience, and this convention took trial and error to realise.

A potentiometer typically consists of three pins and a rotating or sliding knob. By turning this knob, one can change the amount of electrical current that flows through it, thereby affecting the resistance of the circuit. There are two primary methods for incorporating a three-pin potentiometer into a circuit. The more common method involves connecting one pin to the power source, the second pin to the ground (a common return path for electric current), and the third pin to the part of the circuit where the resistance will be adjusted or modulated.

An alternative wiring option for the potentiometer allows for the exclusion of one of the pins. In this case, one pin is connected to the voltage flow, and the other pin is connected to the ground. However, this configuration may lead to the circuit failing to function in specific circumstances. For example, if engineers opt to leave out the power line and attempt to connect the input voltage and the output voltage (after encountering the resistance) directly to the rest of the circuit, as shown in the accompanying diagram, the circuit will not work as expected. In many cases, this two-pin wiring approach can be effectively employed, essentially transforming a three-pin potentiometer into a two-pin device. In this scenario, it is not suitable, and all three pins need to be wired into the circuit.

The potentiometers adjust the resistance in the circuit. In the case of the potentiometers attached to each step of the sequencer, it adjusts the musical pitch produced by the synthesiser unit. The additional eleventh potentiometer incorporated on the side of the bot's body controls the musical tempo of the loop sequence. This control enables the player to change the speed of the musical steps, similar to how a conductor might speed up or slow down the pace of an orchestra. This feature adds an extra layer of interactive control for the user, enhancing the musical experience by allowing for a broader range of expression.

Diodes are components in electronics that are a bit like the one-way traffic signs of the electrical world. They allow current to flow in one direction but not the other. Typically, these diodes are especially important in circuits with what are known as 'inductive loads', components like motors and transformers that use magnetic fields. Without them, the motor can destroy the circuit when it is turned off as the magnetic field breaks down and flows into the circuit. However, in this circuit, there are no inductive loads, which raises the question - why are diodes needed? After testing if they could be eliminated, it was discovered that the diodes play a key role in this context. They manage the voltage supplying power to a key part of the circuit - the Integrated Circuit, or IC for short. The IC can be thought of as the brain of the circuit. It contains a set of electronic components on a small chip that performs a variety of functions. In this case, the IC's function is to draw current from the control voltage (the adjustable electrical power) and then release, or discharge, that current out again in a pattern that oscillates regularly. It does this for each of its output pins, effectively turning the power on and off for each step in the sequence in order. This becomes obvious when looking at the circuit.

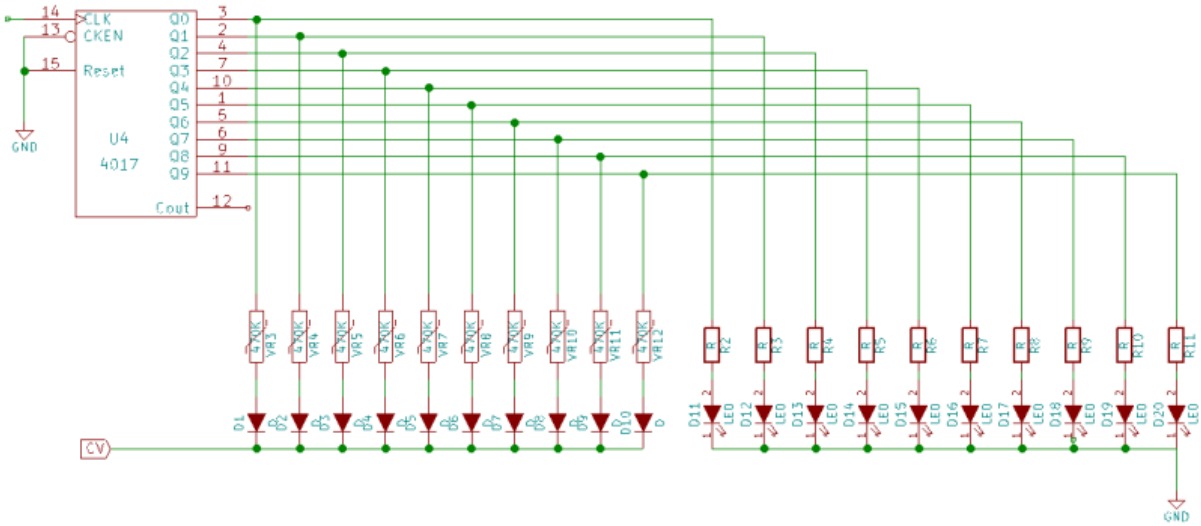


Figure 24 The Circuit Diagram for the Baby10 (Whiteford, 2016)

Without the diodes controlling where the voltage goes, the circuit wouldn't function correctly. The diodes prevent the voltage from circulating back onto itself and instead channels the power towards the Light Emitting Diodes (LEDs). These LEDs serve two main purposes: they visually indicate which step is currently active, and they display the speed of the clock. This researcher relayed this knowledge back to the public via a comment on Hackaday, documenting the circuit's construction. As such, Hackaday serves as a collective, shared reservoir of shared experiences surrounding specific circuit designs. By elucidating what transpired, the aim is to enhance the schematic's accessibility for other makers. While both circuits do not represent original work, the process of recreating, testing, and modifying them provided a valuable opportunity to delve into the materials used in early electronics. Lastly, both units are designed to connect to an instrument amplifier.

Additionally, the step sequencer's heart shape comes from prototyping the circuit. When building the circuit on the breadboard prototyping surface, the IC requires placing each side of the package across a break in the electrical current. This arrangement also allows room to place components on the side of the pins. When configured, the shape the pins take with the dip at the top of the chip is a semi-circle.

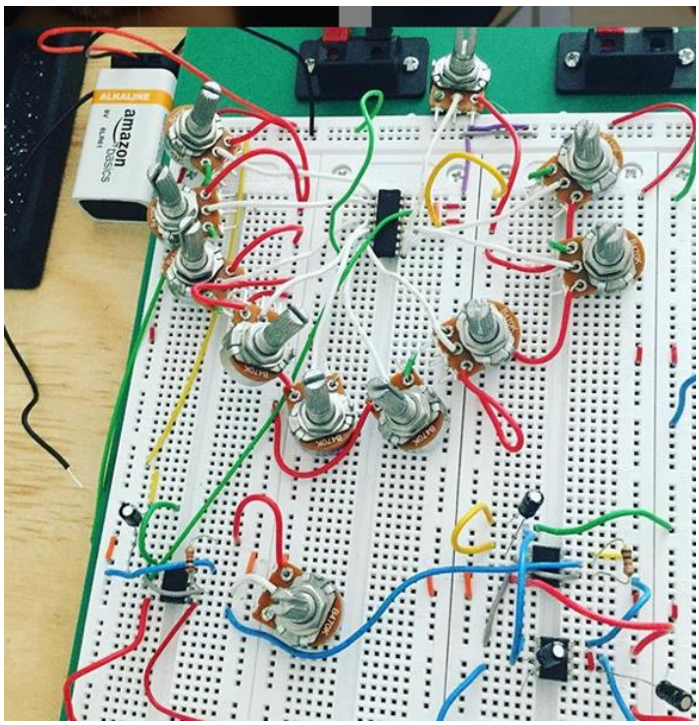


Figure 25 Baby Bot Step Sequencer Breadboard Design

This pattern suggests a heart shape. It was not that the step sequencer was in the form of the heart through design choice first but organically arose as a conversation between this creator and the materials themselves. Only by prototyping this circuit would the heart design become apparent as the most straightforward implementation of the design. Conveniently, it was also in line with this project's design goals. LEDs used are soft, warm colours similar to tones found in sunlight, which nod to the fact that physical warmth stimulates oxytocin and can create positive emotions - soft pinks, warm yellow and orange, and light purple—engaging directly with the material that illuminated the design space. (Uvnäs-Moberg et al., 2015) This dialogue between material and design fundamentally impacted visual design choices.

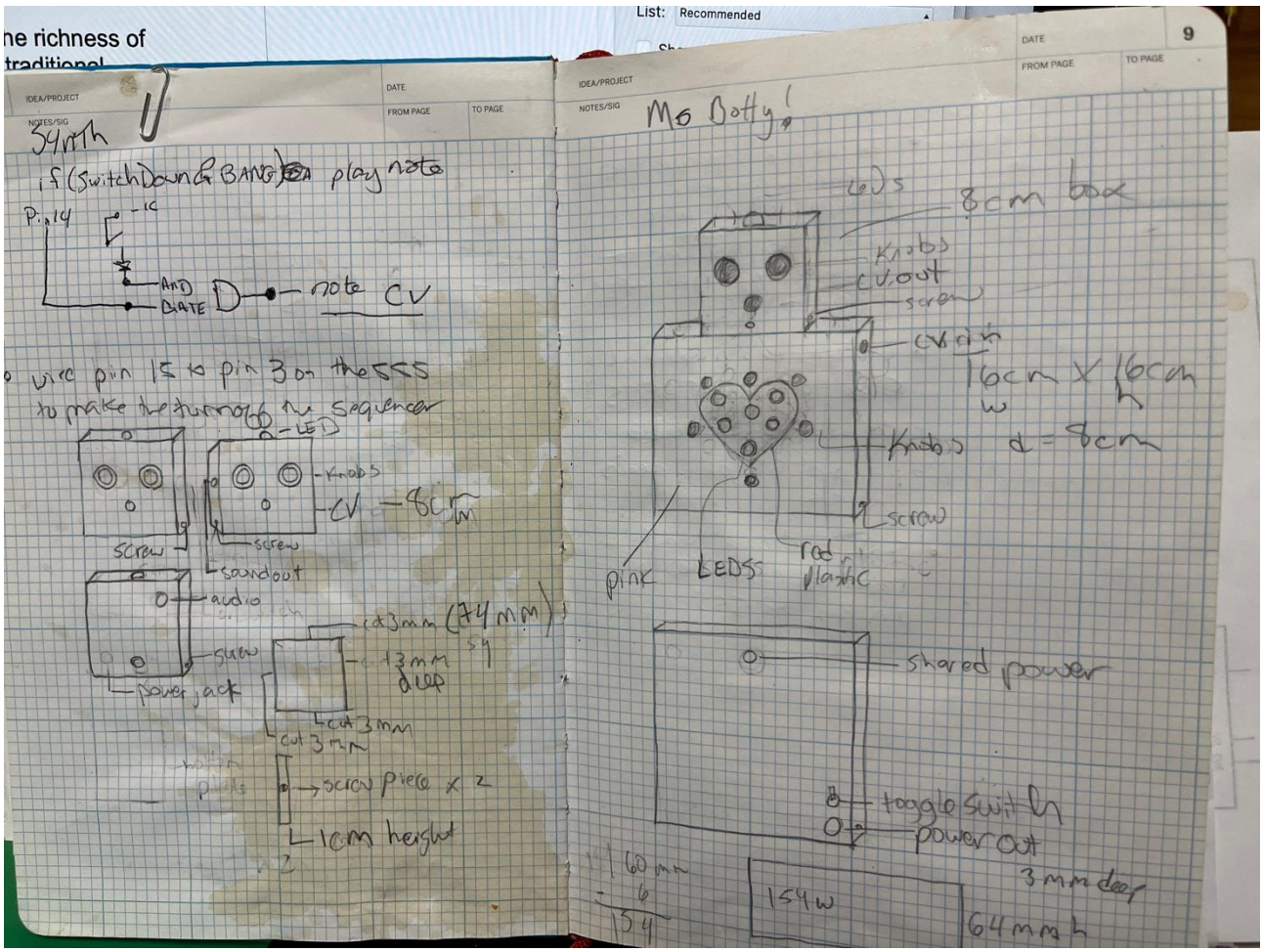


Figure 26 Maker Journal Sketch of Casing

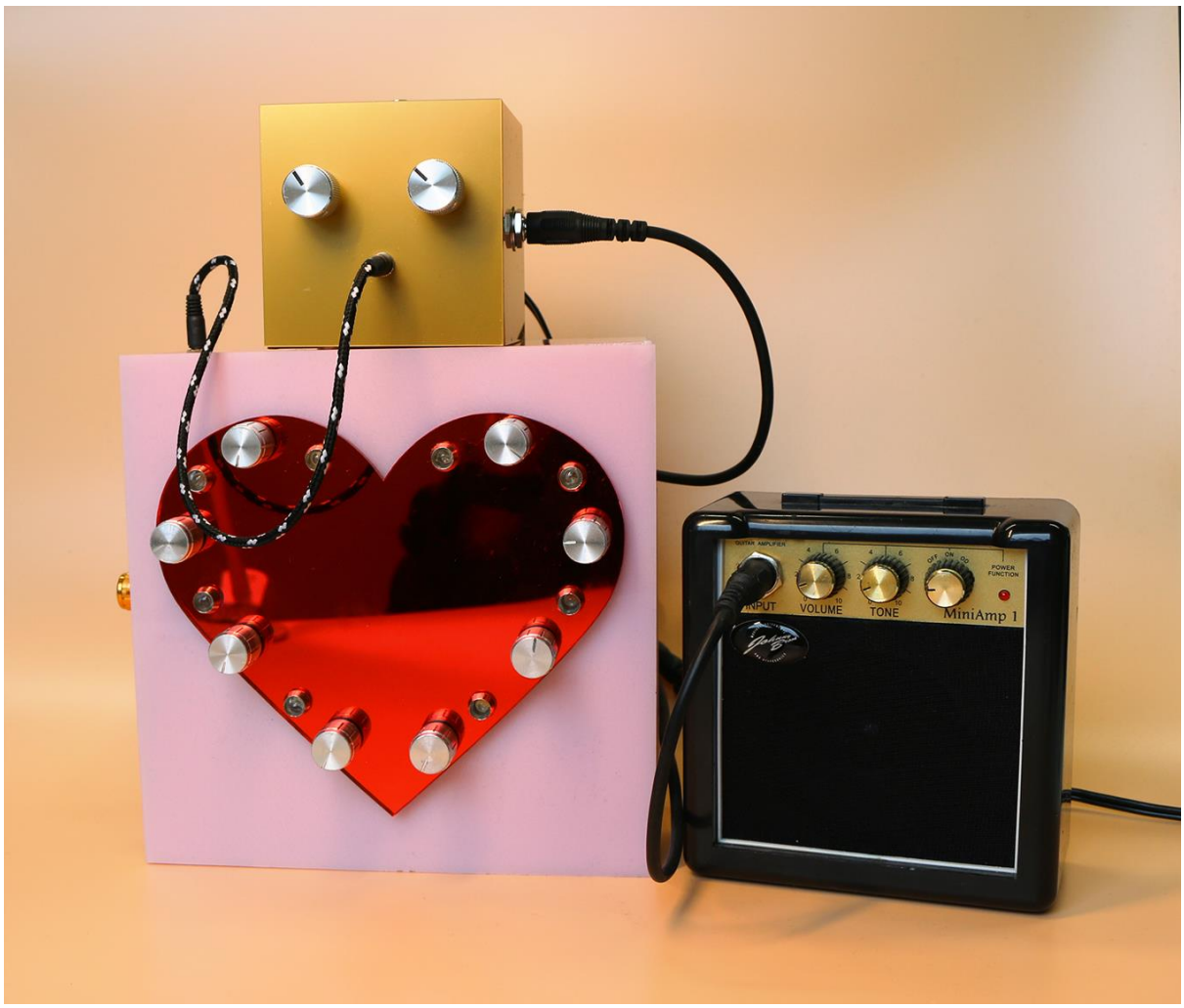


Figure 27 Baby Bot Synth and Step Sequencer casing

4.2.2 Exhibition

This work debuted at an exhibition called Women in Games and The New Intimacy, Incubate Arcade, Tilburg, NL, curated by Zuraida Buter. September 2016. Many of the pieces at this exhibition likewise explored innovation in game design through physical interfaces, collaboration, and social intimacy. The contexts of the show produced an appropriate situation to observe group experiences. As well, the curatorial statement aligns with the feminist design themes inherent in the project's design. Work from multiple initiatives supporting feminist approaches to game creation showed games, including Code Liberation, Girls Make Games, Pixelles, and Game On! El Arte en Juego. (“Incubate Arcade 2016,” 2016)

The gallery, as part of the multidisciplinary Incubate Arts festival, welcomed both Dutch and international attendees, spanning across multiple venues and boasting a staggering attendance of approximately 17,000 people. Over the course of four days, an estimated 500 individuals visited the gallery exhibition. The audience composition was diverse, with families with children constituting the majority. A smaller percentage consisted of young adults in their twenties who attended specifically for the gaming event, in addition to the general audience from the Incubate music shows. Unfortunately, these are the only statistics made available by the festival staff in conversation. Further enriching the event, a series of talks and workshops were organized revolving around the games and their content. I had the opportunity to share insights about the work on a panel titled

"Experimental Design," alongside notable figures like Celia Pierce and Kaho Abe. This dialogue created a valuable space for discussing and expanding on the themes and mechanics of the work.

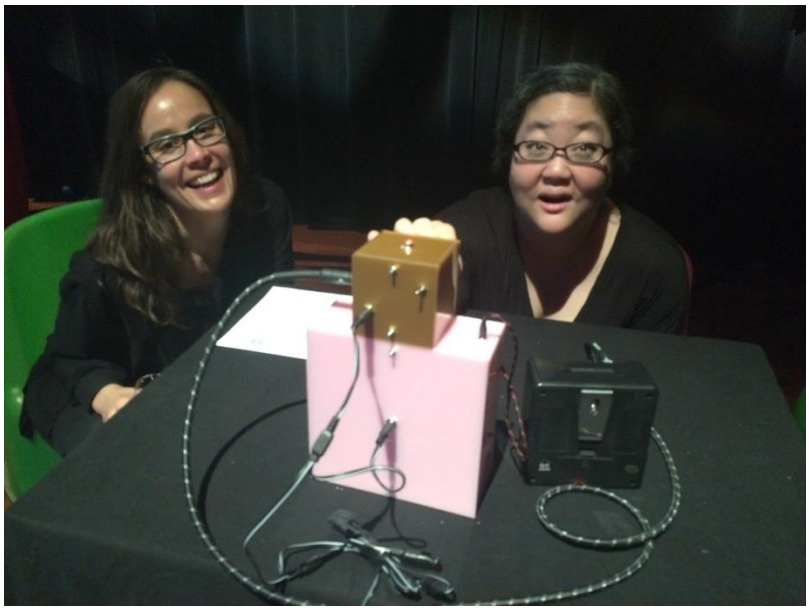


Figure 28 Kaho Abe and Phoenix Perry playing Baby Bot at Incubate Arcade

4.2.3 Evaluation

4.2.3.1 Iterative Playtesting

The strategic plan for this playtesting session was two-fold, with the primary focus areas being social music-making and emotional engagement with the work. Through direct observation of players, I sought to understand if they would engage collaboratively with modular synthesis units. Simultaneously, the informal conversations with participants offered valuable feedback on the direction of the enclosure design.

This experiment not only provided an opportunity to invite the public into discussions about the underlying concepts but also served as a litmus test for the feasibility and value of this research direction. The key questions were: Could this approach prove valuable enough to warrant further exploration in the research? Could it reveal ways in which group play might be facilitated through sound and embodied interface design? These questions guided the observations and interactions during the playtest.

Several inquiries were framed to spark open-ended conversations:

1. Have you had any experience playing music? If so, have you ever used synthesisers, specifically modular synthesisers?
2. How would you describe your feelings towards the bot?
3. If given an opportunity, what aspect of this experience would you want to change?
4. If you could introduce one feature to enhance this experience, what would that be?

The framework for this playtest involved direct observation of the participants, which included the capture of interactions through photographs and videos and dialogues

between the creator and the player.[1] It includes 14 photos and two videos. This approach aimed to foster design exploration rather than merely validating a preconceived notion. Conversations were typically held at the conclusion of the play cycle, with one exception necessitating an interruption due to an extended duration of play. As a researcher, I wrote in a journal to record observations and notes from these interactions. Given the event's fluid nature, the collection of structured surveys seemed intrusive, which led to the adoption of this more flexible, responsive approach.

4.2.3.2 Results

The interactions observed fell into two primary categories - individual play and collective play. Observations were conducted during the opening weekend of the exhibition, specifically in two three-hour sessions over the first two days. Individual players were observed exploring the different sound patterns they could produce. The device's amplified sound served to pique the interest of other potential players. Often, individuals would first observe and listen to the musical loops being created before deciding to engage with the game themselves. Even when played solo, the arcade setting fostered a performative and relational dynamic between the player and their audience. As evident from the photographic records above, attendees were drawn in by the sounds produced by the current players and often listened to their play through before taking their own turns. However, the instances of solo play or play only in the group of people who were attending the exhibit together were more frequent than desired, considering the project's objective of fostering collective engagement. Therefore, it became clear that the design should be tweaked to encourage players to invite others to join them, thereby facilitating collaboration among strangers.

Figure 29 Two friends playing Baby Bot at Incubate Arcade.

[1] The photographic and video data from the festival can be found here: https://www.dropbox.com/scl/fo/nx5u8bquwz8dl2ng2qt2i/h?rlkey=yim736z2od57p12pq5qs079v9&dl=0

Players who engaged in longer lone play cycles tended towards having musical experience, suggesting a correlation with expertise in electronic music creation. Two players owned Eurorack Modular synthesis units. According to this researcher’s notes, one player played for an estimated 20 minutes before I approached him. He traded a circuit board of his design for a sketch of the Baby Bot 10 circuit at the exhibition.

Children who came across this installation were often puzzled by the function of a physical knob, requiring their parents to demonstrate its operation. The intensity with which children engaged with the device led to multiple necessary repairs on site. One child exerted enough force on a knob to detach the electrical cables from the pins and dislodge the component that was secured with hot glue. This encounter underscored the need for re-evaluating the use of movable parts in the design, particularly when children comprise part of the audience. The duration of solo play sessions varied, ranging from less than a minute to around five minutes. Only one participant returned for a second round, engaging with the game for an estimated 20 minutes.

Groups of players usually consisted of two or three individuals. These players collaborated, working collectively to adjust tones or patterns. During two-player sessions, a recurring dynamic emerged: one participant would alter the step sequencer while the other would manipulate the bot head knobs. This required players to sit closely together, naturally fostering physical contact, as documented in photographs. Interestingly, groups of children displayed less forceful interaction with the hardware compared to solo players. It appeared that most children moderated their actions, cognizant of their shared playing experience. Notably, no damage to the unit's knobs occurred during these group play sessions.

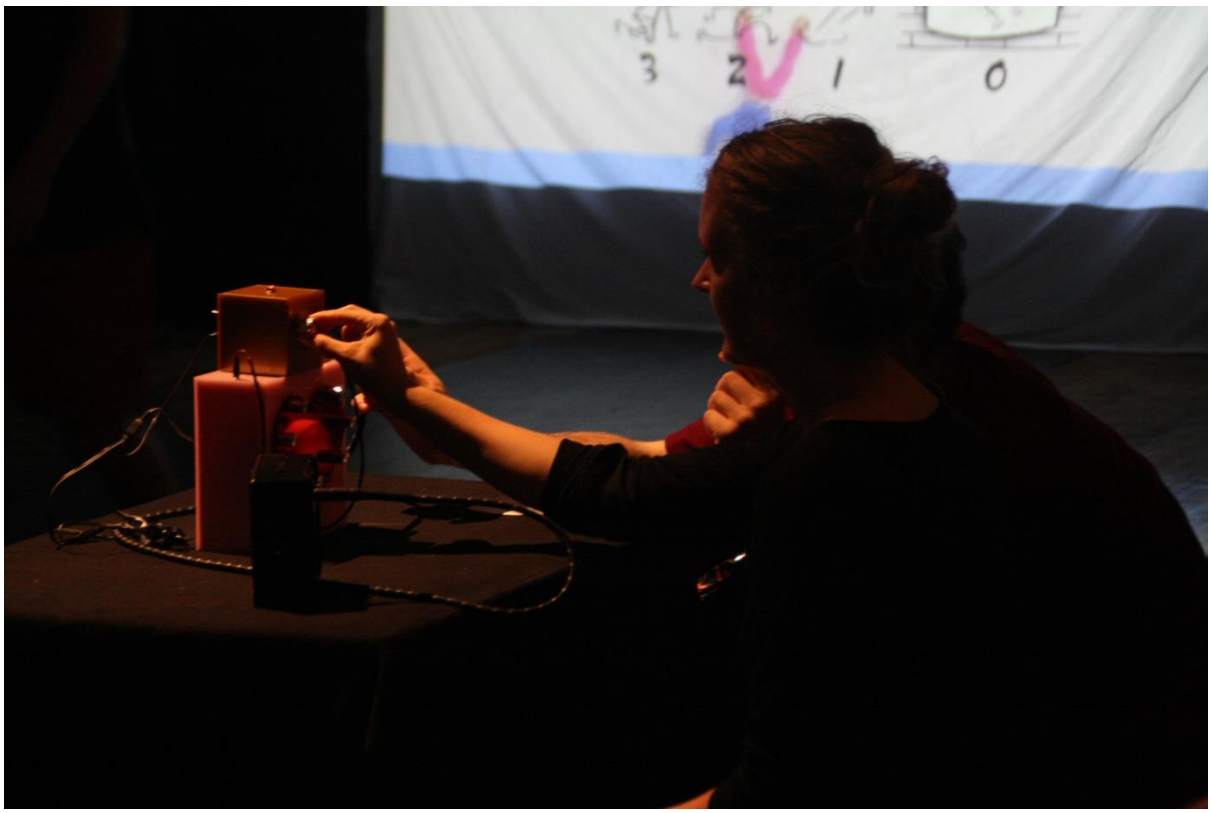


Figure 30 Two Players playing both Baby Bot units together.

Figure 31 Two children playing Baby Bot

Intriguingly, while the observed gentler play during group sessions could be attributed to coincidence rather than causation, research studies conducted on children's group play point towards a potential correlation, suggesting that group play may enhance prosocial behaviour (Kirschner and Tomasello, 2010). The duration of play cycles in groups fluctuated, ranging from less than a minute to approximately three minutes.

While participants in groups engaged closely with the bots, their range of motion appeared limited and their interactions brief. Remarkably, only a few individuals opted to hold or lift the bot during play. Another interesting observation, noted both in solo and group players, was the occurrence of the 'bot selfie'. Players posed with Baby Bot as if it were a friend, indicating a level of positive emotional engagement with the work.

Regrettably, the continuous noise emanating from the game proved to be a source of irritation for the staff overseeing the space, leading to frequent instances where they turned off the sound. This action often misled players into thinking the game was non-functional, necessitating the creator to rectify the situation by turning the volume back up. This pointed towards a significant area of design improvement.

An unforeseen complication with the physical enclosure surfaced during shipping. In short, the entire structure had vibrated apart. The solvent used to bind the boxes, although invisible and strong, failed to withstand the rigors of transportation. After the festival returned the unit to the creator, despite careful packaging, the case needed comprehensive reconstruction upon arrival. This transportation failure highlighted a significant constraint and underscored the necessity for robustness in design, especially for facilitating wider public engagement. Open-ended conversations with players yielded many quantitative points. Players commented on the design and interface feedback clustered around three main areas: the desire for improved experience design, game design requests, and comments on the scale.

Overall, the bot's design scheme was mostly successful. Visual design feedback was positive. Repeatedly, the term cute characterised the players' opinion of the design. Several people commented positively on the colour scheme. Multiple players noted the

use of the heart shape for the step sequencer design as successful. Requests were made for purchasing the unit and for schematics from other creators. These requests suggest a positive reception to the work.
Players suggested it would be interesting if there were dozens of units and characters to choose from versus merely two connected as one character. Several people suggested the possibility of adding a story to the project and more gameplay. Perhaps the work could grow beyond being just a musical instrument into a game? Additionally, people wanted to be able to pick them up and be able to move around with the character to explore connecting them in multiple configurations.

The form factor was another noted area for exploration. Multiple players suggested smaller units would make it easier to pick up and play with the bots. Longer cables to allow for more movement were likewise requested. One player suggested making the bot at least a meter in size.

4.2.4 Conclusions

From observing this object's interaction with the public, several outcomes are clear. Based on these findings, research suggested the visual design was popular enough to continue to develop. The robot successfully attracted an audience, and the selfies suggest emotional engagement was happening on some level.

However, the above clearly showed a need to enrich the experience, and the feedback was helpful enough to point towards avenues for inquiry. The exhibition proved fertile ground for considering possible future design directions. To incorporate the above findings, the project required reconsideration. A submission to Now Play This proposed a work based on this research to a curator at Somerset House. The proposal was to create multiple bots which users could connect in meaningful ways with sound as re-enforcing the design objectives.

4.3 Prototype Two: *Bot Party* 2

After the exhibition, this researcher was unsure what to make next, and how to proceed. During this period, ideas for an entirely new game, *Thrum*, emerged. Unpacking player feedback caused a rapid phase of idea iteration for group play. After a few months of working on *Thrum* in the fall of 2017, the research was exciting enough to contact Now Play This and attempt to change the successful proposal to be allowed to work in that direction alone. A swift, firm no from the curator was received. *Bot Party*, as this creator newly dubbed it, had been chosen to be a focal point of the exhibition, and the change would disrupt the curatorial flow of the space. However, *Thrum's* prototype could be shown as well on one of the days, which was highlighting experimental games in development. What resulted was an over-promising on the part of this creator and a very intense several months of concurrent game development which would not have been possible without access to an accessible prototyping space with fabrication facilities.

As a part of the Makerspace Machine's Room, I was immersed in a vibrant community of creators and collaborators, benefitting from round-the-clock access to fabrication tools and studio space. The significant role of this space in the execution of the research at hand merits explicit recognition. (“About Machines Room,” 2020) Prioritising accessibility in their design approach, Machines Room distinguished itself as a unique maker space in London.

Several modifications were made within Machines Room specifically for my convenience and accessibility, including the installation of adjustable monitors at eye height, provision

of computers equipped with Wacom tablets for operating fabrication equipment, adjustable workspaces, dedicated storage facilities to mitigate the need for transporting heavy work, and the invaluable assistance from fellow members in moving bulky items.

Numerous other adaptations were also put in place to accommodate other users' needs. This included an eco-friendly, wheelchair-accessible restroom constructed collectively by the community, provision of simplified manuals both online and in print on coloured paper to enhance readability for users with dyslexia, and support for leaving accessible equipment on-site.

The accessibility and tools provided by Machines Room were instrumental in the realization of this project, which aimed to explore alternative modes of interaction that diverge from traditional game controller design patterns. By fostering a community that encompasses a diverse range of abilities, we collectively shaped the environment as part of an ongoing dialogue, ensuring the facilitation of creative work.

4.3.1 Controller Design

Throughout this phase, multiple iterations of the case were produced using materials like wood, cardboard, and assorted plastics, utilizing laser cutters. Initially, cardboard was employed, given its status as a readily available and recycled material. The unit's enclosures acquired new points of interface interaction, with a button supplanting the knob to enhance durability. By fastening the button to the box's interior, it circumvented the damage exhibited in the Baby Bot model. Cardboard's affordability and ease of manipulation enabled rapid and cost-effective testing of various types of buttons and LED mounts.

One of the objectives was to ascertain if painted cardboard or a similar substance could serve as the final material. An experiment was conducted to determine whether the boxes could be flattened and assembled at the exhibitions themselves. However, cardboard's primary drawback was its susceptibility to getting crushed; even after a few tests, signs of wear and tear became evident.

Exploring the use of polypropylene as a foldable box solution presented an opportunity to learn and adapt. This researcher was required to repair a donated laser cutter to ensure it had the power necessary to score the material, a process which led to the creation of informative documentation that supplemented the Machines Room's accessible manual collection.

Through this experience, a deeper understanding of laser beam focusing issues was achieved, particularly how manual positioning of the laser led to improved scoring marks on polypropylene. Optimal fold lines were achieved through etching into the material. The challenge lay in managing the laser's tendency to melt the polypropylene, which necessitated a low-power, high-speed approach to avoid perforating the material. Defocusing the beam slightly also proved beneficial, as it distanced the laser from the material.

However, the polypropylene boxes, while successfully cut, felt sharp to the touch and were structurally unsound, easily exposing the electronics with a gentle squeeze. These challenges led to the decision to abandon this direction. The trials of folding the enclosure proved problematic, leading to a preference for pre-assembled, glued boxes as the optimal solution.

The optimal size of the bots was determined through an iterative process of testing and conversing with other artists and the public at Machines Room, ultimately settling on an 8x8x8cm cube. This dimension was comfortable for both adults and children to handle. While smaller sizes could possibly work, they presented a challenge in accommodating the necessary electronics. On the other hand, larger rectangular shapes that were previously used to house the step sequencer were discarded, as they proved to be too cumbersome for players to grip and interact with simultaneously.

A significant shift in the design process was prompted by a playtest, which aimed to prototype the patching mechanic of the game. This involved using wooden boxes of the chosen 8cm cube size, though these iterations were devoid of any electronics. Three players were instructed to connect the boxes in various configurations. In lieu of cables, two-meter lengths of twine were used, attached to the boxes with masking tape.

This exercise lasted for three minutes and provided an insight into the interactive dynamics between the players. While the collaboration started aligning with the project's goals, it also revealed an unintended complication - the twine often ended up in knots, making untangling a part of the experience. This deviation brought about a collaborative puzzle-solving aspect, which while metaphorically fitting with the theme of human connections and their complexity, didn't align with the project's specific intention of fostering an experience of human connection.

The task of untangling the knots risked overshadowing the desired gameplay experience, as it shifted the group's focus towards puzzle-solving. It threatened to turn the project into an object-oriented endeavour, drawing players' attention away from each other and towards the object they were all modifying. This stark contrast between the actual outcome and the project's goal led to a reconsideration of the gameplay. The aim was to enhance player awareness of each other, not to focus them on an external problem. Thus, the experience design needed to be reevaluated and refined to better encapsulate the project's objectives.

To encourage connections between people and the boxes, a novel approach was needed. This prompted an exploration into the use of different materials and technologies, and capacitive touch technology emerged as a promising candidate. This technology uses the skin as the primary point of interaction, registering touch when a person makes contact with an object. The question was, could capacitive touch be manipulated to facilitate more complex interactions, such as detecting contact between individuals, and also allowing for a diverse range of connections at varying points in time?

In standard applications, a touch sensor, like the MPR121, is added to a microcontroller to detect touch on a surface. However, this setup alone wouldn't fulfil the requirements of the project. One potentially useful piece of hardware was the Makey Makey, a popular board based on the ATMega 32U4 microcontroller. This board is often used as an educational tool to introduce electronics to children.

Despite its apparent suitability, the Makey Makey in its standard configuration couldn't detect touch in a manner conducive to group play without extensive reworking of the microcontroller's code. The Makey Makey uses high resistance switching to detect connections to various materials, including those with low conductivity like pasta. However, it requires a ground connection to function correctly.

To clarify the limitations of the Makey Makey in the context of this project, let's define the interaction space for three touchpoints:

1. Point 1 to ground: The connection is made when one individual touches point 1, with the system grounding through their body.
2. Point 2 to ground: This connection happens when another individual touches point 2, grounding the system through their body.
3. Points 1 & 2 to ground: This requires two individuals to touch points 1 and 2 simultaneously, grounding the system through their bodies.

These scenarios expose the constraints of using the Makey Makey board for the desired gameplay and hint at the need for a more complex, customized solution to facilitate the desired interactions.

The constraints of the Makey Makey board continue to emerge when considering more complex interactions. A direct connection between point 1 and point 2 is not feasible with this system. One of these two people needs to be holding the ground as well as the point. The device cannot differentiate between a touch on point 1 and no touch at all, unless the user also comes into contact with the ground pin. The predefined pins also limit the output options on the microcontroller, reducing the scope for customization.

Moreover, the cost of the Makey Makey is roughly as expensive as a full development board such as an Arduino Uno. Though it is possible to build additional circuit boards to expand its functionality, the task would be more cumbersome compared to using most other microcontroller prototyping boards. Given these constraints, the Makey Makey's embedded software and hardware turned out to be less than ideal for this project. Despite the interesting applications presented by the board's C++ code, it was not the best fit. (“sparkfun/MaKeyMaKey,” 2018)

An alternative option that proved to be more suitable was the Teensy 3.2. This microcontroller was not only more flexible but also more powerful, aligning better with the project's goals. With a 72 MHz Cortex-M4 processor, it offered faster speeds than the ATMega 32U4, and its larger number of Input/Output (I/O) options provided more possibilities for experimentation. The Teensy 3.2 boasts thirty-four user-configurable I/O pins, making it an excellent choice for larger-scale iterations of the project. Furthermore, at a cost of £15, it was significantly more affordable than the Makey Makey.

The exploration of capacitive touch for creating interactive interfaces brings to light a noteworthy study, Touché, conducted by Disney Research.(Sato et al., 2012) The researchers in the study were able to establish capacitive profiles for a vast array of potential gestures and interactions. The process involved sweeping through an oscillating wave of voltage and observing how the frequency and amplitude of the voltage were influenced by touch across various inputs, effectively creating an offset. These wave profiles were then passed onto a recognition system. While the specifics of this system weren't explicitly detailed, it implied the utilization of some form of machine learning-based classification or regression for recognizing distinct waveforms. The concept is rather straightforward and can be replicated in a basic form using an Arduino, opening doors to myriad applications.

Arduino, as detailed by Banzi, stands as an umbrella term denoting four simplified engineering processes tailored for novice developers and rapid interactive prototyping. Arduino is a programming environment that operates within a subset of C/C++ functionality, providing a beginner-friendly introduction to coding principles.(Banzi, 2014) It serves as an integrated development environment (IDE), a dedicated platform to write and compile code. Thirdly, Arduino enables developers to program a microcontroller - a compact computer on a single integrated circuit meant to govern specific operations in an embedded system. In addition to programming the microcontroller, Arduino facilitates

uploading the written program onto the microcontroller via a serial connection over a USB port. This feature is particularly useful in the iterative process of code testing and debugging, offering a convenient mechanism for software updates. Lastly, Arduino is a generic term used to refer to all microcontroller boards officially released by Arduino.cc. Several other boards, such as the Teensy used in this project, are dubbed "Arduino-compatible". This implies that these boards can be programmed using the Arduino subset of functionalities within the Arduino IDE. Consequently, the Arduino IDE can upload the code to these Arduino-compatible microcontrollers, providing developers with a wide variety of hardware options for their projects.

After engaging with analogue circuitry in the Baby Bot project and reviewing the Disney research, an intriguing question arose: could this application be recreated using Arduino? Could the unique interplay between voltage oscillation and the resistance of the human body serve as a lesser-explored facet of interface design? To probe this, a recreation of the experiments described by Disney Research was conducted. In this setup, three pins on a microcontroller were connected via wire to three boxes, each with one side of aluminium foil serving as a sensor.

The process began by generating a waveform on an output pin of a microcontroller, where the voltage oscillated between high (5V) and low (0V). This oscillation created a waveform over time. The principle behind this is that touch reduces the voltage across a capacitive touchpad since human skin can store electric charge. Thus, a person would effectively absorb voltage from the sensor and dissipate it across the resistance of their skin.

To translate this physical phenomenon into usable data, the value of an output pin set to 5V was read and stored in a variable. Subsequently, the same pin was set to 0V and re-read, with the result saved into a second variable. The change in voltage was then calculated by subtracting the low value from the high value. By saving this change in a sum variable and adding it to the sum of the high reading minus the low reading of the next pin, the data shifted according to the last known reading. Continuous measurement of this pin, with the results saved and changes compared between the first value and the subsequent reading, yielded a series of data points. The remaining task was to filter this data in a manner most conducive to the application's purpose.

What's fascinating about this application is its simplicity, making it highly replicable. Indeed, several creators have documented similar processes online, with some resources predating this research and others developed subsequently. (Panos, 2014) Mads Høbye, for instance, achieved considerable success in reverse-engineering this concept by creating an easy-to-produce circuit. (Hobye and Löwgren, 2011) Nevertheless, the approach adopted in this PhD project, while straightforward, appears novel and distinct from the documentation found so far. Developers implementing this concept may choose to filter the data in ways that yield optimal results for the application and sensor materials chosen.

In this research, modifications were made to Høbye's original touch code with the intent to enhance its stability and reliability. One of the challenges with Høbye's code was the waveform produced by his touch-detection function. The function yielded abrupt and irrelevant jumps in the signal around the expected value for a touch, leading to an unpredictable system. In response, I adopted a strategy of reducing the signal's resolution. This involved remapping the potential 1024 outputs to just 10. This decision to reduce to 10 was not random but the result of a systematic process of trial and error.

In addition to this, Høbye’s code often picked up noise, which led to extremely low or negative values in the mathematical outcomes due to the way the waveform was being

sampled. In essence, the code was sensitive to unwanted noise that compromised the accuracy of touch detection. To resolve this, I hard-coded a low-pass filter into the system. This filter essentially discarded all the values lower than 2, effectively acting as a noise filter. In signal processing, a low-pass filter allows signals with a frequency lower than a certain cutoff frequency to pass and attenuates frequencies higher than the cutoff frequency. By applying this low pass filter, I mitigated the impact of irrelevant high-frequency noise, thus cleaning up the signal.

As a result of these two significant modifications—reducing the resolution of the signal and hardcoding a low-pass filter—the touch data's reliability was vastly improved. The combination of data reduction and filtering ensured a cleaner signal that was more consistent, leading to more predictable and accurate touch detections. These modifications to Høbye's original code proved to be an effective strategy in enhancing the system's performance and reliability.

To validate the feasibility for expanding this method for interactions involving three outputs, the data was visualized using an oscilloscope. The wooden boxes created at Machines Room, each with dimensions of 8cm^3, served as the interfaces. Household aluminium foil was affixed to one side of each box, forming an 8x8cm sensor pad. Each of these pads was directly linked to a microcontroller pin via conductive aluminium tape. Observation of voltage variations on the oscilloscope in response to different interaction points confirmed that touch between boxes was indeed detectable. Further processing of the signal or application of machine learning could provide precise data on whether contact occurred. However, it was unclear at this stage as to the limit of this methodology - while three people were detectable, would it hold true for four or more? Playtesting was needed to shed light on this question.

To better understand the potential number of players the game could accommodate, an informal experiment was conducted with seven participants to probe the hardware's limitations. Three of the participants were given boxes, which were distributed evenly around the circle to the best extent possible with seven players. Following the group instructions to form different hand-holding configurations, the voltage data from all three pins were graphed and observed using Arduino's default serial plotter tool. The results showed significant voltage shifts in the circuit in response to connections, suggesting that group interactions beyond three people were viable. It was demonstrated that a connection could be formed with five people between the first and second player, and even with all seven participants.

Additionally, it was noted that if all three boxes were simultaneously linked via people, a discernible drop in voltage occurred due to the significantly increased resistance present between the sensors. With this understanding of the possibilities, the focus of the project shifted towards improving the circuit and refining the game design. The use of human participants, rather than patch cables, to form connections between units emerged as a straightforward solution. It simplified the circuit and provided players with a clearer understanding of the design values. Consequently, this became the interaction model for *Bot Party*, prompting a reassessment of the design values considering this new research.

At this point, reviewing the design questions from the first iteration are useful. They were:
1. Most modular synthesiser interfaces are solo experiences. Is there a way to distribute sound exploration among a group of participants?
2. Are there ways to consider feminist design principles in the game design to create emotional engagement?

Drawing on insights from tangible engagement and playtests, it becomes clear that the original notion of constructing modular synthesis systems has evolved to serve as an inspirational reference. This significant shift necessitates a reassessment of the initial research questions. Existing studies by Kirschner and Tomasello, which observed children participating in group music creation scenarios, found that children engaging in collective music-making are more likely to exhibit prosocial behaviour subsequently.(Kirschner and Tomasello, 2010) In the context of *Bot Party*, could sound function not merely as an experiential enhancer but also as a potent driver of embodied engagement within the piece, achieved through sonifying bodily movements? Given this, we need to explore if journeying through a shared soundscape can elicit prosocial behaviour as effectively as collective music creation does. Moreover, it is worthwhile to consider if granting sufficient agency to players through motion tracking can nurture a similar sense of collaboration and foster prosocial behaviour.

During this period, I and many others who promoted equality in the games industry were recovering from the extreme toxicity of becoming international hate group targets by what later emerged as the alt right during a period which was dubbed Gamergate. Gamergate was a twitter hashtag that was used to harass, threaten, dox and hound women in the games industry doing feminist activist project, as I was with my project Code Liberation Foundation (CLF). CLF taught women to make games for free and was most active between 2012 – 2019. (“Cyberfeminism Index,” 2023) Could *Bot Party* become a feminist point of resistance, a game which sits directly counter to acts of violence and rather encourages pro-social action and community?

Surprisingly, despite the critical role tactility plays in promoting wellbeing, few digital technologies, particularly games, utilise it as a form of interaction. It raises a pertinent question: How can games, especially those introducing custom controllers, stimulate embodied play and foster touch among players in a group setting, with the goal of enhancing positive affect? Moreover, how can these interactive experiences be designed to embrace the touch-sensitive nature of human interactions to engender a deeper sense of connection and empathy among players? Can extending feminist notions of softness into the game design support healthy community behaviours?

The quality of softness can potentially encompass a wider range of empathetic engagements among players. To support the second objective, an Inertial Measurement Unit (IMU) was integrated into the circuit to provide players with a broader range of motion and possibilities for exploring sound through the movement of their bodies. A freeform game that fosters multiple possibilities for action, encourages physical touch among players, and enhances the clarity of the experience design was envisaged, built around the following observations from the first prototype and above design prototype experiments:

1. The game should be quieter between plays and simply make sounds occasionally to welcome players over to play, as well as blink.
2. There should be a sonic acknowledgement that players picked up a box
3. Each box is a character from the game. There are three characters, and their sonic personalities should correspond to these characters.
4. On button press, each character should emerge with a signature sound
5. Touch between players should generate a sound in the vocal range of a character that sits clearly outside the sonic space of the music to make it a unique event.
6. When all three players touch, a keystone event in the sonic field should happen. All of the other sounds should be less important than this pinnacle moment.
7. Moving with the box should make a sound - Ideally, it should control filters and effects on a synthesised sound. Direct sounds such as single hits are not suitable, but clips or sequences which the user navigates through via motion are excellent.

8. The LEDs will correspond to button presses to make the characters feel alive.

The decisions regarding how sound should behave in this interactive experience are a culmination of this researcher's prior work creating public interactive soundscapes. One significant influence was a lesson learned from a previous project, Night Games, developed in 2013. Night Games aimed to let the audience generate a sonic playspace, using motion triggers from a PlayStation Move controller to produce sounds.(“The Games of Jane Friedhoff and Phoenix Perry,” 2014)

However, the unpredictable movements of the players resulted in a lack of sonic cohesion, leading to a sense of chaos. Users reported difficulty in discerning which sounds they were responsible for manipulating, creating a disconnect between their actions and the audio response. This experience was chaotic and perplexing for the players, as the correlation between their actions and the resulting sound changes was not intuitively clear.

Informed by this prior experience, the proposed design choices for the current project were viewed as potential solutions to these past challenges. One major change was binding the movement to the modulation of filters and the progression of a MIDI clip. Instead of triggering arbitrary sounds, this approach grants the player more control over an ongoing sonic sequence, enabling them to explore the soundscape more deliberately and predictably. By providing a clear relationship between user movement and sound output, this design aimed to prevent the confusion experienced in Night Games, enhancing player comprehension and engagement in the sound experience.

Considering the interactive and exploratory nature of the project, the introduction of a playful narrative could indeed provide an additional layer of engagement and intrigue. For instance, a story about the bots exploiting human contact to covertly transfer data between isolated networks using an inventive BSSB (Bot-to-skin, skin-to-bot) protocol could be introduced. In the narrative, these bots, due to a recent decrease in human performance, feel the need to assume a physical form to retrain their human counterparts in the art of human connection. Players might be given auditory instructions such as "Let's connect", "Skin to Bot", and "Touch me!" to guide their actions and immerse them more deeply in the storyline.

However, the addition of this sonic narrative and the requirements for sound design necessitated collaboration with an audio expert. Given the substantial workload involved in hardware engineering and embedded coding for the hardware component, the responsibility of authoring the sound—a domain where this researcher's expertise is comparatively limited—required external assistance.

Two prospective collaborators for this task were Frieda Abtan and Brian Jackson. Unfortunately, Jackson was unavailable within the required timeframe, leaving Abtan as the chosen collaborator. Her shared research interest aligned well with the objectives of the project, making her an ideal partner in bringing this sonic interaction narrative to life. With her contribution, the project could be adequately prepared for its exhibition at the upcoming Now Play This event.

Abtan's unique approach to sound design and her take on the design instructions for the soundscape brought an additional layer of interaction potential to this version of the game. Notably, her in-depth understanding of the use of algorithmic manipulations in sonifying movements played a significant role in shaping the project's outcome. Her ability to leverage these complex sonic manipulations to express movement in compelling ways added a rich texture to the project.

Furthermore, her sonic contributions considerably enhanced the project's appeal during its exhibition. Abtan developed a unique sound design structure that added depth and complexity to the project. The sound design included three distinct soundscapes and three individual instruments, each attributed with specific interactions, thus providing a dynamic, evolving auditory experience throughout the exhibition. This went beyond the ask of this research to create one such world. The play cycle was defined by transitioning the sound environment each time all three players made hand contact, providing an engaging, fresh auditory experience throughout the session. With the above design goals of having different sound space for each bot, Abtan segmented the composition into three parts: rhythm, melody, and drone. Each segment had specific interactions associated with it, which were tailored to the player's actions.

For the rhythm instrument, the pitch was controlled by the tilt of a cube in three dimensions. This instrument was further enriched with two IMU parameters, which were tied to player movements, creating an immersive, responsive sound experience. The melody instrument, on the other hand, was designed to produce individual notes from a Markov chain when the player made a jerking motion with the bot. This was achieved by measuring changing acceleration within a small temporal window. The tone's filters were derived from motion metrics, providing a richer sound experience beyond just note value. Lastly, the drone instrument utilized an adaptive 3D tilt to modulate the speed of an envelope and filter. This design encouraged players to explore the sonic environment by creating slow-changing, amorphous sounds that responded to and rewarded languid manipulation of the cube. This approach effectively incorporated the physical movement of the players, enhancing the immersive, multi-sensory experience of the game.

For the contacts between people, she composed interaction sounds for the three characters that were designed by this researcher - a bear, a cat, and a girl. This researcher wrote instructions appropriate to the game's narrative, which users trigger by the bot's button. Abtan used a vocoder to match the sound design to the story.

Abtan's sophisticated methodology for extracting meaningful data from the Inertial Measurement Unit (IMU) was instrumental in shaping the immersive auditory experience. She implemented a series of strategies that made the most out of the sensor data, which helped to map the movements onto meaningful game interactions.

To begin, she incorporated a system to recalibrate the compass after one minute of inactivity, ensuring the sensor's accuracy. Additionally, she resynchronized the data stream to a reliable 100ms interval, which further enhanced data consistency. Secondly, to utilize the 3D tilt of the bot, she processed the sensor data in several ways. She started by smoothing and scaling the sensor readings based on the minimum and maximum values received since the last recalibration. She then measured the tilt's direction and calculated the displacement of the angle to derive the total tilt. Following this, she computed the rate of change to determine the speed of the tilt.

Abtan also developed an intricate system for using the bot's acceleration data. The system not only tracked total acceleration but also measured the fastest and slowest movements within a specified timeframe and detected periods of stillness. Importantly, it calculated the time since the last stillness, providing an insight into the duration of a player's engagement. Furthermore, she developed techniques to detect both slow and fast movements, which enabled the system to identify various player behaviours. These include sudden motion, jerks, shakes, and changes in the cube's position. Abtan's extensive work in deriving interaction mechanics from these observations significantly supported my user experience design within the game. Her approach went beyond the

initial project requirements, thus enriching the game's overall interaction design for players.

During this phase of the research, my focus shifted from creating sound circuits to a complete redesign of the game, the circuitry, making and designing the casing, and programming embedded software. The objective was to create a robust set of objects that could endure the rigorous interaction from the 2000-3000 children who attend the annual Now Play This event over three days. The design of the controllers underwent an iterative process, incorporating playful elements to support the narrative, as was covered above.

In a whimsical twist, two of the bots were equipped with glasses, and one with false eyelashes. The intention was to make a joke of humanizing them to downplay their robotic nature, while also adding an element of charm. The Groucho Marx disguises are a playful, whimsical addition. By enhancing the eyes in this way, the bots were given a more innocent, childlike, and appealing appearance. The red and pink colour palette was expanded to include a calming shade of blue along with gold and silver mirror hues. The placement of the button on the controllers mimicked a mouth, further anthropomorphizing the bots. The main box, housing the microcontroller and a Mac mini, was made from wood, setting it apart visually. The game's title was also inscribed onto this box, further establishing its name recognition.

The incorporation of classic looped phone cables to link the bots not only presented a practical solution for connectivity but also introduced the symbolic concept of communication and exchange. This approach imbued a layer of visual narrative depth to the overall design, reinforcing the theme of interconnectivity and collaboration within the game. The aim of this comprehensive design strategy was to construct an interface that was not only visually engaging but also provided a deep level of player interaction with the game.

Given the design limitations of the phone cables, which only accommodated three wires, certain compromises and adaptations were required to ensure effective transmission of serial data. For instance, each bot was equipped with an accelerometer and a button state that communicated with the central radio receiver through radio waves. This receiver, connected to a computer, would receive, and process this data.

Within each bot was an intricate network of hardware components. A Teensy 3.2, a small yet powerful microcontroller, served as the heart of each bot. Attached to the Teensy via header pins was a shield that hosted an XBee Series 1 radio, responsible for wireless data transmission. Sitting atop this assembly was a prototype shield equipped with an accelerometer.

To cue players and communicate with players, LEDs and buttons were integrated into their casings. These elements were connected to the appropriate microcontroller pin, thereby ensuring their functionality. The phone cable was utilised to connect the bot's power, ground, and touch sensors to the main circuit linked to the computer.

To facilitate the interfacing of these systems with the computer, a couple of distinct hardware packages were attached via USB ports. One package included a Sparkfun XBee Series 1 shield hosting another XBee radio. This shield was plugged into a USB port, enabling the receipt of serial data from the bots. The second package consisted of another stack of circuit boards, starting with a Teensy 3.2 connected to the computer via a USB cable for sending serial data. Sitting on top of this my custom-made circuit board designed to connect the phone cables to the Teensy.

To quickly iterate and prototype, these DIY circuit boards were reinforced with a thick 3mm layer of hot glue. This approach was chosen to stabilize the connections and address stability issues that had been encountered with a previous version of the project, Baby Bot. While this method did somewhat limit the potential for swift on-site repairs, it did provide a much-needed level of security and robustness to the electrical connections. Superglue was used to replace the more professional acrylic glue which was used in Baby Bot to keep the boxes from being damaged.

Figure 32 Bot Party bots set up at Now Play This

4.3.2 Now Play This Exhibition

Now Play This is a well-regarded festival held annually in London that showcases innovative and experimental game design. The event takes place at the historic Somerset House and attracts a diverse array of game enthusiasts, creators, and academics. In 2017, the festival was curated by Holly Gramazio. The comprehensive summary report issued by Now Play This offers invaluable insight into the event's audience ("History," 2020). According to the data collected from ticket sales and visitor surveys, the third edition of Now Play This, held from 7-9 April 2017, welcomed a total of 2,639 visitors. The gender distribution among attendees was roughly equal, indicating an inclusive atmosphere that catered to various interests and demographics.

Interestingly, the survey revealed a shift in motivational factors compared to previous years, with a noticeable uptick in family-related motivations. This suggests that the event's appeal extended beyond individual gaming enthusiasts to encompass group and family interests, turning it into a communal and interactive experience. Furthermore, there was a significant increase in the number of visitors under 35 years of age, specifically those aged 25-34. This 10% increase compared to 2016 is indicative of the event's increasing

relevance and popularity among younger demographics who are often at the forefront of gaming and technology trends.

One of the striking findings from the visitor surveys was the event's ability to attract a more ethnically diverse audience compared to other Somerset House activities. With 22.2% of attendees identifying as non-white, compared to 17.1% for other exhibitions and events in the preceding year, Now Play This emerged as a multicultural platform with broad appeal. This diversity underscores the appeal of gaming and experimental play to a broad audience. This detailed profile of the audience provides a clear understanding of the different demographics who engaged with the exhibited works, enriching the contextual background for our analysis and evaluation.

Figure 33 Bot Party Play Cycle at Somerset House

4.3.2.1 Evaluation

4.3.2.2 Using Open Coding and Iterative Playtesting

To comprehensively evaluate the success of this design in relation to the posed research questions, three distinct forms of data collection were utilized - documentation through photos and videos, direct observation, and public player feedback shared through social media channels like Twitter. Over the course of the three-day event, twenty-six points of documentation were gathered. These included a mixture of photographs and videos that captured different aspects of the game in action, as well as its interactions with the audience. As the festival featured multiple games running simultaneously, dedicated observation time was limited. Therefore, the approach adopted was to observe the game and its participants during free moments, aiming to capture the overall ambiance and participant engagement.

Public player feedback constituted another valuable source of data. The festival's attendees shared their experiences and impressions on social media, particularly on Twitter, offering candid insights into their gameplay experiences. These online reactions, paired with the multimedia content shared by players, enriched our understanding of the game's reception among its target audience.

However, due to the physical constraints of the event's venue - in terms of both space and noise levels - as well as the enthusiasm and excitement of the players, direct conversations with players were somewhat limited. Most of these interactions took the form of brief, informal chats. Additionally, I listened to players' verbal reactions and dialogues during gameplay, noting down their conversations as another means of gathering player feedback.

As outlined in the methodology section of this thesis, the process of exhibiting the game to gather data for analysis employed a mixed-method approach. Open coding helped in generating insights from the data, and Iterative Playtesting from the previous versions were integrated to support the refinement and improvement of the game design. During the exhibition and from this process, new insights for the next version of the game are gleaned.

4.3.2.2.1 Coding Results

The data collected during the event was transcribed and subjected to open coding, a process in which data is examined, compared, and categorized to identify common themes. Data that was used for text description was video documentation of gameplay and photos of game play, both generated by this author and the festival and social media posts made by players on Twitter.[2] Overall, there are four videos, thirty-five photos, and four social media posts, one of which became a thread. This process revealed several emergent themes that became instrumental in our understanding of the gameplay dynamics and user engagement.

Coupling this method with iterative playtesting achieved a dual-purpose. Themes, derived from our open coding process, pointed to potential research directions that might deepen our understanding of the user-game interaction. Meanwhile, the iterative playtesting method, based on continuous testing, observing, refining, and improving, offered a practical lens to identify opportunities for the development and optimization of the physical gaming system. In the pool of data, this researcher discovered engaging findings that unveiled emergent play styles. Emergence in games, according to Salen et al. (2004), can occur when complex systems interact with players, leading to players inventing new ways of interacting with the system in group settings. Such emergent behaviors might not have been predicted by the designer, but the complexity of the work permits these unforeseen outcomes.

The process of data coding was greatly enriched by employing detailed descriptions of the visual material – photographs and videos. By translating the visual data into rich textual interpretations, a comprehensive database was constructed that effectively captured the various aspects of the game experience.

Physical tools, such as highlighters and post-it notes, proved to be beneficial in the initial identification and categorization of codes. As the investigation deepened, the use of NVivo, a qualitative data analysis software, facilitated a more intricate analysis. This

[2] Data can be viewed here:
https://www.dropbox.com/scl/fo/nx5u8bquwz8dl2ng2qt2i/h?rlkey=yim736z2od57p12pq5qs079v9&dl=0

deeper level of scrutiny led to the emergence of additional codes from the video data. Following this, patterns began to form, and themes started to crystalise from the coded data. These codes were then clustered and arranged under their corresponding themes, creating an organized, thematic structure.

The investigation identified several notable themes based on the data. These included Emotion, which captured the players' joyous and engaged responses; Customization, reflecting the players' desire to personalize the game; Strategies and Synchrony, encompassing the various tactics and synchronized movements employed by the players; Group Play, reflecting the predominance of collective game engagement; Gender, which hinted at possible differences in gaming preferences and styles between different genders; and Gestures, which highlighted the diverse range of physical movements and interactions within the game. This robust process of coding and thematic analysis provided a comprehensive understanding of the game's reception and interaction dynamics, yielding valuable insights for future design improvements and directions.

Figure 34 Initial Coding Cluster

4.3.2.2.2 Emotions

The data analysis revealed an overarching pattern of positive affect experienced by the participants. The images and videos captured showed that whenever participants engaged in group play, their faces were lit up with smiles, signifying enjoyment, and satisfaction. During instances of solo play, the participants' expressions were notably more restrained. However, despite this observation, numerous solo players took to Twitter to express their fondness for the bots. One Twitter video was accompanied by a comment stating, "I love these," highlighting the positive sentiment felt by the participant.

The game's structure also invited players to exercise their curiosity and focus on different play methods. The gamut of expressions witnessed during these moments ranged from neutral to mildly positive, suggesting an overall positive engagement with the game. One notable comment from a player explaining the game to his son encapsulated this positive sentiment perfectly. He described the game as a representation of life and love, showing

that the game's mechanics touched on deeper emotional and philosophical themes for some participants. These observations provide robust support for the design choice of using touch between players, combined with movement, as effective mechanics for generating positive emotional responses within a game’s exhibition context.

However, it's important to acknowledge that there was one exception to this generally positive trend. Some players found the game's soundscape unsettling and voiced that they were frightened by it. This fear was associated primarily with the sonic atmosphere of the game, which was deemed as too dark or "spooky," as one player described it on Twitter. Despite this, it was observed that the unsettling music did not deter players from engaging with the game. Although the feedback was largely positive, the comments concerning the sound suggest a potential area for improvement. A consideration for future iterations might be to adapt the sounds to be less intimidating, thereby further enhancing the positive emotional engagement of the players.

4.3.2.2.3 Customisation

The enclosure design approach, which was extended from the first version of the project, received an overall positive response. However, during the exhibition, it was noted that the young audience discovered an unintended affordance of the bot casing. They found they could slip their fingernails underneath the glasses attached to the bots and pull them off, effectively detaching them from the enclosure.

This led to several instances where children attempted to play "dress-up" with the bots, reinterpreting them as customizable toys. In one incident, when a child was asked by their parent why they had removed the glasses, the child responded, "I thought it was like Mr. Potatohead." This remark provides insight into how children interact with and perceive interactive objects, drawing parallels with familiar toys and games. Player customization, a feature that allows players to modify the appearance or attributes of game characters or objects, is a common mechanic in many contemporary games. It enhances player identification with the game and creates a deeper level of engagement (Dolgov et al., 2014). The children's natural inclination towards customization suggests that they had expected a similar feature in this interactive piece.

In a particularly delightful instance of gameplay, a child who wore glasses identical to those of one of the bots held the box up to his face, placing the cases against his cheeks on either side of his head to play the game. The player's self-identification with the bot added a layer of charm and personal connection to the interaction, suggesting that the child saw a reflection of himself in the game. This unique interaction implies that players may find it appealing and engaging to see elements of themselves mirrored within the game. This can create a sense of personal relevance and a deeper level of engagement. The concept of introducing 'bot avatars' that can mirror aspects of the players themselves could offer a valuable avenue for exploration in future game designs.

The potential to personalize or customize bots to reflect players' attributes or preferences could further enhance the user experience. This approach could lead to a more immersive and personal gaming experience, reinforcing the emotional connection between the player and the game. In addition, such an approach could potentially introduce more variability and replay-ability to the game, as players may be curious to explore how different personalisations or customisations could impact the gameplay experience.

By the end of the exhibition, the glasses of all the bots had to be taped in place to prevent further removal. However, this unforeseen interaction with the bots' design hints at a

potential game mechanic that could be implemented in future iterations. If properly designed for, this feature could further increase engagement and positive interaction among the players, especially the younger ones, adding an additional layer of playfulness to the experience.

4.3.2.2.4 Strategies and Synchrony

Figure 35 Codes for Strategies Node in Nvivo

An analysis of photos and videos showed players taking a significantly more exploratory approach to the game compared to the first version. Players experimented with various strategies to interact with the sound and other players, indicating a more engaged and strategic approach to gameplay. Numerous patterns emerged, many centred around synchronised moves made in combination, which were evident in both solo and group play.

For solo players, such synchronisation often involved moving the bots close to each other and using one hand to touch them together while the player's free hand engaged with the buttons. Simultaneously pressing buttons and touching bots were other strategies observed in solo play. These examples hint at a diverse range of player interactions that could be considered in future design improvements. Solo players would also adjust the bots to face different directions as a means of experimentation. These actions often coincided with players employing combination moves with the buttons.

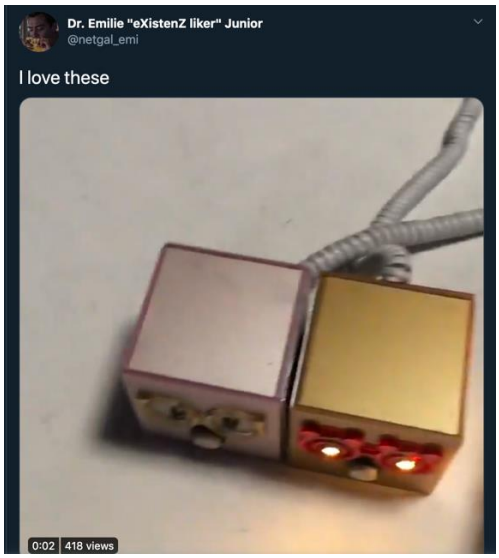


Figure 36 Fan Tweet from NPT

In group settings, similar synchronous strategies were observed. Two or three players would often press the button on their bot at the same moment or combine button pressing with hand holding in different configurations. This highlights the potential for designing more elaborate group interactions in future iterations. Additionally, players were observed stacking bots both vertically and horizontally, and in varying orderings. They seemed to be testing if the stack would respond differently depending on the configuration, indicating an interest in discovering varying responses based on the different sides of the boxes. Such behaviour was observed in both solo and group play. These observed behaviours suggest a player interest in more complex affordances within the system. They hint at an appetite for richer and more varied interactions, both in solo and group play. Future design iterations could potentially tap into this, creating an even more engaging and immersive gameplay experience by expanding the range of possible player interactions and strategies.

In this updated iteration of the game, most of the photo and video documentation, combined with observational data, shows a notable increase in group play. Around 65% of the recorded instances involve multiple players, as opposed to solo gameplay. This trend may or may not be directly influenced by the specific data collected for this study and could be attributable to several factors.

One significant factor could be the demographics of the festival attendees, which saw a high proportion of families. Much of the documented group play involves children playing the game with their guardians. This family-centric demographic could naturally lend itself to more instances of group play compared to a different setting or audience composition.

However, it's worth highlighting that there's a noticeable increase in group play instances involving strangers in this dataset compared to the data from Incubate. This suggests that the game's design or the social context of the festival may encourage spontaneous cooperation or shared experiences between people who might not know each other, which can be seen as a positive aspect of the game's social dynamics. Coding revealed collaboration as the most popular of the strategies, making it the first and most obvious choice to support in future iterations.

While it's challenging to draw definitive conclusions from this trend, it does point to some intriguing avenues for future research and game design. Further studies could delve into the specifics of how the game's design or the social environment influences players' choices to engage in group play. This could potentially reveal insights on how to optimize the game for different audiences or settings, or how to better encourage social interactions and cooperation in gameplay.

4.3.2.2.5 Gender

From the photo and video documentation, it's noteworthy to observe that a higher percentage of male presenting adults and children, sixty-two per cent to be exact, are seen engaging in the game in the documentation footage made by the gallery. This group includes both adult men and boys. The reasons for this disparity could be multifarious and layered, as it is linked to multiple social, cultural, and even environmental factors. One aspect that could potentially influence this trend is the physical placement of the game within the exhibition space. Positioned in the centre of the room, the game assumes a prominent, performative presence. This might have appealed more to men and boys who felt comfortable being at the centre of attention, thus resulting in higher engagement from this group.

Another possible explanation could be the game's core mechanics involving physical touch. The idea of initiating physical contact with other players, especially in public spaces, might have been more intimidating or less appealing for those socialised as women and girls, thereby influencing their decision to participate. The game play design might need to be improved to invite players into the experience in a more friendly and consent driven way. Simply having the bots on and waiting might not provide a clear enough experience cue.

Yet, without additional data and context, these remain as hypotheses. It's entirely possible that the game saw higher participation from women than other games at the exhibition, but this isn't captured in the current dataset. What is interesting is that while the photos from the gallery and the authorised photographer who filmed the work show more men, the social media posts and interactions are predominately from non-male players. This could also reflect a bias on the part of the photographer.

This observation of gender disparities in game engagement raises interesting questions and points towards potential areas for future research. It would be interesting to delve deeper into understanding how gender preferences might influence participation in games involving physical touch and cooperative gameplay. While such an investigation lies beyond the scope of this thesis, it would be a worthwhile exploration for future researchers in the field. Overall, this data may or may not be relevant and is inconclusive.

4.3.2.2.6 Gestures

Figure 37A photo showing an arm touching gesture and positive emotion.

The analysis unveils a fascinating aspect of player interaction: the diverse range of physical gestures. These gestures differed notably depending on the game mechanic players were engaging with - either touch or motion. While exploring touch mechanics, players demonstrated varied hand movements. They would extend their hands towards each other's arms, often resulting in handholding while they attentively listened to the game's auditory response. Physical contact, whether via fingers or arms, emerged as a prevalent form of interaction. However, there was a marginal preference for hand-to-hand contact over other forms. Players often sustained hand contact, enabling them to discern shifts in the soundscape that would only persist as long as they maintained touch. This mimetic aspect of play, where players observed and imitated each other's actions, added another layer to the experience. A particularly memorable example is the child mentioned above who explored whether sound could travel through his face by placing a bot on each side of his head - a novel approach that brought him evident joy when it worked.

On the other hand, an unusual trend observed was players attempting to listen directly to the bots by placing them near their ears. They engaged in this behaviour despite the presence of visible, nearby speakers that were emitting the sounds. This suggests that identifying the sound's source or associating specific sounds with a particular bot was not immediately apparent to the players. Incorporating speakers within the bots might be an insightful design consideration for future iterations.

When investigating the game's motion mechanics, players displayed a broad spectrum of movements, from quick, side-to-side or up-and-down shaking of the bots to more thoughtful, refined gestures. These subtler movements were observed among 'sound explorers' who moved the bots in a more fluid, circular manner while intently listening for shifts in the soundscape. These softer, more fluid movements were exclusively associated with the bot that emitted drone sounds, indicating the potential influence of the sound type on players' gestural responses. These varied gestures provide valuable insights into how players chose to engage with the game, offering tangible avenues for enhancing the player experience in future game versions.

4.3.2.2.7 Iterative Playtesting Results

Figure 38 Fan Twitter Comments

In addition to the insights gleaned from coding the data, iterative playtesting also uncovered potential avenues for improvement, particularly regarding the game's soundscape. Abtan, the sound designer, created three different sound palettes for the game, with each one set to change whenever all three players made physical contact. This design choice led to confusion among players who had just begun to understand the mechanics of the game, only to have the soundscape shift unexpectedly. Players often left the game, expressing their frustration verbally. A possible resolution to this issue could involve a more explicit structure, such as a level system, that informs players about the upcoming change. Naming each soundscape and linking it to a specific button could further clarify this aspect, providing players with a sense of control and the opportunity to explore multiple sonic environments.

The overall tone of the soundtrack, which I hoped would be crafted with inspirations given from Chipzel and David Kanaga's work samples, was a darker, carnivalesque theme featuring sounds of storms, rain, distorted circus music, and an uncanny cat's meow. While this may have added an interesting dimension to the game, the soundscape was somewhat intimidating, particularly for young children.

On a positive note, the incorporation of vocal range tones to signify player touch was effective, and the successful delineation of different sound spaces for each box was well understood by players. However, there were moments of confusion, possibly attributed to the bustling environment of the festival during peak hours. One observation from the playtesting was that the game's motion mechanics – specifically the use of accelerometers – were popular among players. However, rapid shaking gestures created chaotic sonic patterns, suggesting a need for reconsideration to maintain sonic coherence when three players are interacting simultaneously.

The bots' response when initially picked up was well-received. They remained mostly silent between play cycles but would intermittently blink their eyes and make playful sounds designed to encourage engagement. This less noisy ambient state was a significant improvement from the Incubate experience and greatly appreciated by the

gallery staff who were managing the game. This realisation may point to important considerations for balancing gameplay and environment management in future game designs.

Players approached the bots like a curious puzzle, which was featured in the coding and reinforced in the observations. They looked for hidden functionality. By seeing it as a secret, they appeared to be wanting more obvious rewards for their discoveries. Accomplishing this with light and sound could be possible. The system itself had several engineering issues, which are solvable with more robust casing. Halfway through the show, this researcher made emergency repairs with superglue that held better than the acrylic solvent and the hot glue. Another issue was with the LED mounts. The LEDs on the face of the owl vibrated out of the enclosure due to frequently and furiously shaking. The lack of clearance between the LEDs of both eyes made it hard to isolate the cables internally. Next, the phone cables, while charming, yielded knots and thwarted players. Finally, several players asked if there could be more than just three bots.

4.3.2.3 Analysis Conclusions

The experience at Now Play This evidently marks a notable progression from the project's inception – Baby Bot – with substantial advancements in game design, audience engagement, and the physical system. Furthermore, the experience offered an opportunity to sharpen the focus of design objectives. The informed design choices between Incubate and Now Play This have successfully steered the project towards a game centred on physical player interaction. The feedback received highlights possible avenues to further expand and enhance the design of the system.

Observations drawn from the public interaction with the game yielded several clear outcomes. For one, research suggested that the game's visual design was well-received and thus worth developing further. The engaging visual aesthetics of the bots not only attracted audiences, but the captured selfies and player dialogues during gameplay suggest a level of emotional engagement with the game. However, while the visual design was successful, the sound design did not elicit a similarly positive response and hence offers room for refinement towards generating a more positive effect. The observation of players customising the bots points towards a potential area of development. Furthermore, strategies discovered by players to interact synchronously with the interface in groups suggest an emergent affordance of the system that presently lacks designed support. Incorporating rewards for such interaction might further encourage group exploration of the game.

Group play was noticeably more prevalent at Now Play This, with the touch mechanic evoking visibly positive responses in players' facial expressions. While gender disparities among players and differences in play styles in public spaces could be subjects for future research beyond the current project, attention will be paid to these dynamics in the project's ongoing development.

Players' gestures underscored an interest in exploring the different sides of the boxes, an element that could become significant in future versions. The accelerometers in the boxes tended to induce sweeping gestures and shaking of the bots, especially on the drone sound, suggesting that the game's tones might be influencing the players' movements. The observed trend of players placing the bots close to their ears indicates that embedding the speaker directly into the enclosure could help clarify their individual contributions to the overall soundscape.

The physicality facilitated by the length of the bot cables and the touch mechanic primarily involved interactions using hands and arms, though occasional facial engagement was noted. The positive emotions visible in player expressions suggest that the touch mechanic is indeed fostering at least some positive emotional interactions between players. The public installation also brought to light potential improvements to the system's robustness. Key takeaways included the need for stronger solvents and cabling and for enabling player-controlled level transitions via buttons. The rapid shaking gestures encouraged by the game's sound underscored the necessity for a more robust component mounting on the casing. In conclusion, the Now Play This exhibition proved to be a productive experience that offered valuable insights into potential areas for improvement and development of the game.

4.3.2.4 Autoethnographic Design Reflection

The process of creating and showcasing both *Bot Party* and *Thrum*, a large haptic floor-based game, was a physically demanding and emotionally taxing endeavour that pushed me to my limits. The commitment to debut these games required an intensity of effort that was overwhelming at times, which left me physically drained. In the weeks leading up to the exhibition, my body was pushed to its limits, often getting less sleep than was necessary or advisable. Complicating matters further, I developed significant weakness in my ulnar nerve and began to experience hand tremors, both indicative of extreme fatigue. The magnitude of the task - to construct such expansive installations on my own within a compressed timeline - was more challenging than I had ever undertaken and certainly exceeded my physical capabilities.

Despite these physical constraints, or perhaps because of them, I began to devise my own creative adaptations, or crip hacks, to my workstation. One such workaround involved soldering with the iron held in my mouth. I layered the end of the iron with electrical and washi tape to create a more manageable grip. Simultaneously, I made modifications to my workspace. By incorporating multiple helping hands, I was able to secure components that were otherwise difficult to hold steady. I also utilized rolls of washi tape and a system of rubber bands to keep parts in place temporarily. As a result, I ended up with little bits of tape everywhere. In an act of whimsey, I decorated all my testing hardware boxes and tools with this tape. What these hacks point out is the lack of good ergonomic workbench tools and the need for more accessible bench tools, specifically grip modifications. These hacks, specifically the practice of taping parts into place so I did not need to hold them while soldering, were educational – a better workbench was required moving forward, specifically a better helping hand system.

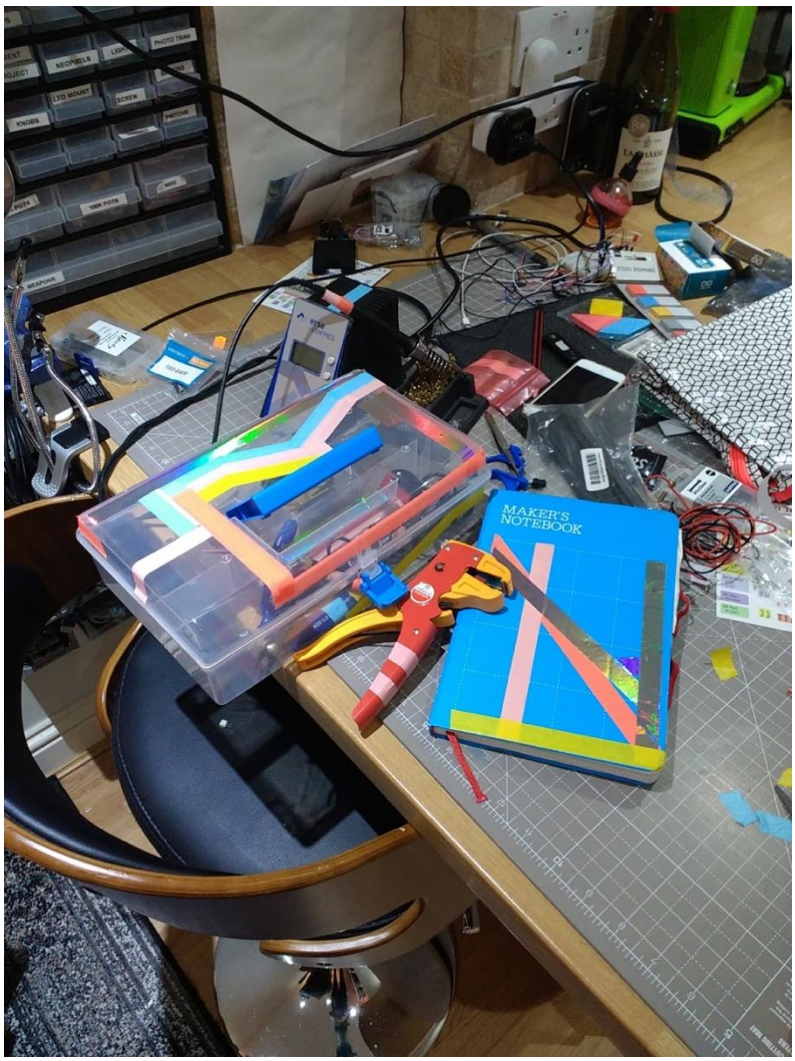


Figure 39 Workbench modifications

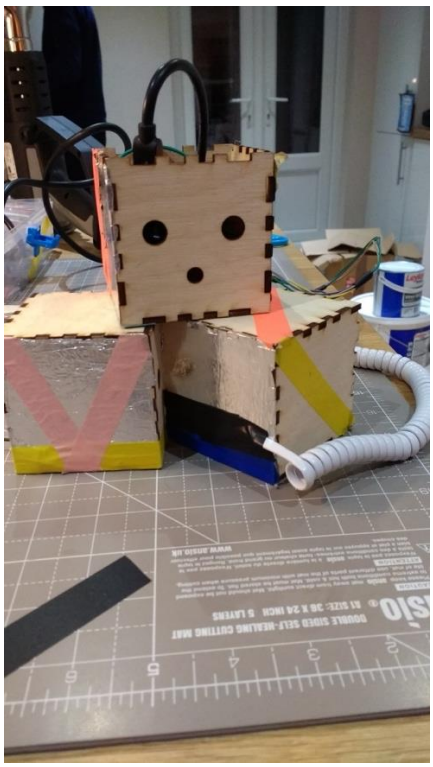


Figure 40 Testing hardware decorated with spare washi tape.

The operation of the exhibit during the event was largely delegated to the gallery staff, although there were occasions when I interacted with the game alongside players. These play sessions were moments of pure joy that temporarily eclipsed my exhaustion. Images documenting these interactions show my face lit up with delight, proof of the positive emotions that the public engagement inspired in me. For me, this interaction with the audience was rewarding.

As part of the exhibition, I found myself in the role of a caretaker for the bots, an activity that, while occasionally stressful, could be seen as a metaphorical representation of the self-care I needed to practice. It's intriguing to note that while several other DIY hardware-based games failed during the festival, I didn't observe other creators employing the same on-the-spot repair strategies that I did. These instances of live patchwork often resulted in impromptu game sessions with audience members waiting for me to finish. This public display of repair work fostered a dialogue with the audience, transforming the act of maintenance into an unexpected performance of care.

4.4 Feral Vector Exhibition

4.4.1 Controller Modifications

This next exhibition was soon after Now Play This (NPT) and there was no redesign to the build or software for this exhibition, but there was a significant hardware malfunction. It served as an opportunity to observe the IMUs in isolation to the touch mechanic. During transport to Feral Vector, a mechanical issue arose. The jack of the Teensy microcontroller, housed inside the main game controller and responsible for connecting the game to the computer, detached from its circuit board. This malfunction was particularly significant because this board was responsible for transmitting all the touch data from the bots to the computer. It is plausible that the microcontroller's unsecured status inside the enclosure, combined with its movement during gameplay, led to this unfortunate failure. The tangling of the vintage phone cables used to connect the bots could have also contributed to this issue. Despite this setback, the game was still able to be presented thanks to a secondary microcontroller located within each bot. These microcontrollers wirelessly sent data to the computer, including information from the IMU and the buttons. This allowed the game to be presented without the touch mechanic.

Unexpectedly, this equipment failure provided a valuable opportunity to observe the game in a new light. Without the touch mechanic, we could isolate and assess the success of the IMU and the sound design as stand-alone gameplay elements. This incident, while unfortunate, revealed new design opportunities for the game, demonstrating the potential of the IMU and sound design as unique gameplay elements.

4.4.2 Exhibition

Unlike many of the larger, more mainstream events in the gaming community, Feral Vector in 2017 ran from June 1st to the 3rd and catered to a more exclusive, niche audience. Approximately 300 attendees estimated from venue size, which was an old church. Attendees spanned across a spectrum that included indie developers, academics who study games from a critical, interdisciplinary perspective presenting their research, and game designers. The age range of the participants was quite broad-based on this researcher’s observation, but no statistics are available here.

4.4.3 Evaluation

Despite the initial setback during the setup at Feral Vector, the limited data that was collected during the event proved insightful, but it was limited to my observations, casual conversations with players and one fan photo. What I observed is that player engagement suffered a noticeable drop, with most data collected through hastily scribbled notes based on player observations and conversations with other designers, many of whom had interacted with the game at the previous month's event and considered the work broken. Play cycles were down to a few seconds in some cases.

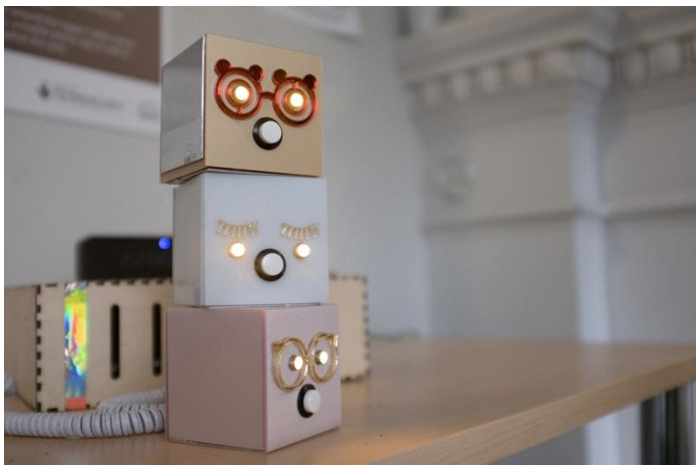


Figure 41 Photo of installation at Feral Vector captured by a fan and later shared via Discord showing the stacking mechanic being tried.

The gaming experience in question was situated in the peripheral space of the conference venue, just at the boundary of the main speaking area. This positioning created a logistical requirement to disable the game during scheduled talks to prevent any potential auditory disruptions. The intermittent nature of the game's availability, therefore, resulted in accessibility being limited to only the designated intermissions.

The placement of the game in a passageway, while maximising exposure to attendees moving between sessions, inadvertently positioned it as secondary to other more socially centred spaces. Specifically, the coffee and tea rooms, which served as primary congregation areas for conference attendees, inevitably drew more attention. Consequently, the game was often bypassed, overlooked by the attendees in favour of the convivial and conversation-friendly environments provided by these communal areas.

When the game did succeed in garnering attention, it was primarily due to its striking visual appeal and multiple people commented on the cuteness of the bots. Participants who interacted with the game expressed positive sentiments towards its casing design and presentation. However, these affirmations did not necessarily translate into prolonged engagement or repeated play. The average playtime was estimated to be less than 60 seconds, with many players leaving before the researcher could even take notes. This experience underscored the importance of having a backup set of hardware available for such situations. It also highlighted the need for a set of emergency repair hardware and tools while traveling for exhibitions, to mitigate any future hardware failures.

Notably, there was a significant drop-off in player engagement, suggesting that despite the visual appeal, soundscape, and the motion responsive IMUs, these aspects alone did not provide a compelling reason for players to interact with *Bot Party* beyond a fleeting engagement. This observation suggests considering prioritising the touch mechanic and

integrating the IMU into the game design verses having it support a purely explorative experience. Participant interaction often manifested as cursory exploration - shaking a box or pressing a few buttons - before rapidly waning. Participants' interest levels seemed to drop precipitously after this initial interaction. Another consideration suggested here is the need to rethink the intersection between game design, player engagement, and the utilization of public spaces in a conference setting. The open-ended game design wasn't sustaining engagement beyond a minute or so. This observation suggests considering prioritising the touch mechanic and integrating the IMU into the game play itself verses having it support a purely explorative experience.

A possible secondary factor for limited play sessions could be attributed to the acoustics of the space. The volume of the game was muffled because of the booming church acoustics, and the architectural characteristics of the space caused the game's audio to blend into the background noise, making it challenging for players to discern exactly what was changing in the soundscape. This signalled the need to enhance the ways players receive information during gameplay, especially in louder environments where the game's soundscape might be overwhelmed.

From a hardware robustness perspective, it became evident that the Teensy USB port was not sturdy enough to withstand the stress exerted on it within the game enclosure as was evidenced by the fact it had torn free of the circuit board entirely within the casing. This incident indicated that it might be beneficial to revisit the cable design to reduce the stress on internal components, thus enhancing the overall durability and performance of the game's physical components. The mounting of the microcontroller within the enclosure also needed reconsideration. While professionally produced, custom circuit boards would potentially offer more stability in the hardware design, they could also limit opportunities for experimentation and modifications. Finally, it was obvious from this situation that it would be prudent to travel with a basic hardware repair kit and backup bots.

4.5 IndieCade Exhibition

4.5.1 Hardware Changes:

The next iteration of the game's hardware and software was developed for IndieCade upon the request of Mattie Brice, the curator of the festival's NightGames! Exhibition. The earlier showcase at NPT and Feral Vector provided valuable insights into potential enhancements that could enrich player interaction and experience. The first modification involved the soundscape change that occurred when all three players held hands. This feature frequently caused confusion, necessitating its revision. Additionally, a new incentive was needed to encourage players to hold hands and engage more deeply with each other and the game. This exhibition was a rich opportunity to attempt to improve version two with data from two earlier events.

The project's stability was a critical area for improvement. The vintage phone cables, which caused undue strain on the circuit board, had to be replaced. The game's enclosures also required reinforcement to prevent damage from player interaction – an issue that resulted in several on-site repairs during the NPT exhibition. These changes were especially important considering the game was to withstand a transatlantic journey and possibly more boisterous play given the evening nature of the IndieCade exhibition.

Another upgrade aimed to improve the audio experience. Installing speakers capable of delivering clear sound in a crowded room could help players understand their influence on the soundscape better. The game's overall soundscape needed a tone shift. The current

'gothic' or 'spooky' soundtrack was inconsistent with the project's objective of fostering a sense of warmth and connection among players. Therefore, a change in the auditory theme was planned.

Several significant hardware modifications were undertaken to improve the game's reliability and user experience. Firstly, the Teensy microcontroller was replaced with an Arduino Uno for improved performance and ease of use. The radio communication system, although it allowed for wireless gameplay, was expensive and complicated the codebase due to the need to support both wired and wireless configurations. To streamline development and cut costs, this feature was replaced with direct wiring, facilitated by easy-to-use JST Connectors, which replaced the three pin connectors used previously for the phone cables. The phone cables, prone to tangling and causing hardware damage, were replaced with more resilient rainbow ribbon cables encased in a protective fibreglass sleeve. This change made the game easier to pack, transport, and set up without fear of cable-induced hardware failure, reducing the hardware setup time to under 30 minutes. Finally, a backup bot was added to the travel kit just incase of bot failure.

The game's casing also underwent revisions to enhance user interaction. The original wooden box was replaced with a clear acrylic laser-cut box, with a bot placed on each side instead of all at the front. This design broadened the play space and encouraged players to face each other, promoting more interactive gameplay. This change was inspired by observations from the Now Play This event, where players naturally tended to stand around the game but found accessing the controllers difficult due to cable crossover issues. LED lights were incorporated into the new enclosure housing to make the game more visible in low-light conditions, catering to the evening setting of the Indiecade event. These lights also served to illuminate the players, enhancing the overall aesthetic experience.

Lastly, the audio system received a significant upgrade through a sponsorship deal we secured with Merrill Audio. They gifted me positional speakers with the promise they would be highly visible at all the major gaming events in the US going forward. These extremely expensive and professional-grade audio monitors could deliver professional high-quality tightly focused sound output even in noisy environments, without adversely affecting other nearby games due to their quick sound drop-off feature. These more advanced speakers served to support playing the game in noisy game festivals.

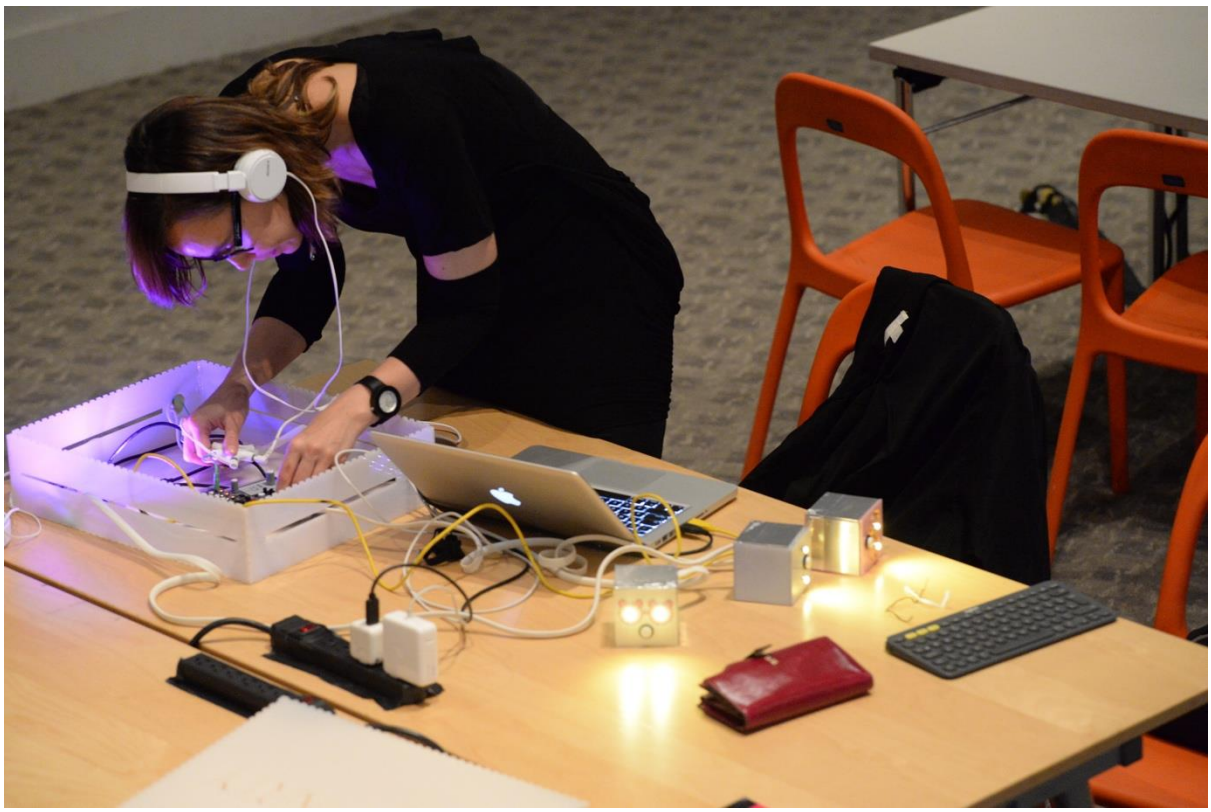


Figure 42 IndieCade setup captured by the festival.

4.5.2 Software Changes:

To create a more fitting ambience for the game, the soundscape was significantly revised. The heavy, gothic elements were toned down, and a greater emphasis was placed on the incorporation of natural environmental sounds. The carnival sounds, which previously featured in the game, were entirely removed. In response to player feedback, another important change was the elimination of the audio landscape switch that previously occurred when all three boxes were connected. A new sound experience, a generative, soothing rainstorm was introduced when all three boxes were being touched and linked together by players. The storm lasted for as long as all three boxes were connected. This modification was designed to make the gaming experience more reliable and enjoyable.

On the technical side, the embedded code was refactored to run smoothly on the Arduino Uno platform, which replaced the Teensy microcontroller and XBee radios in the hardware redesign. Despite these alterations, the basic software configuration remained the same, with MAX/MSP handling audio processing and Arduino responsible for game logic and embedded interactions. These changes were aimed at not just improving the game's stability and reliability, but also at refining its aesthetic and auditory appeal based on player feedback and observations from previous exhibitions.

4.5.3 Exhibition:

IndieCade, widely acknowledged as a preeminent festival for independent game development, has been faithfully celebrating innovative and imaginative game design since its inception in 2007. (“ABOUT – IndieCade,” 2023) This renowned festival, held annually in Los Angeles, provides a critically important platform in the United States for independent game designers to showcase their works. It's an event of significance that

champions the spirit of creative freedom and technical experimentation in the gaming industry, particularly among indie developers.

The specific exhibition here took place during the 2017 iteration of IndieCade, precisely on the evening of October 8th, 2017, and ran for three hours. Over the years, the festival has been known to attract an eclectic audience of gaming enthusiasts, developers, and academics. The 2017 edition was no exception; it managed to draw an estimated crowd of around a thousand attendees. These individuals, each bringing their unique perspective and experience to the festival, formed a diverse audience for the wide array of independent games on display.

4.5.4 Evaluation

4.5.4.1 Coding Results

Photographic and video documentation stand as principal forms of evidence for this iteration of the game, providing a vital source of data that was subjected to coding and thematic analysis. There were eight photos and two videos.[3] Additionally, observations and notes on player behaviour were recorded, subsequently informing iterative playtesting, and triggering further modifications to the game.

Notably, the contexts of previous showcases like NPT and Feral Vector, which spanned entire weekends including Thursday and Friday, contrast sharply with the IndieCade experience. The latter event was constrained to a few hours, consequently impacting the quantity and quality of data gathered. Unlike the earlier occasions, where a wealth of interactions could be observed and analysed over multiple days, the scope for data collection at IndieCade was considerably reduced.

This constraint meant that the available data predominantly originated from fan-generated content, including videos and photos which were shared with me post-event, in addition to official festival photography. This shift in the nature and volume of data resources necessitated a slightly different approach to the analysis and subsequent application of findings in the ongoing development process. Despite the shorter timeframe of IndieCade, the captured video evidence offered valuable insights into player engagement, behaviour, and responses, contributing to the comprehensive understanding of the game's reception and performance.

[3] Indiecade Data can be reviewed here:
https://www.dropbox.com/scl/fo/nx5u8bquwz8dl2ng2qt2i/h?rlkey=yim736z2od57p12pq5qs079v9&dl=0

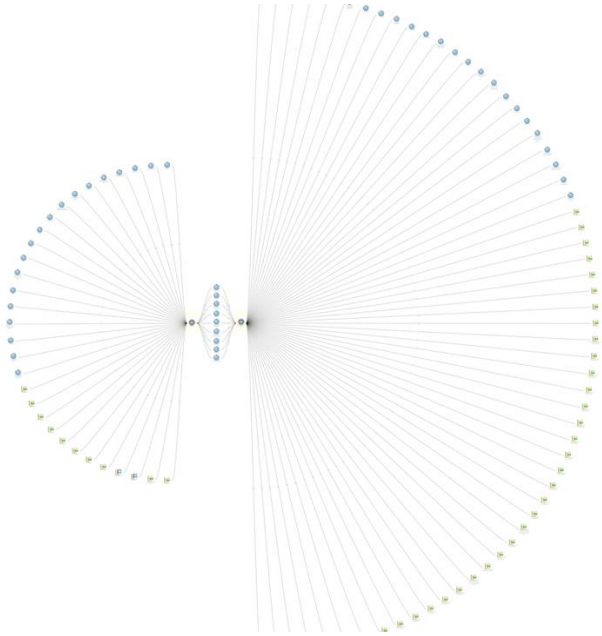


Figure 43 Codes and data points compared between IndieCade and NPT. IndieCade is on the left side.

4.5.4.2 Emotions

In alignment with the coding data from the Now Play This event, the expressions observed on the players' faces during the IndieCade exhibition were nearly always positive or neutral. However, a notable increase in curiosity and surprise was evident among the participants at IndieCade. This analysis is based on a total of eight different photographs and two video sources taken by an enthusiastic observer during the event.

The systematic coding of this data yielded various findings. Specifically, it revealed four distinct instances of multiple players smiling simultaneously, two groups of participants who could be characterized as curious explorers, and one photograph that distinctly captured players expressing surprise. This further underscores the marked enhancement in the range and intensity of the emotional responses elicited by the game during the IndieCade event.

Nodes\\Expression	1	11	1
Nodes\\Expression\Angry	0	0	0
Nodes\\Expression\concentrating	1	1	1
Nodes\\Expression\confused	0	0	0
Nodes\\Expression\curious	2	2	2
Nodes\\Expression\excited	0	0	0
Nodes\\Expression\eye contact wit...	0	0	0
Nodes\\Expression\laughing	1	1	1
Nodes\\Expression\neutral	1	1	1
Nodes\\Expression\Smiling	4	4	4
Nodes\\Expression\surprise	1	1	1

Figure 44 Affective Coding from IndieCade

Nearly every player engaging with the game showcased a spectrum of positive emotions and invariably stood quite close to each other during gameplay. Evident expressions included happiness, surprise, and even a few moments of laughter. Moreover, there was a noticeable sense of curiosity. The players in question demonstrated an increased

willingness to experiment with the game and tended to remain engaged with it for longer periods than the typical audience at the Now Play This event.

This increased engagement could potentially be attributed to minor modifications made to the game's soundscape, which rendered it less eerie and more inviting. Alternatively, it could be surmised that the addition of an extra layer to the three-player touch mechanic made the game far more compelling, thereby prolonging engagement and yielding positive effects.

During the Now Play This event, while many players were seen smiling, they often tended to be players who didn't immerse themselves in the game for extended periods or treated it merely as a curiosity. With this version of the game, however, even those players who were initially more reserved in their engagement began to exhibit more pronounced expressions of positive emotion.

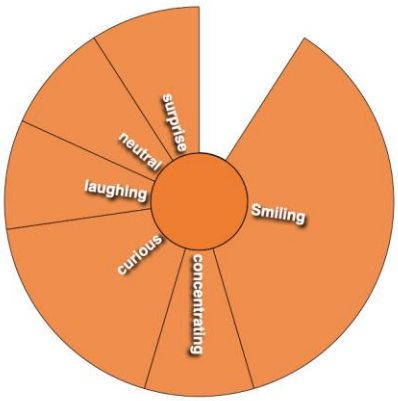


Figure 45 NVivo generated pie graph of the player emotions.

4.5.4.3 Strategies and Synchrony

The notes from this iteration of the game reveal an increased engagement with its bridging dynamics. There were instances where players formed larger networks, extending beyond the basic triadic interaction. They explored a multitude of touchpoints within the group, demonstrating a more intricate and complex interaction with the game.

In a pattern reminiscent of the players at Now Play This, players also engaged in sound exploration. This strategy, prevalent in the IndieCade session, saw participants employ creative methods to manipulate the controllers. They would move them in different directions - back and forth, up and down, or even drop them only to catch them again. The aim was to discern the resultant changes in the soundscape, a testament to their curiosity and eagerness to interact with the game at a deeper level.

Another emergent pattern was the frequent pressing of buttons in rapid succession. Players discovered that they could create diverse character voice configurations that would trigger repeatedly. This led to some moments where the sounds produced mirrored the complex rhythmic patterns. Several instances of stacking behaviour were seen, where players pressed multiple buttons simultaneously. These unique interaction patterns contributed to an ever-evolving soundscape and showcased the players' willingness to engage deeply with the game's mechanics.

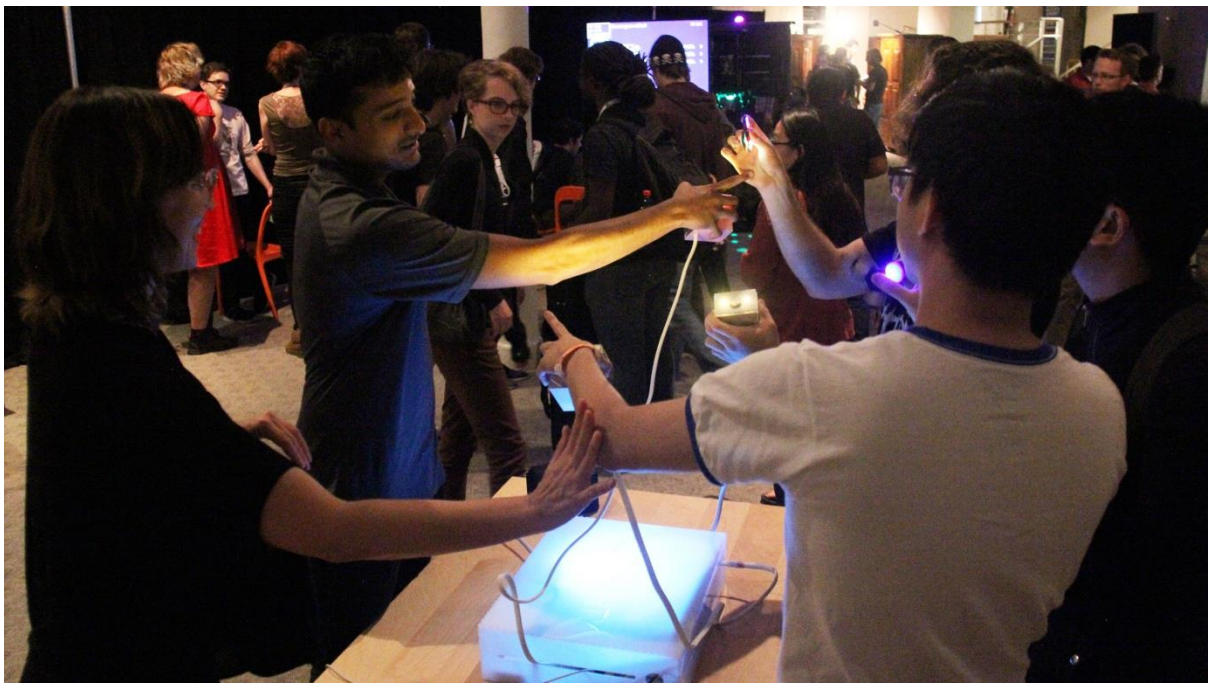


Figure 46 Players interacting with the bridging mechanic.

4.5.4.4 Gestures

The IndieCade iteration of the game showcased a noticeable surge in physical interactions between players, particularly in the form of handholding, as well as arm and finger touching. As seen in the video documentation, one group maintained uninterrupted contact for an extended duration of over thirty seconds to collectively experience a rainstorm soundscape. This compelling observation was a result of a strategic modification implemented in the game design. The previous mechanism that automatically switched soundscapes when three boxes came into contact was replaced with an evolving soundscape feature. This critical change was instrumental in driving increased player engagement and sustained physical contact among the participants.

Interestingly, these observations indicate a potential rise in prosocial behaviour among groups interacting with the game. Players were seen not only sharing the tactile experience of the game but also subconsciously engaging in cooperative actions to enhance the collective experience. This underscores the game's capacity to foster interpersonal connections and stimulate cooperative behaviours, which could form an interesting basis for future iterations and research. Increased connection points to the potential design of future game mechanics which support and foster the use of the three-player touch mechanic.

Figure 47 Bot Party at Indiecade. Players and author smiling and forming a bridge of sustained contact.

The documented visual evidence from the event primarily showcases groups of players engaging with the game. Despite, or perhaps because of this engagement, there was a notable decline in player interest concerning the sound exploration component of the game during this event. This observation implies a potential shift in player preferences and interaction styles, which could be indicative of the evolving dynamics of the gaming experience within the participatory context. The reward of hearing the rainstorm was enough to significantly encourage the physical bridging between large groups of players. It also highlights the opportunity to adapt and recalibrate the game design in line with these evolving user behaviours and patterns. The value of fostering prosocial interactions and behaviours is more in alignment with this collaboration.

4.5.4.5 Performance

During this exhibition, I assumed a more active role by overseeing the game throughout the entirety of the event. There are several instances in the documentation where I am depicted as an active participant, engaging in gameplay with the visitors and mutually partaking in their moments of excitement and happiness. Beyond merely enjoying the game, I took on a facilitative role, orienting players about the game's rules and guiding them as they navigated their way through the gaming experience. The photographic evidence bears testament to the level of enjoyment I derived from interacting with the audience. The images capture instances of genuine surprise and elation, manifesting the profound gratification I experienced while playing alongside the participants.

This proactive involvement not only fortified the bond between the creator and the audience, but it also presented an opportunity to observe first-hand the user experience and the dynamics of player interaction, thereby gaining a more nuanced understanding of how the game was received and experienced by the audience. This experiential insight could prove valuable in future design adaptations.

4.5.4.6 Emerging Themes

My direct observation of the game underscores several potential emergent themes that the game design seems to nurture extended play cycles, explicit display of positive emotions, and the promotion of pro-social behaviour through collaboration and close physical proximity, along with the growth of networks of players. This observation is particularly marked when I participate in the play throughs with larger groups of players. These play cycles tend to focus on engaging in collective play. One secondary benefit of the game is the deepening of my connections with other members of the indie scene. This valuable networking serves as a very real basis for strengthening my personal bonds within my community.

The data validates these themes, demonstrating that the design principles fostering pro-social behaviour are more effectively actualised in this version of the game as compared to its predecessor, Baby Bot were very few large groups were able to engage in close physical proximity.

The values that were initially laid down at the outset of this process were:

- Challenging and playing with social norms
- Designing around scenarios rather than disabilities
- Promoting agency and interdependence
- Encouraging embodied and tactile interaction
- Sensitivity towards gender, intimacy, and connections
- Promoting playfulness
- Fostering pro-social behaviour
- Building community

A thoughtful examination of these values, and their extrapolation, uncovers two significant themes that could serve as promising focal points for the next iteration of the game - **embodied joy** and the **fostering of a shared sense of human connection**. These themes, in turn, could act as stepping stones in moving closer to the realisation of the overarching design principles of the game. They could steer the evolution of the game in a direction that accentuates its ability to foster pro-social behaviours and foster a sense of belonging and community amongst its players. As the game's designer my own experience of embodiment is one of chronic pain. Seeking embodied joy feels like a radical act of rebellion through design.

4.6 Prototype Three: Bot Party 3

After IndieCade, I decided to take a risk and submit *Bot Party* to the Alt.ctrl exhibition at the Game Developers Conference (GDC). To my surprise and joy, it was accepted. The time leading up to the event was marked by intense design and development activities, as well as frequent playtesting. This period catalysed a significant evolution of the game. By the end of this cycle, not a single piece of hardware or a single line of code from the previous iteration survived. The final product of this metamorphosis is the version of *Bot Party* we recognise and cherish today. Fans of the game and I agree that this iteration marks the game's true release.

In 2018, GDC was a hub of activity with an estimated 28,000 attendees, and my game held a place of honour at the entrance of the main hall. But this event is more than just a showcase - it's a juried exhibition. This means that a selection of games is meticulously chosen to be displayed on the convention floor. Among this carefully curated array of 20 titles, a jury of three industry experts sampled each game and nominated six for the revered GDC Award, one of the most distinguished accolades in the gaming industry.

Version three of *Bot Party*, which had undergone such a dramatic transformation, was nominated for the top award at the exhibition. Although it didn't capture the ultimate prize, the game's impact, media coverage, and popularity with the audience were acknowledged through invitations to numerous future exhibitions. This reinforced its status as a mainstay in the 2018/2019 Alt Ctrl indie gaming scene. Sweetening the event further was the fact that the award went to a former design mentee of mine. Despite not winning the award, it was a heartening experience. In addition, upon returning home, I was recognised for my work with the Goldsmiths award for Early Career Researchers.

This version of the game was curated into the following shows:

- PlayUK, Kulture Centar GRAD. Belgrade, Serbia, January 2020.
  Dank Jank, Apex Art, NYC, NY. April, 2019
  Now Play This, Somerset House. May 2019.
  We Throw Switches at Loading Bar. London, UK. April 2019.
  EGX Rezzed, presented by Rock Paper Shotgun. London, UK. April 2019.
  NYC Resistor Solar Punk Interactive Show, NYC, NY. April 2019.
  PlayUK, Presented by the British Council. Skopje, Macedonia November 2018
  Playful Interfaces, Rich Mix, Artful Spark. London, UK. Oct 2018
  Clujotronic, Presented by the Goethe Institute, Cluj, Romania. Sept 2018.
  Playful Arts Festival, Werkwarehuis, 's-Hertogenbosch, Netherlands. June 2018.
  GDC Alt.Ctrl, San Francisco, US. March 2018.GDC Award Nominee

This chapter will examine the following components:

- Iterative Playtesting data from the period leading up to GDC.
- Data collected from exhibitions with a focus on several key exhibits which offer useful insights including GDC, Rock Paper Shotgun's EGX Booth, The Spring Show at NYC Resistor, and We Throw Switches at Loading Bar.

To comprehend the impact of the project, I will undertake a thematic analysis of the collected data, which encompasses transcripts and photos from the playtests leading up to GDC, and data from the exhibitions including photographs, videos, and social media posts.[4] For the purpose of this analysis, all data obtained from the various exhibitions will be considered as a singular data point. This decision is grounded in the fact that there were no specific modifications to the game implemented for individual exhibitions.

There are two primary factors driving this analysis. The first concerns whether this iteration of the project has moved us closer to realising our established design values. The second examines how the gathered data relates to the research questions initially proposed. With these considerations in focus, the insights derived from this analysis will be invaluable for charting potential paths for future development of the game. These findings will not only shed light on the project's current success but also provide a roadmap for its continual evolution.

[4] https://www.dropbox.com/scl/fo/nx5u8bquwz8dl2ng2qt2i/h?rlkey=yim736z2od57p12pq5qs079v9&dl=0

4.6.1 The Design Period Pre-GDC

In the countdown to GDC, the re-design and re-development process kicked into high gear, with several iterative playtesting sessions incorporated into the frantic journey of creating a new, more advanced version of the game. This period of intense gameplay re-development took place over three months, initiated after GDC had already selected the game for exhibition.

As the development phase unfolded, the collaborative dimension of the game broadened. Initially developed in collaboration with Abtan, the project started to encompass new team members - Charlie Ann Page took on the role of game developer, and Helen Steer was entrusted with the task of supporting my mental and physical health and mitigating overwork. She was my hands when my hands were fatigued. After the significant downturn of my health directly after making the previous versions, I learned that I needed additional support, specifically a friend to make sure I did not overwork myself and cause injury. In a game which has care and crip values at its heart, it was critical I care for myself. Brian Jackson assumed the position of audio designer. With this diversified team, we succeeded in creating a much more comprehensive and robust game, which was adept at capturing and reflecting the various gameplay styles exhibited by players during public exhibitions. Our objective was twofold: not only did we aspire to elevate the quality of the game beyond the initial prototype stage, but we also aimed to ensure it was primed for its premiere at an event of such high prestige and career-defining potential.

The expansion of the team brought about a significant shift in my role. Instead of merely being the project's originator, I found myself taking on the responsibilities of a Creative Director, Software Architect, and Embedded Engineer. This transition required me to wear multiple hats at once - not only did I contribute to developing parts of the codebase and engineering the hardware, but I also offered guidance on sound design and the selection of tools.

Juggling these varied roles was a challenging but rewarding exercise, and it was made possible by the wider team's involvement. The addition of new team members took some of the workload off my shoulders, which provided me with additional time that I could dedicate to more thorough design iterations. This had a significant positive impact on the user experience design and the development of the hardware. It allowed for a more focused, meticulous design process, resulting in a more polished and refined gameplay experience.

With a broader team, we were able to pool our diverse skills and perspectives to better address the many facets of game development - from the technical requirements of software and hardware to the artistic considerations of sound and user experience design. This collective endeavour greatly enhanced the overall quality and scope of the game, preparing it for the elevated visibility and rigorous physical demands on the hardware that are inherent in high-profile, high-traffic events.

4.6.1.1 Changes to the Game Design and Software

The IndieCade experience was enlightening regarding my design aspirations. I sought to create embodied joy among groups of players and foster a deeper sense of shared human connection. Furthermore, it dawned on me that my role in *Bot Party* was as central as the bots themselves. My interactions with the audience, active participation, and post-game conversations were all fundamental to the project. My personal engagement with the players played a major role in shaping the overall narrative and impact of *Bot Party*.

To be able to deliver on my creative vision post IndieCade, I decided to transition the game to the Unity platform. This was done strategically to allow the incorporation of multiple levels into the game. My aim was twofold: to maintain the open-ended musical exploration for sound enthusiasts, while introducing a new level to support the extended hand-holding behaviour observed by players. Given these changes, a platform allowing for hands-on access and quick modifications was necessary. The switch to Unity necessitated a change in the sound engineering role due to Frieda Abtan's unfamiliarity with the platform. Given the deadline, it was crucial for me to work with a tool in which I had expertise, and Unity is my platform of choice as a developer. However, this does not diminish Abtan's involvement - she remains part of the team, attending GDC to assist at the booth and is credited as a sound designer for the project. This change was strategic, reflecting the choice of tools rather than Abtan's contributions.

With Unity as our foundation, Brian Jackson was invited to step into the role previously filled by Abtan. Unity's inherent audio capabilities were a clear advantage, and to exploit these fully, we integrated a Unity add-on called Helm, along with its compatible open-source software synthesiser and sequencer VST plugin for Ableton Live. This setup allowed Brian to design sound patches using Ableton Live, which could then be imported directly into Unity via Helm’s add-on. This not only streamlined our sound design process but also offered us great flexibility and control over the game's auditory environment.

For this iteration, I sought the expertise of Charlie Ann Page, a fellow disabled game designer, developer, and a member of my non-profit, Code Liberation. Charlie played a crucial role in the Unity development process and contributed as a level designer to this build as well. While I was responsible for co-designing the software architecture, hardware data packets, and serial code, Charlie wrote the necessary abstractions to make the game levels scalable, constructed the game levels, and enhanced the event system I had initially designed.

During our design phase, we found ourselves engrossed in a conversation about player behaviour and IndieCade feedback. I shared my desire to incentivise players to touch each other in sequences, inspired by the choreographed moves in *Dance Dance Revolution*. This conversation ignited the creation of the level *Little Secret Ciphers* (LSC), internally referred to as *Touch Touch Revolution*. I was keen on ensuring that the game lasted approximately the length of a typical pop song - roughly three minutes. This was to provide players with a complete, rounded experience, encompassing a clear beginning, middle, and end to the experience. I had noticed that many players would walk away from the game without a sense of accomplishment or a clear understanding of the game's progression. To address this, *Little Secret Ciphers* effectively deploys a distinct game loop that provides players with a comprehensive and satisfying gameplay experience based on their feedback over the prior year.

For the *LSC* level, which spans roughly three minutes, I felt it was important to incorporate a player onboarding into the story world of the game. This phase acquaints players with the touch mechanic, a necessity highlighted by the video documentation from IndieCade. There, I observed myself spending significant time explaining this touch mechanic to the players. My goal was to embed this training directly into the game, removing the need for my manual explanations about how the game rewards physical contact between players while handling a bot. By making the game more self-explanatory, we could enhance the overall player experience.

After this training phase, my vision was for the game to gain momentum, echoing the intensifying pace of a previous game of mine, *Nightmare Kitt*y (Perry and Fox-Gieg, 2011). Similar to the second version, I wanted the bots' spoken text to act as cues for the players.

During a brainstorming session with Charlie, we conceptualized a bot narrator. In the game, the narrative of having to (re)training the Human Intelligences (HI) in the art of human communication frames the level. Loosely based on the idea of Artificial Intelligence, the bots are having the humans perform an input to the system by touching each other. At the end of the game, they tell the humans how they have done in the form of their transmission speed. Charlie and Brian led their voices for this synthetic robot guide. This narrating bot leads players through the game, offering real-time feedback on their performance.

Players must connect the boxes in specific sequences. If players connect the wrong boxes together, a negative sound plays to provide feedback. On the other hand, correct connections are reinforced with a positive sound. This added another layer of interactivity and feedback for the players. The entire User Experience Design Document can be found in Appendix B*, Bot Party UX Document.* As noted, Charlie designed the touch sequences as they flow between each section of game play and these specifics are not in the UX Doc.

The User Experience Design Document enhances the freeform mode. After players grasp the game's mechanics through the "Little Secret Ciphers" level, I expect that they're better equipped to enjoy the freeform experience as a unique and separate level. I maintain the idea of individual musical voices for each bot - drums, melody, and a synth drone harmony - and continue to allow players to experiment with the motion sensors.

We have developed something somewhat like the second prototype for this level, but it isn't an exact replica. We needed to tweak the data from the IMU (Inertial Measurement Unit, a device that measures physical movement) to make the players' movements feel more satisfying, and we still have plans to incorporate more of Abtan's original creative inputs. In our current design, we primarily detect major shifts in the IMU data and adjust the game's response based on which bot is being used.

The motion sensors and an algorithm known as a Markov chain guide the progression of possible notes in the melody. The drone tone of the pad changes in response to player movement, and the speed of the drums can be controlled by shaking the box. Brian has also completely revamped the soundscape to create a warm, inviting, and playful atmosphere. This refreshed ambiance further enhances the players' experience and interaction with the game.

4.6.1.2 Hardware changes

The biggest change was to take all the electronics from prototype boards to properly constructed and professionally produced circuit boards. This gave the electronics a level of security not achieved previously. However, in this process, every single component was reconsidered, and most were replaced. Considering the challenges, the game was set to face – including a 14-hour trip from London to San Francisco, being packed as checked luggage, and enduring three days of non-stop interaction with thousands of players at GDC – it was vital that the hardware was considerably strengthened. To accomplish this, I designed and printed two professional circuit board designs: one meant to function as an Arduino Uno Shield and another designed to fit inside each bot. I added the ability to disconnect all the individual components within each bot using JST connectors. This feature facilitates effective troubleshooting and replacement of components if there's a hardware failure, ensuring the game remains operational throughout the entire event, no matter what it encounters.

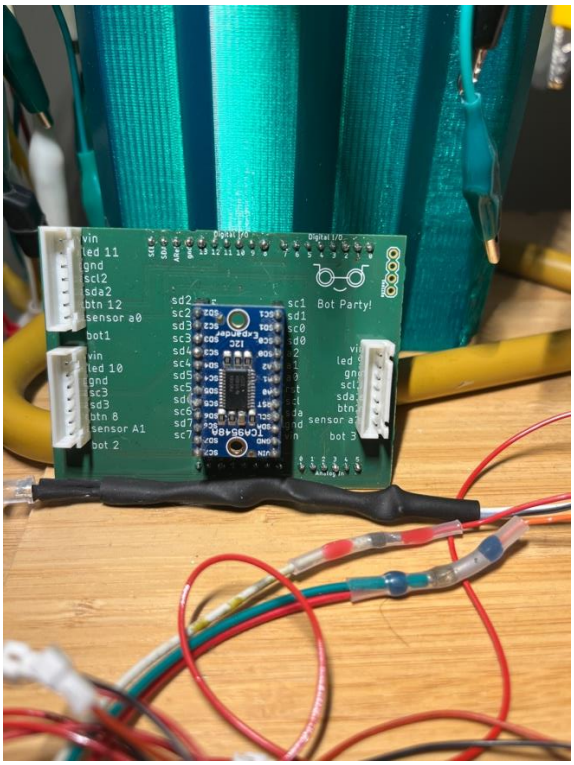


Figure 48 Bot Party Arduino Uno Shield

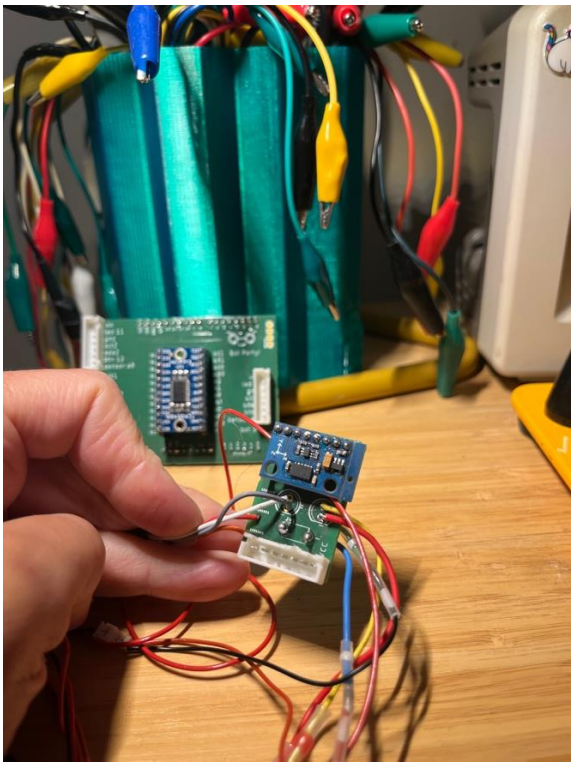


Figure 49 The circuit board in each bot.

In addition to hardware enhancements, I also made significant adjustments to the Arduino code to support the new behaviour of sending data to and from Unity. In previous versions of the game, the bots only sent data to Max. However, with the transition to Unity, the bots needed to have two-way communication – not only sending data but also receiving

instructions from Unity. This allowed Unity to control the bots' states, turning them on and off based on the game mechanics.

As a design constraint, I challenged myself to design all the hardware, the speakers, and the repair kit for this exhibition to fit within one single piece of checked luggage. Having a single box shielding the laptop that was easy to access if you picked it up was also a non-starter. What if I needed to take a break and leave the booth unattended? To address these security concerns, I designed a new, arcade-style enclosure that was built using CNC and laser cutting techniques. The design provided a secure compartment for the laptop, which could be locked to ensure it couldn't be removed without a key. The enclosure itself was quite hefty, being made of wood and acrylic making stealing it at least an awkward experience. To complete the design, I added a cut out that let us lock the entire enclosure to the display table with security lock. On the face of the tabletop cabinet, I also cut holes for traditional arcade style buttons for level selection, as well as the names of each level, allowing players to easily navigate between the different levels of the game. I kept the LED lighting from version two and cut the name of the game into the face. The result was a secure, functional, and aesthetically pleasing setup that could withstand the bustling environment of a game convention floor.

Figure 50 GDC enclosure on the GDC convention floor.

Figure 51 Bot Party in suitcase with note for the TSA on how to test the hardware.

4.6.2 Software Design

The structure of the software is intentionally designed with a focus on extreme adaptability. At the heart of this design is a goal to enable any developer, regardless of their knowledge of the other levels, to work on any aspect of the game. This means they can contribute to or modify different components of the game, or even create new ones, without having to understand every single detail about how the whole system works.

Let's break it down further. The software's structure is built around several main abstract classes. Think of these abstract classes like blueprints or templates. They outline the basic structure and functionality of a system within the game. Each level of the game utilizes these blueprints for its own systems, which means every level shares some common ground. Inside these blueprints are a series of events that are triggered based on certain conditions. For instance, when Bot Two and Bot Three make contact, that action triggers an event. This could be anything from a sound effect to a change in the game's LEDs. Now here's where the flexibility comes in: every level of the game is subscribed to these events. This means they all respond to the same triggers, like the Bots making contact. However, the exact response can be different in each level. All any level needs to do is implement the abstract class then override the appropriate function with the level-specific code. As they create a new level, they can pick and choose from these predefined events and subscribe additional functions to the event based on the needs of each experience. This adaptable architecture promotes creativity and ease of development, making it a dynamic and efficient system for designing and improving the game.

As the game is built around custom hardware, the game logic is separate from the hardware systems. Doing this allows for different hardware to be experimented with. Facilitating this, the Input System has its own abstract manager class. Below is a diagram of how this process works for the game’s Inputs, which can be the serial data from the Arduino hardware or Keyboard Inputs for testing. Since both implement the Abstract Input Manager, switching between them in real-time is possible.

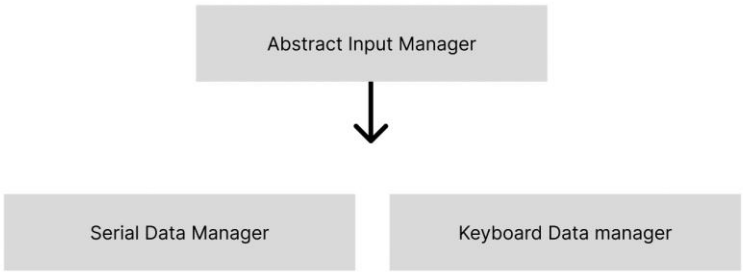


Figure 52 A diagram documenting the Abstract Input Manager System

The operation of the game hinges on a persistent Game Manager prefab that remains constant across all the levels, or 'scenes', as they're called in Unity's terminology. For those not familiar with the term, a prefab in Unity is akin to a blueprint for a game object that encapsulates all its components and their respective values. Think of the Game Manager prefab as the conductor of an orchestra, maintaining references to key game components such as the Serial Data Manager, Keyboard Data Manager, Bot Data Manager, and Touch Manager. These components could be seen as the musicians in our orchestra, each playing their own part to create the symphony that is the game. Just like the Game Manager, these references continue uninterrupted from one level to another. In essence, each level is equipped with the necessary building blocks and functionalities required for both hardware interactions and keyboard-based testing environments. This setup allows for seamless transition between levels and a consistent gameplay experience, regardless of the specific scene the player is interacting with.

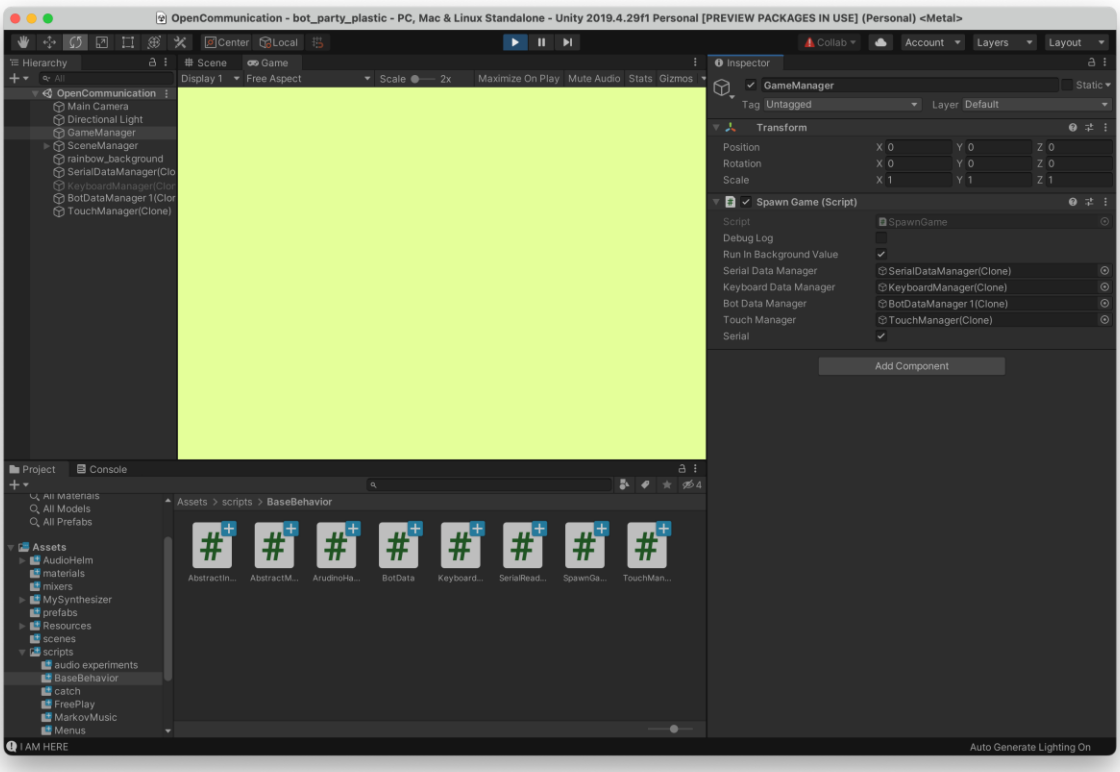


Figure 53 Bot Party Open Communication level showing the Game Manager in the Inspector in Unity

4.6.3 Visual Design

Initiating the visual design process, I curated a mood board comprising potential elements to encapsulate the game's distinct aesthetic. Guided by the vibrant hues and whimsical visuals of the cybertwee aesthetic, I formulated a unique colour palette that could effectively communicate the game's spirit. Beyond colour, I also designed a bespoke type and logo brand mark, further solidifying the game's identity. These collective design efforts culminated in a cohesive set of visual assets, which I delivered to the Game Developers Conference (GDC). These assets were not only representative of the game's identity but were also prominently displayed in the awards ceremony video, showcasing the game's distinct visual style to a broader audience.

Figure 54 Bot Party Award video and logo

For this version of the game, we enhanced the visual design by incorporating illustrative artwork by Mimi Sotudeh. We commissioned Sotudeh for three specific illustrations, each of which served to visually instruct players on key aspects of the game. The illustrations graphically demonstrated two of the most fundamental concepts in the game's interaction space. The first concept communicated through the illustrations is that players need to physically connect with each other while also holding a controller. This helps illustrate the unique aspect of *Bot Party*, where physical interaction between players is just as important as their interaction with the game's hardware. The second concept visually expressed is that all three players can simultaneously connect while holding controllers. This underscores collective participation in the game. When commissioning the artwork, I made sure to communicate the desired visual style and colour palette to Sotudeh, ensuring that her illustrations would seamlessly blend with the existing game controller aesthetic. The final art was turned into stickers for booth decoration. Smaller stickers were made players could take after playing. These visual enhancements added another layer to the game,

further immersing players in the interactive world of *Bot Party*.

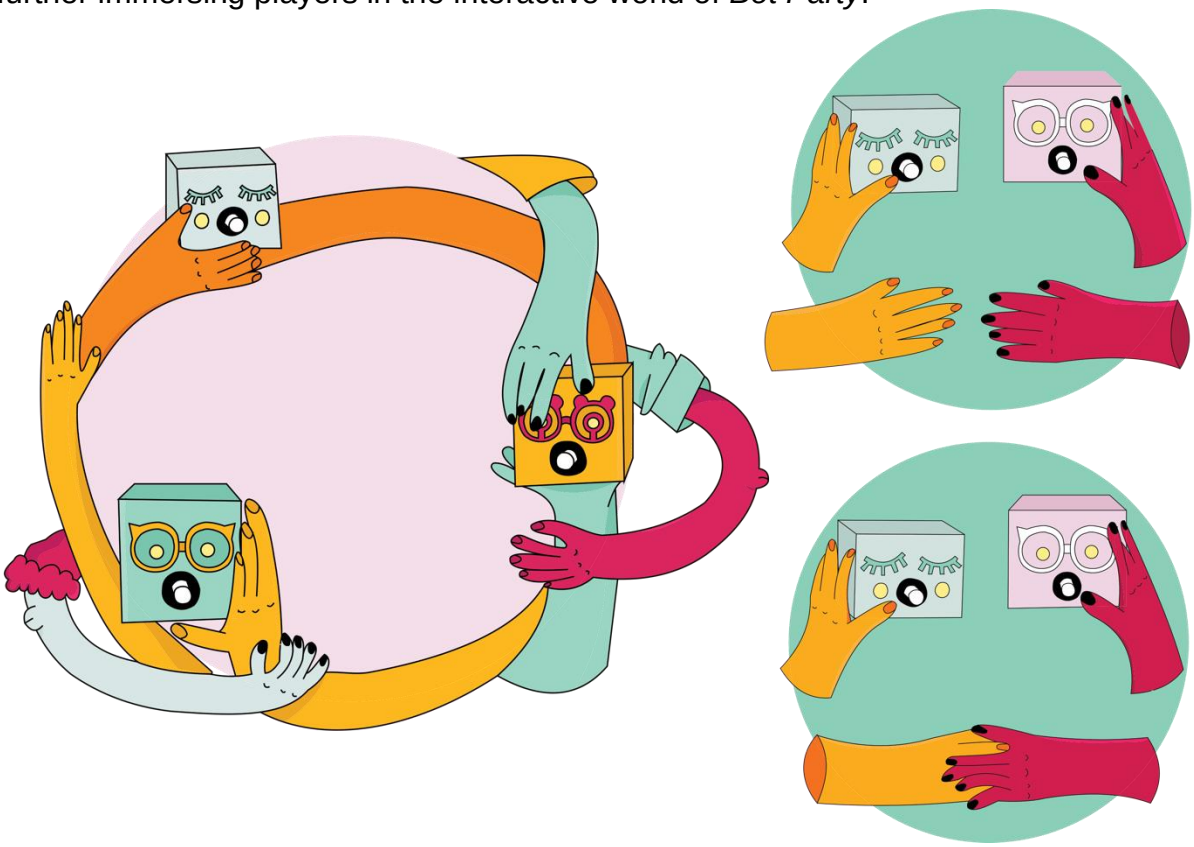


Figure 55 The Illustrations of Mimi Sotudeh showing gameplay examples.

4.6.4 Playtest One

The first significant round of playtesting occurred on March 8th, 2018, in my office at Goldsmiths with four participants. The participants were fellow students who played the game and then gave in-depth feedback by answering questions and having a post-play-through discussion of each level. This initial playtest was crucial as it guided multiple changes that were implemented into the final version of the game. For detailed reference, both video documentation and a transcript of this playtest are available in Appendix X. Please note this transcript, which was auto generated, should be used as a rough guide alongside the video files available in the documentation folder.

One challenge with the auto-transcription's readability arises from the dual roles Charlie played during the playtest. As she was acting as the bot narrator and helping run the playtest, there are moments of overlap and confusion which are more readily understood when viewing the time-coded video at specific points should the reader so choose.

The feedback from this playtest was processed similarly to previous exhibition feedback but the focus here is on playability, using iterative play testing. The playtest was performed with the IndieCade hardware and a minimal viable build of the GDC game with both levels in place. This setup allowed us to evaluate the effectiveness of the new levels and identify areas in them needing improvement. The insights from this exercise were instrumental in refining the game's design and hardware ensuring that it delivers a consistent user experience.

Additionally, notes were taken during the conversation to make sure that all the best input was captured in an easy to access way. These rough notes were turned into a to-do list immediately after the playtest to capture the important points into action items. The

feedback was prioritised into four main categories: Must be, Performance, Attractive, and Irrelevant. While insights were raised that sparked possible future innovation, they were not the focus given the time frame, but they might be returned to in future levels.

4.6.4.1 Iterative Playtesting Questions:

The questions posed during this playtest aimed to assess functionality and determine whether the new gameplay was engaging and comprehensible for players. LSC introduced several new elements that required player understanding: the instructions, signals for successful and unsuccessful connections, and the remaining time players must make a connection before the game times out and results in a failure. All these components were integral to the overall player experience and required careful observation and analysis during the playtest to ensure they were conveyed effectively and added value to the gameplay. These questions are designed for the team to be able to pick out the player's understanding of what is being experienced and consider where improvements can be made.

Could you describe the behaviour of the LEDs and what they communicate?
Why did the screech (the negative sound effect in this version) happen?
If you can add only one thing to the game, what would it be?
If you could remove one element, what would it be?

4.6.4.2 Playtest Results

Balancing the synergy between the hardware and the game level was a crucial aspect of this playtest. Players found the new time-based touching mechanic engaging, yet confusing. They struggled to discern when and which bots should connect. A significant issue was the lack of visibility regarding the state of all the LED bots from a single glance. Only the player holding a particular controller and looking directly at it could ascertain whether their controller was one of those needed for the connection. We also introduced a very low-resolution sound effect, specifically Charlie saying the word, "Screech," to signal an unsuccessful connection. However, because of the above visibility issue, players struggled to understand that this sound clip indicated an incorrect connection. Other issues included the players not knowing how long to hold hands in LSC during each connection. To address this, I opted to make the bots translucent so that they could light up entirely, making it immediately clear which two or all three controllers were active at any given moment. The LEDs now turn on and off indicating which the boxes to connect and for how long. The negative and positive feedback sounds were changed to be simple and stylised. The positive sound evolved into, "Yep." The negative sound is a game show like crash.

Furthermore, players proposed the idea of integrating the knowledge acquired from using the motion sensors in the controllers during the Open Communication level into the LSC level. This input suggested that they appreciated the extra layer of interactivity offered by the motion sensors and saw the potential in extending this feature to other levels. In response, we included a bridge in the song structure, during which the narrator instructs players to shake the boxes. This mirrors the interaction observed in the Open Communication level and the boxes perform similarly, only with sounds specific to this level.

The play testers also recommended that the level should progressively build in intensity, as they found the current iteration monotonous during play cycles. Simply speeding it up slowly was not proving engaging enough over three minutes. We addressed this feedback by adding a mechanic where the tempo speed in the Open Communication level is tied to all the player movement. After a certain rate of movement, the soundscape locks in and

keeps running in a unified way until the motion either drops beneath the threshold or stops. After the bridge in the LSC level song, gameplay resumes, but now the pace at which it progresses is directly linked to the intensity with which players shake the controllers while making connections. This modification aims at creating a more dynamic and engaging game experience, offering players an additional level of control over their gameplay progression.

The development of this version of *Bot Party* underlines the significance of incorporating ongoing player feedback and an adaptable development process. The challenges that arose - including the initial confusion around the time-based touching mechanic - were addressed through design modifications such as light-up bots, changes in feedback sounds, and clearer game progression cues. By integrating the motion sensor mechanics used in the Open Communication level into the LSC level, an additional layer of engagement was added, enriching the level. Addressing the monotony players experienced led to the incorporation of a mechanism that linked the game's rhythm and speed to the intensity of the player's movements, creating a dynamic game experience that offers players more control over their gameplay progression. This iterative and responsive process illustrates key opportunities to make the gaming experience encourage more physical interaction and motion. What results from these changes is a game which could encourage releases oxytocin into a player’s brain repeatedly through multiple rounds of player contact, but a level of motion which often inspires dancing after the bridge. (Uvnäs-Moberg et al., 2015).

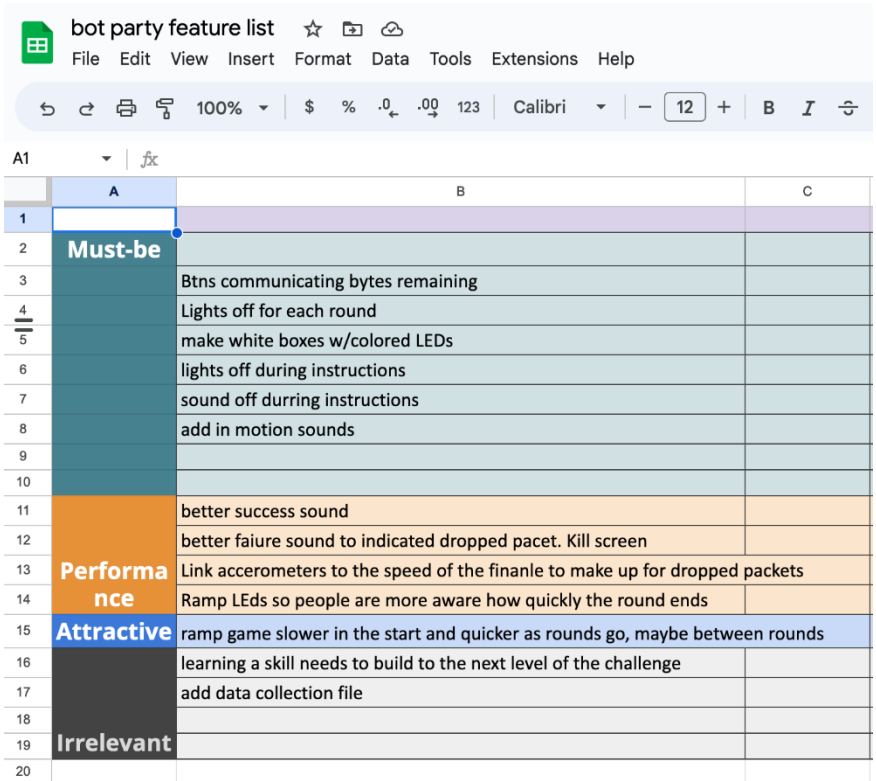


Figure 56 Post play test to do list and priority list.

4.6.5 Playtest two

Our second play test occurred on the 14th of March 2018 at the Mughead Cafe, just a few days before the exhibition. This critical test aimed not only to identify and fix any remaining bugs but also to trial the setup process for the exhibition. Given the proximity to the exhibition date, we focused our efforts primarily on code fixes following this session. We

were fortunate to have a mix of café patrons and passers-by participate in the testing, which provided us with a broad range of player perspectives. The primary objectives of this test were to conduct a stress test of the game in preparation for its debut on the convention floor and to showcase the game to friends and acquaintances before the official event. The test also provided us with an opportunity to assess the durability of the hardware when used by the public, including children.

Data was collected from my first-hand observation playing the game with the audience in the form of quickly jotted-down notes. Our findings from this play test were overwhelmingly positive. The game code performed according to specifications and the hardware proved robust enough to withstand public play cycles. Players repeatedly displayed positive emotions and expressed positive feedback. We were also able to confirm that the game could be set up in under 20 minutes, making it suitable for easy transportation.

However, we did identify some minor issues that needed addressing. These included some sound balancing adjustments to ensure the clarity of all audio cues, as well as a few minor code glitches that required patching in the serial data. Once these tweaks were made, we were left with a solid build that gave us confidence ahead of the exhibition. This final play test was crucial in affirming the game's readiness for the show and allowed us to make the necessary adjustments to ensure a seamless experience for players at GDC and beyond. It also was the first time that I ran a public stress test pre-exhibition, which served to help me realise we had reached a more polished build this round.

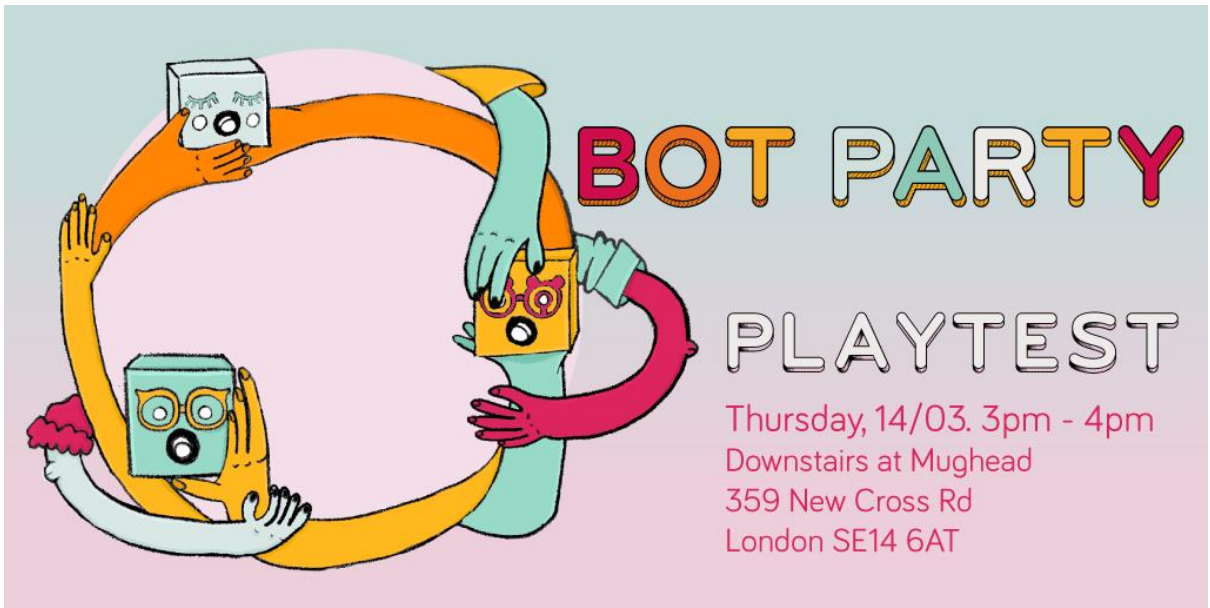


Figure 57 Playtest flyer

Figure 58 Playtesters and I playing the game.

4.6.6 Exhibitions

As previously stated, each exhibition of this version of the game utilised identical hardware and software configurations. Thus, I have elected to amalgamate all the gathered data, organising it into distinct themes and latent codes of significance.

As an active participant in the game, I will recount various experiences and dialogues from these exhibitions. In doing so, I will employ an Autoethnographic design approach to derive conclusions. Autoethnographic design, as conceptualised by Neustaedter and Sengers, constitutes a situation where the "researcher(s) build the system, they use it themselves, learn about the design space, and evaluate and iterate the design based on their own experiences" (Neustaedter and Sengers, 2012).

In addition to the Autoethnographic Design, a Reflective Thematic Analysis (RTA) of my own autoethnography will be used to supplement the assessment of the gathered data. Moreover, I will apply RTA to the data collected in the forms of photographs, videos, and social media posts. This data includes 53 photos, 11 short video clips, and 13 social media shares. Additionally, press was all positive including press from Gamasutra, The Verge and PC Magazine. [5]

These combined methodologies facilitate a deeper comprehension of the data and provide a structured framework for interpretation. By integrating the autoethnographic approach with RTA, this combined methodology provides a comprehensive exploration of the

[5] Data found here:
https://www.dropbox.com/scl/fo/nx5u8bquwz8dl2ng2qt2i/h?rlkey=yim736z2od57p12pq5qs079v9&dl=0

game's influence both on myself and players, ranging from personal experiences to overarching thematic patterns.

4.7 Autoethnographic Reflections

4.7.1 Game as Resistance

Presenting the game at GDC with thousands of players allowed me to reflect on the existing biases surrounding my presence on the convention floor. This was not my first time being in this general area of the convention. In 2013, I was there to demonstrate my game, Crystallon, to assist PlayStation in launching the Vita console. My experience at that GDC was disconcertingly surreal. I was unprepared for the level of sexism I encountered on the convention floor. Even though both business practices and player attitudes towards issues such as booth babes, disbelief in female game creators, and a general lack of inclusion have improved since then, I still felt a degree of apprehension about inviting this crowd of strangers to hold hands with me. Thankfully, the combination of jet lag and caffeine seemed to help me overcome my initial fears as the doors opened.

My deliberate positioning in this space was a feminist crip act of resistance against the pervasive toxicity within the industry. As a gameplayer, so many of the games GDC serves to launch year in and year out are inaccessible to me. The participation of every single marginalized person in the gaming convention is an assertion of our presence and contribution. We are here. We are not going away. We are continually creating titles. At this GDC, I felt that I managed to command the space around me more effectively, and I was significantly more comfortable with my game. I can't definitively say whether this increased level of comfort was due to the more humanizing atmosphere created by *Bot Party*, but it was noticeably different. It's clear that I was far more at ease at the end of the first day of this event than I had been by the end of the third day back in 2013.

4.7.2 Crip Resonances

A significant moment for me arose when a disabled player approached our booth in their wheelchair and acknowledged that we were the only ones to have made an accessible booth in the Alt.Ctrl exhibit. This had been a deliberate decision on my part, as I wanted to ensure that disabled players, including myself, as well as shorter and younger players, could easily access the controllers. Upon our arrival, all the tables provided were bar-height, far too tall for me to be comfortable standing at all day. Acquiring shorter tables took some persuasion, and I finally had to firmly assert that my disability necessitated the option to sit occasionally, and that the elevated angle was impractical for using my computer. This modification ended up creating a booth that was accessible for all. The player was so impressed by the game that they tweeted about it, including it in their thread of favourite accessible games at GDC. This incident serves as a powerful example of the positive impact that can arise when disability considerations are incorporated into game design discussions.

Figure 59 Tweet by Adreyn that underscores the accessible display created for Bot Party

In one striking instance, a player who suffered from a phobia of physical contact decided to play the game, driven by curiosity to push beyond his fear. He approached me, confessed his phobia, and declared his intention to play to see how long he could endure the experience. He managed to last over half the game before he let out a startled yelp - akin to someone encountering a spider - and abruptly retreated.

Another unforgettable player, shared with me that he couldn't recall the last time he'd touched another person. He played the game multiple times over the course of the event with an array of players, and with each playthrough, I could perceive a subtle change in him. When we discussed the game, he fought back tears of joy, expressing how much he had enjoyed the experience. This interaction resonated deeply with me, not so much for what was explicitly said, but for the unspoken implications. It underscored the essential role that touch plays in fostering unity and connection in our human community, and the profound effects its absence can have on a person.

An insightful suggestion for improvement came from a blind player, who proposed the integration of haptics into the game to enhance its accessibility. This was an idea I had previously contemplated but hadn't found the time to develop. Thanks to his feedback, I've since incorporated this feature, enhancing the game's accessibility for blind players.

4.7.3 Embodied Joy

Generally, the reactions from participants filled me with happiness. What often began as curiosity or uncertainty was swiftly dispelled by the engaging mechanics of the game. Players were eager to compare their performance against the day's high score. Some teams returned multiple times to check their standing on the leader board, and if displaced, they would attempt to regain their top position. Observing the strategies players developed to improve their scores was a delight.

The first strategy involved one player extending their hand in the centre while the other two touched this hand, and all players stood as close as possible for the entirety of the game.

Figure 60 Bot Party Players using a strategy of placing their hand in the centre.

The second strategy saw players form a sort of arm triangle where everyone extended an arm to create a triangular shape, then they would stand as close as possible to maintain the connection.

Figure 61 This is the strategy where players stand as closely together as possible.

The third strategy typically commenced after the bridge in the game. Players would dance and jump as quickly as possible to accelerate the game's speed and score points rapidly. These play cycles consistently resulted in enthusiasm and what I can only describe as embodied joy. On one occasion, it even led to three players dancing and chanting the game's name in the Open Communication mode after playing LSC.

Figure 62 A group of players dancing and shaking bots.

One moment that moved me deeply was when a young woman approached me to discuss

the game. Her understanding of it was profound. She perfectly articulated what I had been trying to achieve - proposing a new way of being and a fresh approach to designing games that centred on gentleness, kindness, humanity, and joy. This conversation filled my soul as we deliberated on the transformative potential of such work to progress the industry.

A vivid memory that springs to mind involves one of my students, who attended the event on an IGDA scholarship I had endorsed her for. She graciously volunteered to oversee the game for a few hours, allowing me the opportunity to attend a yoga class and rest my back. While this may appear a minor detail, it held profound significance for me. Alice, who is openly transgender, demonstrated a sense of safety and comfort amongst the players. This indicated to me the supportive and inclusive atmosphere that had been cultivated around the booth. Seeing Alice on my return, together with a group of players, visibly enjoying herself, provided me with a deep sense of accomplishment.

Whenever more than three players expressed interest in the game, I would instruct them on how to incorporate additional players as bridges between those holding the bots. This led to numerous instances of large, circle-formed bridges comprising multiple players. These moments were characterised by wide smiles and palpable enjoyment amongst the participants.

Figure 63 A large group of players forming a circle to connect all 3 bots.

I had the pleasure of witnessing a dancer create a captivating piece of music by taking control of all the bots and moving in ways that were entirely unique. His slow, languid dance style elicited a melodic structure that was beautifully representative of his distinct form of dance.

4.7.4 Expressions of Love

Observing people posing with the bots became a routine occurrence. The design of the game resonated immensely with the players, creating a sense of fondness for their

characters. A myriad of bot selfies found their way onto Twitter in the aftermath of events.

Figure 64 A fan generated image posted on Twitter.

Figure 65 Tweet generated by a fan.

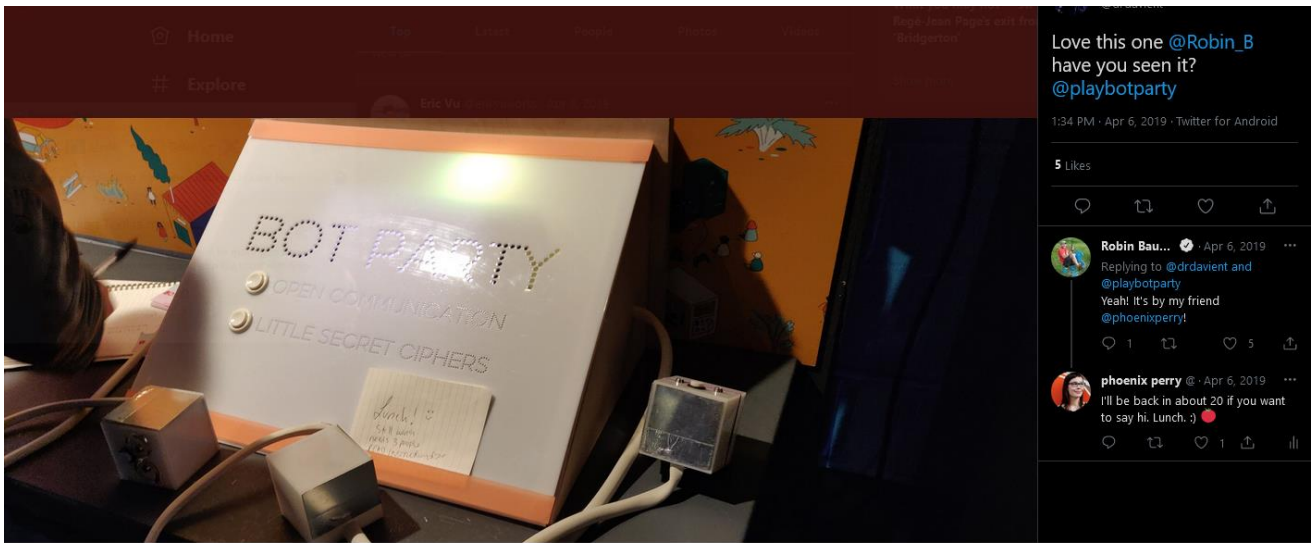


Figure 66 A fan generated tweet saying they loved the game.

A noteworthy trio of players consisted of two parents and their young daughter. On numerous occasions, the little girl took the lead, instructing her parents on how to play. One memorable moment was when she requested them to kiss her to establish connections throughout the game. On the second day of EGX, the family returned, with the mother confiding that their sole purpose for revisiting was their daughter's adamant desire to play the game again.

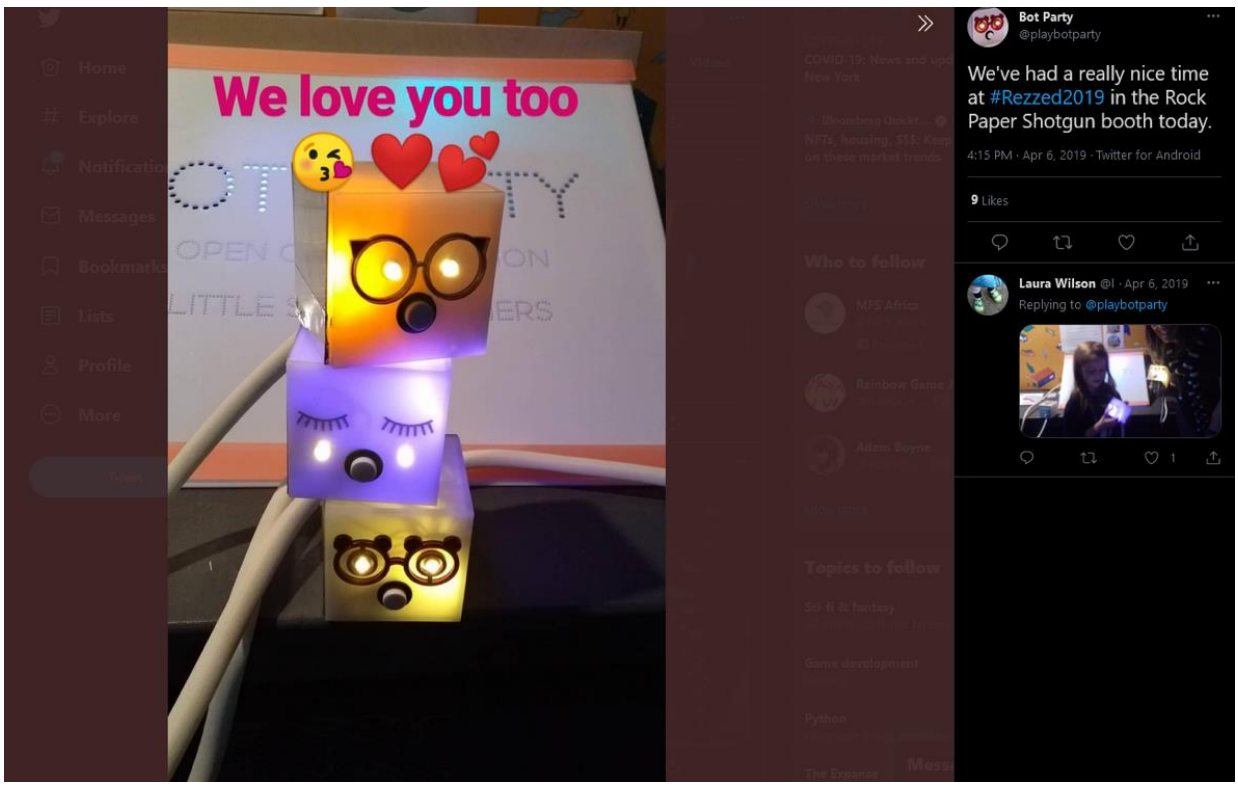


Figure 67 Another fan generated reply to our tweet showing positive feedback.

The game also served as an unconventional tool for expressing affection among a visibly flirting queer couple who played the game while sharing intimate moments. Furthermore,

at a queer games party in London which was held after-hours, *Bot Party* was used repeatedly as a playful platform for flirting and expressing affection.

4.8 Version Four - *Bot Party*: The Sightless Kombat Version

The fourth in-progress iteration of the game retains the original gameplay with one significant enhancement: the inclusion of haptic motors that tactically reproduce the LED information communicated to players visually. This modification was inspired by Sightless Kombat (SK), in honour of whom this version was named. SK self describes as being born Blind. Although the gameplay remains unchanged, the hardware underwent substantial revisions based on lessons learned from the version three hardware build to support Blind players.

The circuit board designs were significantly improved, including the addition of more LED ports. Accommodating the haptic motors required each box to connect not only to the Arduino but also to an external power source. The Arduino on its own couldn't supply enough power to operate all the components simultaneously. Consequently, this necessitated a profound change in the circuit board design, which now had to account for the new haptic feedback system and the external power supply needed to support it. This new configuration provides a richer, more immersive user experience by giving players tactile feedback that corresponds to the visual signals provided.

Figure 68 The printed circuit boards of version 4, including both the bots and the bot brain.

The most noticeable change in this iteration is the shift from acrylic boxes to 3D-printed bots. This change not only visually updates the game, but also substantially improves the accommodation of the internal electronics. The circuit boards are now securely fastened with screws instead of being super-glued, enhancing durability and reliability. The faces of these 3D-printed enclosures can easily be unscrewed, providing effortless access to the interior components. This contrasts significantly with the previous process, which required re-gluing a face to reassemble a bot after repairs. This improvement was motivated by Sightless Kombat's request for a home version; the new design allows for easier user-based repairs, if needed. Moreover, the use of 3D-printed components has streamlined the manufacturing process. Constructing a set of bots, which previously involved around 40 hours of careful cutting, gluing, and setting up boxes, can now be completed in just a day. This includes 3D printing the bot parts and assembling the new circuit boards that simply screw into place. This enhancement has greatly increased the reproducibility of the game, making it more accessible for a larger audience.

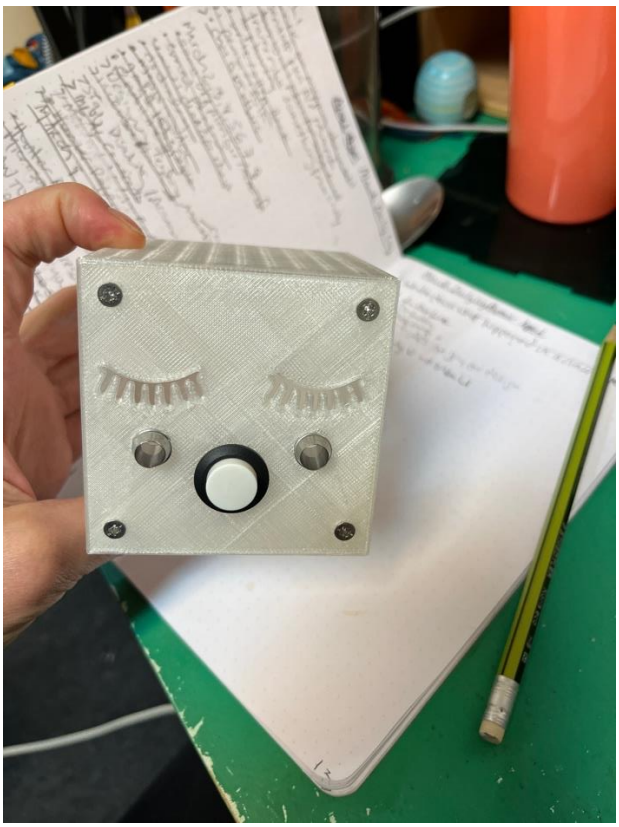


Figure 69 Improved casing for version 4 showing inset screws.

This version remains a work in progress, underscoring a pattern where I seldom finalise a creative endeavour; rather, I continuously iterate on concepts until they organically evolve into new projects. It is conceivable that SK and I might ultimately transform this work into an entirely distinct game, potentially the one he envisions in Chapter 5. Presently, it serves as a catalyst for an ongoing dialogue between SK and me, centred around the themes of accessibility and haptics. The objective is to carve out time for a meeting later in 2023, facilitating an in-depth exploration of ideas and soliciting his invaluable feedback on this iteration.

4.9 Conclusion

Baby Bot (Prototype One) emerged from a studio-based creative process. It is an analogue synthesiser and step sequencer designed to foster playful, group-centric interaction. Exhibited as a concept, it served as a stepping stone for further innovation by gathering crucial feedback. The adaptability and appeal of *Baby Bot* were key in its transformation and further development into more sophisticated, values-centred versions of the *Bot Party* game. This feedback influenced the design and development of *Bot Party*.

Bot Party (Prototype Two) expanded the interactive elements across three separate controllers, maintaining the sonic design principles from *Baby Bot* but adding complexity and depth. The signal which moved across the synthesis units in *Baby Bot* was reimagined as a metaphor representing human movement and connection.

Bot Party (Prototype Three) incorporated a touch-focused, rule-based structure, while preserving an open-ended auditory exploration as a separate level. This design offered players a balance between structured gameplay and the freedom to explore their sonic environment.

Bot Party (Sightless Kombat version) was influenced by feedback from a disabled player, Sightless Kombat. This in-progress version of the game introduced tactile feedback through haptic motors, allowing players to experience game cues not only visually, but also physically. This marked a significant hardware revision, including an improved circuit board design to support these haptic feedback motors. Additionally, the shift from acrylic to 3D-printed bots offered an enhanced, maker-friendly design that facilitated easy access to internal components and allowed for more efficient construction and repair processes.

Bot Party transcends the conventional definition of a game by acting as a social conduit that nurtures human interaction, acknowledges the experiences of the people living with disabilities, and fosters a sense of joy through embodied play, making it a distinct proposition in the realm of digital games. The design process of *Bot Party* has been characterised by thoughtful iterations shaped significantly by the feedback received from play testing and the gaming community at exhibitions. It signifies a commitment to evolving gameplay dynamics and innovating game features that continually challenge the norms of bespoke, Alt Ctrl gaming. Current developments are focused on experimenting with haptics, scale, and the spatial and size dimensions, which will form part of future design enhancements. For instance, a play test beyond the remit of this discussion featured supersized game boxes during a test run at Somerset House in 2019. Whether these variations will continue under the moniker of *Bot Party* or adopt a new name remains to be seen. What stands clear, however, is there is there are few for games like this - those designed to facilitate human touch among strangers, foster a positive sense of wellbeing, and encourage adults to play in embodied ways. to exist and multiply in the gaming sphere.

4.10 Discussion

The evolution of this game, through its various forms, champions a dialog around the opportunity to consider touch and embodied cognition into game controller design. By playing an instrumental role in defining and carving out a space for the Alt Ctrl games genre, my work has made a successful impact in the field of game design. This influence is inextricably intertwined with my personal journey as a disabled games creator; both my disability and the progression of my creative output have been a driving force in this movement.

The insights and perspectives that crip designers bring to the table could serve to challenge conventional design paradigms and push the boundaries of what is considered

within the game design process. Crip designers, through their lived experiences and positionality, bring a much-needed perspective to game design. Their work could inherently challenge notions of universality in design, as disabled designers understand, first-hand, the sheer diversity of bodies that exist in this world through their friction of navigating a world which does not always consider our needs. It's clear that no singular design can accommodate everyone, and we understand this not as a theory, but as a lived reality. My practice, at times intentionally, at others as an act of rebellion, offers alternative ways of seeing and interacting with the world. It questions and disrupts the biases embedded in traditional game controller designs that presuppose a 'normal' body type, excluding many of us who exist outside the typical data sets used in corporate design decisions.

My designs, which may not conform to these unconscious biases, illustrate the richness of diversity and the plethora of possibilities that exist outside the constraints of traditional screen-based games controlled with a console controller. The *Bot Party* controllers have been designed for my own body; a body that deviates from what traditional designs consider as I cannot use a console controller. It is through this personal lens that I position my work and processes. This project is a testament to the power of bespoke game design, where diverse bodies and lived experiences can become the part of the design dialog, not an afterthought.

The three research questions posed in this thesis consider the values and design methods disabled creators use to move towards a crip game design framework. This game, which delves into the realm of physical touch among individuals in group settings, exemplifies one such set of values, offering insights and possibilities that could inspire fellow designers to transcend the confines of traditional screens and forge social connections within physical environments through creating game specific systems. Furthermore, the core values underpinning my work on this project revolve around several key principles. These include the conscious cultivation of positive interpersonal experiences, promoting social bonds through physical interaction, crafting the game as a deliberate embodiment of crip game design to explore my own accessibility, engendering moments of embodied joy for my players, and making purposefully inclusive design choices that consider disabled players.

With each prototype of this chapter, I interacted with the public not as a passive observer of an interface made in a lab being tested with conventional human centred design methods, but as an embedded, situated community member. Using myself, and at points my very skin to form the literal connection between people, my role in this project moves beyond that of designer. I am extending the interface through me – through my crip experience – to weave together a more kind, empathetic moment.

My game design endeavours are fundamentally rooted in values of care, fostering human connection, and engendering positive interpersonal experiences. This philosophy may be seen as a form of resistance against the ubiquity of commercial screen-based games that are often inaccessible due to standardized commercial controllers. My work highlights the potential of creating joy through an embodied, enactive, and entangled form of playfulness. This form of play stimulates a heightened awareness of each other, inviting participants into a metaphorical and sometimes literal dance of mutual understanding and engagement. My process is directly rooted in the act of artistic practice and public exhibition as a form of dialogue driven design.

As detailed in the preceding sections, my research methods encompassed a mixed methods approach. They involved practice-led research, characterised by a continuous

and iterative exploration of the design landscape guided by player feedback. Additionally, I employed thematic analysis to gain valuable insights from the data gathered from players. My autoethnographic reflections documented my personal experiences throughout the research process. Furthermore, the development of the game was conducted through public exhibitions, adding a layer of real-world testing and engagement.

In addition to these methodologies, my work necessitated a degree of adaptability in my creative processes, given the variable nature of my abilities on any given day. This adaptability allowed me to navigate the challenges posed by my condition effectively. Moreover, I actively engaged collaborators who played a crucial role in providing support and expertise, enabling a more inclusive and enriching research journey.

Drawing from the literature review, Lambros Malafouris's theory of Material Engagement underscores how the tools we interact with facilitate an ongoing dialogue between our cognitive processes, physical bodies, and cultural environments, thus influencing our minds (Malafouris, 2015). Moreover, the concept of Epistemic Action, as proposed by Kris and Maglio, highlights how humans transfer a portion of the cognitive work required to play games onto the affordances of game controllers. By considering these theories in conjunction with disability studies and game design, a case can be made that controllers designed by and for individuals with disabilities might open new ways for players to understand and navigate their world. These perspectives, often marginalised, could potentially serve as catalysts for meaningful cultural change. These specifically designed controllers offer an embodiment of experiences and creative solutions that push back against norms and promote a wider inclusivity in the realm of game design and beyond. As detailed in the preceding sections, my research methods encompassed a multifaceted approach. They involved practice-led research, characterised by a continuous and iterative exploration of the design landscape guided by player feedback. Additionally, I employed thematic analysis to distill valuable insights from the data gathered from players. My autoethnographic reflections documented my personal experiences throughout the research process. Furthermore, the development of the game was conducted through public exhibitions, adding a layer of real-world testing and engagement.

5 An exploration in Alt Ctrl Crip Game Design

The literature review has drawn attention to Xenofeminist philosophies, which argue that to advance emancipatory and abolitionist initiatives aimed at dismantling class, gender, and racial hierarchies, we must undertake profound revisions of our understanding of universal concepts (Cuboniks, 2015). This potent idea should also be extended to disability and design considerations. To incorporate emancipatory practices into disability-driven design, we need to contest universal principles from a grassroots perspective. This would mean challenging systemic structures such as User-Centered and Human-Centered Design that have come to define the architecture of traditional game controllers. These design paradigms, relying on a top-down approach, often produce interfaces that exclude those bodies that don't conform to designers' assumptions and biases. An intriguing question emerges: What might transpire when disabled designers adopt a bottom-up approach, creating interfaces tailored initially to their bodies and their needs? The exploration of this question may uncover exciting prospects for widening our comprehension of inclusivity and accessibility in game design.

As I have shown above, when disabled designers imagine interfaces and games attuned to their needs, one could infer they participate in a form of speculative fiction that envisions a world where they are principal designers.(Hendren, 2020; Mills and Sanchez, 2023) Two of the participants in this study both commented on how they are brought into the end of the design process only to consult on assistive technology added onto the game in question. As you will read below, two also mention exclusion from the industry. They construct tools and interfaces suitable for their requirements and create games they can readily access. This narrative stands in stark contrast to the present situation described by, where disabled individuals often must take on the roles of inventors and innovators by necessity. Due to inadequate design by the medical industry and commercial product design companies, they often resort to crip hacking and making—retrofitting and repurposing interfaces. Designing for their needs thus becomes a radical deviation from the norm, a bold declaration of self-determination and creative agency that challenges the prevalent top-down design paradigm. (Hendren, 2020) The Controller Project, as highlighted in the literature review, exemplifies such a community-driven initiative to retrofit console controllers. (Kraft, 2022)

Interestingly, Ronald Mace's Universal Design principles, developed in 1984, have roots in the bottom-up resistance demonstrated by disabled individuals at the Center for Independent Living in the 1970s, who forged their paths across the University of Berkley campus (Center for Universal Design, n.d.)(Peterson, 2015). Mace, a wheelchair user, contributed significantly to the field by devising America's first accessible-building code, focusing his work on making cities and buildings more accessible, a reflection of his profession in architecture and the built environment. Universal Design, as per Mace's definition, seeks to make designs usable by all to the greatest extent possible, without the need for specialized design or adaptation.

However, the decision by Xbox to generate a separate accessible controller and impose additional charges on disabled players exposes the inadequacies of top-down approaches, such as Human Centred Design, in achieving broad-based changes. Their decision highlights a shortfall in ensuring equal cost and accessibility of game controllers, hence it does not meet Mace’s requirements. It underscores the need for a broader shift in design approaches, ones that genuinely incorporate and reflect the diversity of user needs. It also raises the question of whether Mace's concept of universal has been misused by designers who have superficially embraced his contribution to the field without genuinely engaging with access issues and structural inequalities.

Universal Design, User-Centered Design, and Human-Centred Design aim to provide designers across different fields with the tools to create universally accessible products, but these top-down approaches often fall short when compared to the community-driven changes seen in initiatives like the Center for Independent Living and The Controller Project. Such observations accentuate the necessity of moving away from traditional concepts of a universal range of bodies to more encompassing, grassroots design methodologies in games that better serve disabled communities.

5.1 Workshop Description

This workshop serves now to move on to consider the design work of three disabled designers, as well as three established Alt Ctrl Game designers to further explore the research questions asked in Chapter 1 and concludes with a set of shared values, and themes. As a disabled game creator designs a bespoke controller, they create an opportunity to infuse the controller with unique values and traverse alternative design territories. This expansion of the design process can lead to new forms of physical play that integrate the personal values and lived experiences of the designers. This study considers the research questions across a range of creators. How can creating games on bespoke hardware impact the artistic practices of disabled creators? Whereas with *Bot Party*, this researcher built and iterated their own games and technology to explore their own lived experiences of disability, this study looks at the design work of 3 other disabled creators to see what happens when they are supported to build their own playful games and interfaces. What values do they bring into their design processes? What are the key design methods they work with? What do their artistic outcomes reflect on artistic practice?

Further exploration may reveal whether these shared practices and values form an emergent design framework, rooted in crip epistemology, that could potentially inform and enrich the work of other designers. Such a framework could challenge traditional notions of access in game design, focusing instead on a bottom-up approach centring the lived experiences of disabled individuals.
In addition to being theoretically exciting, these ideas also carry practical implications for the field of game design. If such a framework could be identified and articulated, it could serve as a rich tool for game design in the future. It could also open spaces for dialogue and collaboration between disabled game creators and the broader game design community.

Thus, the exploration of these open-ended questions through practice-led design research not only holds potential for transformative contributions to game design theory and practice but also presents an opportunity to reimagine the landscape of game design from a disability-led perspective. The subsequent sections will delve into these explorations, discussing the design process, values, collaborations, and reflections of disabled game creators, with the aim of shedding light on potential new directions for crip game design.

5.2 Workshop Design

To deeply explore these ideas, we adopted a Participatory Action Research approach through a slow-form workshop, which started on April 1st, 2022, and spanned until September 29th, 2022. Participants were equipped with an initial brainstorming tool called *Inspiring Games With Bespoke Controllers*. This worksheet served as a potential starting point, especially for those who might be seeking initial guidance. Four central brainstorming techniques were encompassed: Memory, Presence, Metaphor, and Make Your Own.

The *Memory* technique offered participants a curated list of verbs paired with adjectives and adverbs, nudging them to conceptualize game mechanics grounded in their recollections of these word combinations. An illustrative pair might be "strum" and "swift." This method is loosely inspired by the Mechanics, Dynamics, and Aesthetics Framework.(Hunicke et al., 2004) This framework looks at ways game design can centre these dynamics. In this case, participants were prompted to remember or imagine emotions this combination of works could evoke and consider physicality of the movements they invoke. Thereafter, they are asked to contemplate the narrative potential of designing with the movement as the mechanic.

Drawing from my personal experiences with meditation and yoga, the *Presence* technique was conceived. This method encourages participants to reflect on one of their less predominant sensations, as enumerated by Christopher Eccleston in *Embodied: The Psychology of Physical Sensation* (Eccleston, 2015). Examples include balance, movement, and temperature, among others. The objective here was for designers to anchor their designs in memories tethered to these sensations.

Metaphor, the third technique, borrows insights from the movement metaphors outlined by Lakoff and Johnson in *Metaphors We Live By* and further elaborated upon by Doris Rusch in *Making Deep Games*. A unique twist I introduced was the integration of these metaphor-driven mechanics directly into the controller design, aligning with my conceptualization of Alt Ctrl games.

The fourth technique, *Make Your Own*, offers designers the latitude to formulate their distinct ideation processes and methods and defined their own workshop time frames. They could document these processes via a myriad of mediums, such as video, photos, or notes, offering a rich tapestry of data for subsequent analysis. This unconstrained approach is intended to support personal methods, independent of the techniques.

5.3 Timeframe: Working on Crip Time

As highlighted in the practice-led work of creating *Bot Party*, throughout the project's progression, I consistently recognized the necessity of allocating more time than originally anticipated to achieve our goals sustainably. The dynamics of my disability compelled me to collaborate with others, especially when my range of physical movement fluctuated. This was particularly pertinent during the development of version 3, where both Charlie and I navigated challenges related to physical mobility and fatigue. By tailoring our work schedules to our unique needs—embracing crip time—we established a working rhythm that was sustainable for us.

As a result, this study emphasized completion based on individual timeframes rather than strict deadlines. A flexible timeframe was established for the project duration, prioritizing adaptability, and ensuring participants could engage at their own pace and comfort. This approach was crucial in avoiding undue pressure and allowing everyone to contribute on their own terms. To quote Alison Kafer, "Rather than bend disabled bodies and minds to meet the clock, crip time bends the clock to meet disabled bodies and minds."(Samuels, 2017)

In the development of *Bot Party*, the concept of care gradually became integral to my workflow. For the third version, Helen Steer would frequently assist with tasks like gluing boxes or executing precision work, especially when extended work hours caused my hands to tremble. Consequently, I established care as a foundational principle for this study from the very beginning. Adopting crip time as an ethos created an intuitive space

where care became an inherent part of the design dialogue. With malleable deadlines in place, collective well-being took precedence. Consequently, there wasn't a predetermined number of sessions or a set duration for collaboration. Instead, participants were given the autonomy to determine these parameters themselves.

5.4 Outcomes

The results of this study were made accessible to the independent game community via IndieCade's Beyond Screens Twitch channel. Dr. Rebecca Fiebrink generously provided her expert guidance and feedback on this project in a supervisory role. This research was supported by the UAL Challenge Lab, which provided £1000 in seed funding. This ensured that all participants were remunerated for their prototypes while retaining complete control over all original intellectual property they generated. Additionally, participants were given the opportunity to review and approve any related published research, which pertains to their participation.

In the future, all participants will be invited to co-author any published findings in academic journals or conference proceedings. This chapter strongly supports shared authorship and ownership of research as an essential component of academia. Historically, disabled individuals have often been treated as the subjects of study, as brilliantly chronicled by Jay T. Dolmage in his history of academia's engagement with disability (Dolmage, 2017). By examining the generation of epistemic knowledge as an emergent result of design, this project aimed to highlight meaningful opportunities for developing design work rooted in crip theory.

5.5 Data Collection and Evaluation

Recordings were made of the initial online kick-off event and introductory meeting, which involved all participants. Further data, in the form of video, audio, and Discord chats, was collected by each group during their respective design phases. At the conclusion of the process, the entire group reconvened to share their results. Finally, the group's findings were presented to the public through a Twitch livestream. Observations and memos were made during each stream in the note taking app, Obsidian. These notes, along with key quotes, were then coded and analysed using Thematic Analysis to look latent themes.

Multiple online tools were used to collaborate. Given that all participants were familiar with Discord, it was proposed during our initial discussion to establish a Discord Channel to facilitate communication. Consequently, a private Discord channel was set up for group members, serving as an optional platform for conversations and as a repository for important information related to the study, duplicating what was shared via email. Specifically, Jade and Julia chose to use this platform to document their collaboration, and notes from this thread were included in the analysis. Additionally, Padlet was employed during the online stream as a tool for group reflection. Direct quotes and notes from this online page were incorporated into the coding process.

5.6 Demographics

The participants include both game developers of hardware Alt Ctrl games and accessibility experts working from a place of lived experience who are also creative artists and designers. This section includes their names a brief bio, as supplied by them, of everyone involved in the study as participants. (For full bios see Appendix C)

5.6.1 Accessibility Experts

Louise Hickman

Louise Hickman is an activist and scholar of communication, and uses ethnographic, archival, and theoretical approaches to consider how access is produced for disabled people.

Sightless Kombat

SightlessKombat (SK) is an accessibility consultant and gamer without sight (GWS). He has worked to make games more accessible across a range of platforms.

Jade Hall Smith

Jade is an advocate of disabled and intersectional people, who makes games to raise awareness and promote diversity.

5.6.2 Alt Ctrl Game Developers

Alistair Aitcheson

Alistair Aitcheson is an independent game developer in Bristol, specialising in playful installations, custom-made game hardware, and interactive performances.

Julia Makivic

Julia Makivic creates web-based narrative games and alternative controller games using Raspberry Pi, Arduino and various sensors.

Robin Baumgarten

Robin Baumgarten is a German interactive artist and experimental game developer based in Berlin.

5.7 Method for Pairings

The collaborative pairs formed in this project are notable in that they were not merely assembled based on professional skills or abilities. Instead, I brought together designers and developers based on conversations and shared interest in pioneering approaches to game and play based creative work. This method of pairing based on affinity diverges from a conventional practice of treating individuals as interchangeable tools, expected to yield a professional result due to their skills alone. It's crucial to acknowledge that this approach of forming pairs was rooted in community identification, creative collaboration, and a shared sense of mutual affinity. It was through these interactions and affinities that pairs were formed, fostering a more nuanced and community-driven approach to game design and development from the outset.

All Alt Ctrl developers involved in this project are members of a Discord community called the *alt.control.squad*, which I co-manage with Robin Baumgarten. This community of practice brings together an international array of game developers committed to the creation of alt.ctrl games. Our collective comprises a diverse and intersectional mix, with some members identifying as disabled and others not. We share in the exchange of design ideas, technical skills, exhibition dates, and at times, even collaborate on exhibition planning. These exhibitions offer us opportunities to meet, play each other's games, and build connections.

All the artists and designers involved in this project are individuals who have previously interacted with my creative works. They have either experienced *Bot Party* or have engaged with my research on InteractML. While falling outside the remit of this PhD

research, InteractML was developed concurrently to this PhD research. It is a plugin for the Unity and Unreal engines and encapsulates the process I employed to create my own accessible live performance systems as an open-source machine learning tool for the community.

5.8 Design Processes, Outcomes, Reflections

5.8.1 SK and Robin

SK experienced *Bot Party* (Version 3) at REZ EGX in London, in the Rock, Paper, Shotgun booth. His feedback led to the integration of haptic functionality into *Bot Party* to enhance its accessibility for Blind players. This feature was initially considered but concerns about the potential for the acrylic boxes to disintegrate due to vibration led to it being discarded. However, prompted by SK's comment, the boxes were entirely redesigned in version 4, using 3D printing and screws to mitigate the previous concern.

Baumgarten responded to a Twitter call to assist with soldering my game *Thrum* together in Antwerp, Belgium at 2am for the Screen Shake festival workshop in 2017, where it made its first appearance. He committed himself to soldering connectors, boards, and parts from 2am until 10am, when we installed the piece. Considering the extensive labour required, his assistance was invaluable.

Robin's interest in haptics was a key driver for his involvement. His most renowned Alt Ctrl games incorporate spring interfaces to manage visual systems, but there's an undeniable haptic aspect in all his creations. Their shared interest in haptics served as the motivation behind introducing these two people to each other.

5.8.1.1 The Design Process

The initial collaboration between the two took place at the University of the Arts, London Creative Computing Institute (UAL CCI) during an intensive day-long hack session. This setup was chosen based on the convenience for both: Robin, who is normally in Berlin, who was already visiting London for another commitment, and for SK, who needs assistance with travel within the city, consolidating the collaboration into one day together in the lab.

Upon arrival, both reviewed the brainstorming worksheet provided. However, it soon became evident that the worksheet might be redundant. The reason was clear: both collaborators came with individualistic approaches and a mutual middle ground would have to be carved out for a fruitful collaboration. SK provided feedback that I might want to consider putting something like this in HTML in future as it is more accessible for him than a Word document with headings and accessibility features.

SK entered the session with a clear blueprint in mind—a tube-based game controller tailored for auditory and positional gameplay, complete with thoughts on button placements and interaction elements. Robin, contrastingly, was somewhat taken by surprise SK had an idea already planned. He had anticipated a more fluid collaborative brainstorm, envisioning the day as a joint exploration into the tactile properties of various materials to design a game from. This disparity revealed two pivotal insights: One, SK's revelation of his alienation from game jam communities, having never been able to participate in one previously due to access considerations. Two, the profound impact of traditional game jams and design approaches on Robin’s way of working was evident in the ways he discussed both his involvement in previous jams and his methods for making games, which were rooted in specific styles of collaboration. Such observations hint at a possible undertone of ableism in game jam culture.

This exclusionary nature not only shaped distinct working modalities but also spotlighted Robin's visually dominated approach to conceptualise controllers. As SK verbalized his thoughts, Robin instinctively sketched them. In contrast, SK's participation was rooted in embodied engagement, internal visualization, and spoken communication. Recognizing this ideological mismatch, my immediate facilitator response was to pivot to support SK's hands-on approach. Relying on Material Engagement Theory, which posits that tools can morph our thought processes, I hoped that introducing a tactile element could bridge the gap between Robin and SK. (Malafouris, 2013) SK asked if we had any tubes on hand. Finding a discarded poster tube, I swiftly found distinct arcade buttons for each end. SK had proposed this to help players ascertain the tube's orientation by touch. SK's enthusiasm to be hands-on was evident when he expressed interest in drilling holes for the buttons and helping to build his idea. After familiarizing him with a Dremel, SK deftly installed a button, showcasing finesse that even I couldn't match. Such moments, where a visually impaired individual wields a power tool in a lab might challenge academic health and safety norms. However, drawing from my experiences with *Bot Party* and adapting soldering irons for my nerve loss in my hands, I recognized and respected SK's adaptability. He had earlier told me he had spent the weekend removing and re-tiling his parent's bathroom. Why couldn't he have discovered his own working methods with power tools, just as I had? Reflecting on this, SK later identified this as a standout positive moment in his experience during the study. It was a moment where my disability met his, and a mutual recognition of our shared agency created a sense of respect.

The introduction of a tangible object into the collaborative space remarkably bridged the initial ideological divide between the participants. With a physical prototype to rally around, their brainstorming became more synchronized and dynamic.

SK displayed a keen interest in modular design aspects of the controller, exploring how it could potentially disassemble to facilitate multiplayer gaming. His vision was to create an inclusive gaming space where he could seamlessly engage with his friends regardless of visual abilities. SK's drive for inclusivity became evident in his pursuit of games that would nullify the advantage of sight, ensuring an equal competitive ground for both sighted and blind players.

He envisaged an auditory iteration of the classic Atari game, Pong. Instead of relying on visual cues, players would rely on sound to gauge ball movement. Another compelling idea was a racing game where the tube served as a sonic navigational tool. This concept is particularly striking when contrasted with traditional racing games, which often revolve around sight-based interfaces, like steering wheels. The literature underscores this, emphasizing how conventional user interfaces for racing games predominantly cater to sighted players with specific mobility, deriving from their innate mental model of driving and privileging their assumed physical abilities. SK's innovative approach offers a fresh perspective on the genre. By transforming the tube into a sonic guide, he challenges the traditional visual-centric model of racing games. This not only widens the horizon of game design but also paves the way for a more inclusive gaming landscape, where controls and interfaces can be reconceptualized beyond the abled lived experiences of space, ensuring everyone has a seat at the gaming table.

5.8.1.2 The Outcomes

The duo quickly shifted their focus to maximising the potential of sensors and haptic technologies to enhance the tube's functionality. Engaged in an animated brainstorming session, they voiced their visions for the controller's design, jotting down notes as their ideas flowed. The result was a highly flexible and extremely creative controller design with minimal, clean inputs, flexible adaptions, and novel forms of outputs.

For inputs, their initial design envisioned a controller that users could twist and tilt to signal movements like forward, backward, up, and down. They also contemplated incorporating touch-sensitive areas and installing two to three buttons for players to interact with the game. On the adaptability front, they devised a method to bisect the tube at its midpoint, transforming it into dual controllers suitable for multiplayer games. They further envisioned a motorised mechanism enabling the tube to expand and retract.

As for outputs, the concept of embedding a movable weight within the tube, governed by motor controls, surfaced. To enhance the tactile experience, they integrated haptic feedback, ensuring players received vibrational signals. They also considered LEDs to help sighted players become sensitive to the sound and haptic feedback. By the day's culmination, their fervent discussions and hands-on tinkering resulted in a rudimentary prototype. This prototype, sketched out via breadboard and DIY electronics was registering inputs from two buttons, and driving a vibration motor by the end of the session.

The introduction of a controller capable of morphing shapes and being modularly disassembled represents a pioneering leap in the world of gaming. Such inventive attributes, hitherto unseen in conventional gaming devices, underscore the transformative power of collaboration, particularly when diverse perspectives converge. By merging the experiential insights of someone familiar with the constraints and challenges faced by disabled individuals with the creative expertise of a seasoned game designer, an innovative idea was created, one that challenges the status quo. This collaborative endeavour not only stands as a testament to the potential of inclusive design but also illuminates the horizons of innovation that can be achieved when we venture beyond traditional paradigms in design and design methods.

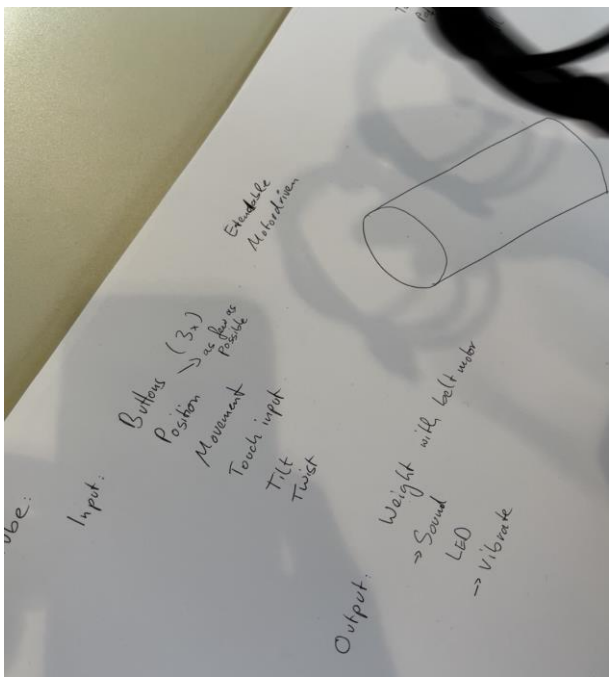


Figure 70 Robin's notes of possible options the two creators discussed.

Figure 71 Completed Rough Prototype including button installed in the top of a cardboard tube and circuit board with haptics attached.

5.8.1.3 Analysis of the Data

The data which consisted of the thematic exploration was primarily grounded in a comprehensive memo note generated from a post-review of a video interview. This interview was recorded at the session's conclusion. Additionally, the analysis was enriched by leveraging both photographic and video documentation captured during the session. It's worth noting that once themes and values were discerned from the data, a crucial step was taken to ensure validity. The identified design values and themes were communicated to the participants, and their affirmation was sought to ensure their points of view were represented and their feedback was integrated.

5.8.1.4 Values Identified for SK:

Inclusion and Accessibility: SK values inclusive game design that makes games accessible to everyone, regardless of their abilities. His interest in creating a game that would level the playing field between sighted and unsighted individuals indicates his commitment to this value.

Tactile Engagement: SK heavily values tactile, physical interaction in the design process, underlining the importance of direct, hands-on engagement with materials.

Practicality and Simplicity: SK shows a preference for practical, simple design solutions that can apply to a variety of games. This is evident in his initial concept of a tube-based controller with minimal buttons.

Personal Empowerment: The act of using tools and getting hands-on with the material design of the controller shows that SK values experiences that foster personal confidence and competence.

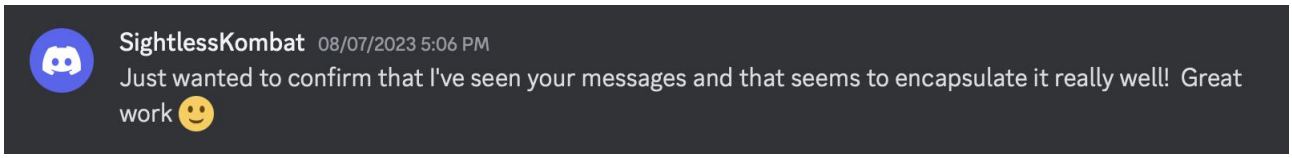


Figure 72 Screenshot from Discord chat with SK after I shared the above values with him.

5.8.1.5 Values Identified for Robin:

Creativity and Experimentation: Robin seems to value a creative process that's open to experimentation. His approach of starting with a mechanic or sensor and imagining possibilities indicates a love for creative exploration.

Material-Driven Design: Robin values the physical properties of materials in the design process. His method involves examining these properties and designing from there, highlighting his appreciation for materiality.

Collaborative Innovation: Robin values collaborating and innovating with others. His history with game jams and his adaptability in this collaborative project with SK underlines his belief in the power of collective creativity.

Challenge and Adaptation: Robin appears to be drawn to projects that push boundaries and force him to adapt, suggesting that he values challenges and the growth that comes with them.

After seeing these values, Robin replied, “Pretty much exactly what I'm trying to do while jamming / inventing” via Discord.

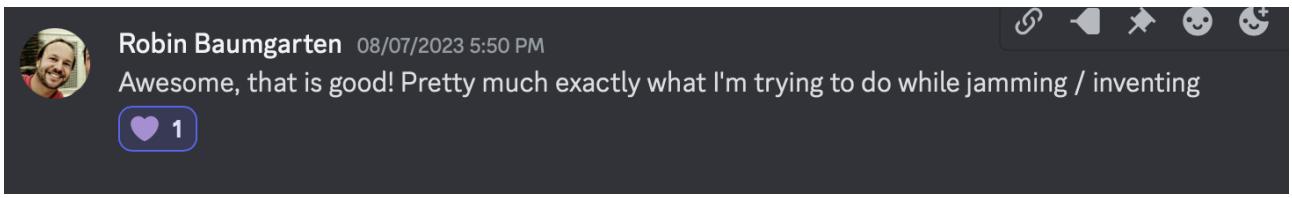


Figure 73 Screen shot of Discord of Robin's input in regard to the above values.

5.8.1.6 Themes from the Session

After reviewing and codes made from the end of session interview, as well as photos and videos made during the day, several larger themes came to the foreground, each based of individual codes.

Game Design Process Adaptation based on Lived Experiences via Tactile, Embodied, Material Engagement:

The rapid adaptation and development of their design process, based on their individual lived experiences, and the physical movement, underscores the flexibility and resilience inherent in their design process. Despite the initial clash, they found a middle ground with their design process through tactility and materiality. SK connected with Robin once he

started showing him tactile objects from his ideas that they could both centre on as a place where the design process could focus its attention. Once they centred on a physical prototype, they were able to better envision the design space.

Supporting Code	Numbers of Codes	Example
Material First Approach	5	“What happens with the tubes as we play around it and then see how the games go around it” – SK
Tactile Engagement	3	Once SK had the tube, he thought of working from the material he could hold and touch and make with and see the hardware as the place the games stopped - they could start and end with the limit of the hardware.
Prototyping with Materials to Understand Possibilities	3	"Let's grab a tube and see what goes into it!" -SK

Clash of methods leading to Collaborative Learning:

The initial clash in design methodologies between Robin and SK represents a significant theme. Robin approached the design from the game mechanic or sensor, working his way towards the controller's physical form, while SK began with a clear mental concept for the controller, from which the game ideas would flow. This divergence in creative processes was a key point of negotiation in their collaboration.

The collaboration between SK and Robin resulted in a mutual exchange of knowledge rooted in both lived experiences and methodologies. Robin learned about SK's tactile design perspective, while SK experienced a traditional game jam approaches from Robin’s side.

Supporting Code	Numbers of Codes	Example
Design Methods / Clash of Design Methods	2	Sightless started with the materiality of the controller he imagined and then let the ideas flow from it for games. robin wanted to start with either a game mechanic or a physical affordance of a sensor. then let the controller take shape around that.
Design Methods / Clash of Design Methods / Collaborative Learning	2	They worked in two ways - Robin wanted to design from the material up and SK designed from the interactions up.

Collaborative Solutions / Collaboration and Feedback	1	- Robin loves game jamming and being creative - - he's always inventing new pieces and trying new things. He collaborates for a living and limits are enticing to him.
Collaborative Solutions	1	SK wanted to be involved to collaborate with new and different people who had done it before to learn from it. He wanted to learn from it – have fun.

Designing Games for Equality Not Access: SK's approach to controller design aimed to create a "level playing field" across all games by minimising the role of visual inputs. This suggests a desire to develop games that are equally accessible and enjoyable for sighted and unsighted players. It also hints that games are not designed to support blind and sighted players equally.

Supporting Code	Numbers of Codes	Example
Design Methods / Game Design for Equality vs Access	3	"Make it a level playing field across everything." -SK

Calls for More Inclusive Game Design Practices*:*

Another prominent theme was the issues of accessibility and inclusion. SK, who has been largely excluded from traditional game jam culture, brought an important perspective to the design process. This theme highlighted the importance of making game design more accessible to diverse creators and ensuring that the process is inclusive to people with different abilities. An interesting quote from SK to support this lack of access was, "I've never been given the opportunity to do anything like this before. It's great to finally be able to enter this scene. After seeing *Bot Party* at EGX, a few years ago, and being like, this is a cool different interaction that isn't just hitting a button to see if it works in a video game sort of controller context. When this opportunity came up, and I was like, you know, I want to be involved in this, I want to collaborate with new people with different people, or even just with people who, you know, have done this a lot before, and enjoy it and learn from that." The evident exclusion SK felt from traditional game jam cultures due to his disability, and his innovative approach to controller design, embodies a desire to not only change but also to deconstruct normative design methodologies. This sentiment is bolstered by SK's vision of designing games for equality rather than mere accessibility. He is not just looking to be included; he's trying to reshape the game so that players, irrespective of their physical abilities, stand on an equal footing.

Supporting Code	Numbers of Codes	Example
Call for More Inclusive Game Design Practices / Deconstruction of	1	SK immediately started thinking beyond a standard controller system and

Normative Practices		wanted to minimise buttons and make the controller he was creating simple to make it easier to use.
Call for More Inclusive Game Design Practices / Underlying Ableism in Game Design Communities	2	SK was never asked to come into the design space, and he is excluded by traditional game jams and designs.
Accessibility Challenges with Universality	1	

Empowerment Through Design Participation and Tool Use: SK's involvement in the design process, his use of tools, and the confidence and enjoyment he derived from it points towards a theme of empowerment. The data illustrates how active participation and hands-on engagement can empower individuals, especially those who might typically feel excluded.

Supporting Code	Numbers of Codes	Example
Empowerment	1	SK was obviously having fun. He fell into the deep end with tools and got practical cutting holes.
Tool Use	2	SK talked about how safe he felt to use the tool and how much it makes him feel confident that he could work with it in the environment.

Customisation and Flexibility

Adaptive Flexible, Modular, Controllers (8 codes): The controller designed has many ways it can be configured. It is not a fixed form, but it physically can take multiple forms.

Interaction Centred Interface Design (5 codes): The design that resulted from this workshop favoured and interaction centred interface that united the game within the controller.

Addressing the Design Space Complexity with Multiplicity (4 codes): To deal with the fact that everyone has different abilities, SK proposed duplicating data across multiple input and output modes.

Supporting Code	Numbers of Codes	Example

Customisable Flexibility \ Point of Use Design Flexibility	1	SK proposes the controller can split / twist apart and become 2 controllers, allowing multiplayer games in the design session.
Access as an Afterthought / Accessibility Challenges with Universal Design / Addressing Design Space Complexity with Modularity	1	SK proposed a design making it possible to match the sighted and unsighted experience as equal levels - aka you could turn off the LEDs and have sighted people play haptics or vice versa or some combination of the two.
Adaptability and Multiple Formats	2	Designing with vibration, weight - multiple tubes for making games.
Design Methods / Multiplicity of Inputs and Outputs, Some Duplicates	2	The pair think about and consider inputs like twist and outputs like sound, vibration, weighs, light.

5.8.1.7 Conclusion

The session between Robin and SK offers invaluable insights into the intricate dance of collaboration, especially when it straddles the boundaries of lived experiences, design practices, and innovation. One salient takeaway is the unmistakable call for inclusivity in game design, challenging the entrenched norms and widening the aperture to embrace diverse perspectives. SK's history, marked by exclusion and barriers due to his disability, introduces a fresh lens to the design discourse, transforming what could be perceived as a limitation into a potent source of inspiration and innovation.

Furthermore, the session underscores the significance of customisation, flexibility, and adaptability. The controller they co-envisioned is not static; it is dynamic, modifiable, and a testament to the ingenuity that arises when diverse thought processes merge. Their divergent methodologies – with Robin's game mechanic-centric approach and SK's vision-driven tactic – highlight that the journey of creation is as critical as the product. These differences, rather than causing strife, became catalysts for a richer, more nuanced design dialogue.

Materiality emerged as a unifying theme, knitting their individual experiences into a shared narrative. Whether it was Robin's visualisation through drawings or SK's tactile engagement, the tangible aspects of the design process were pivotal. This serves as a powerful reminder that design is not an ethereal, detached undertaking; it is rooted, visceral, and profoundly influenced by the individual experiences of the designers.

The element of empowerment at the end of the session was palpable. SK's interaction with the Dremel tool and the newfound confidence he derived from it underscores the transformative power of hands-on involvement, particularly for those who might have previously felt side-lined.

Lastly, the collaboration between Robin and SK paints a vivid portrait of the design process – one that is iterative, adaptive, and always evolving. It's a testament to the magic that can be birthed when diverse points of view converge, and the potential that lies in including blind individuals in the design process and backgrounds they bring. Their journey reinforces the ethos that true innovation in game design – or any design for that matter – necessitates embracing diversity, fostering inclusivity, and championing collaboration.

5.8.2 Jade Hall Smith and Julia Makivic.

In the next pairing, I brought together Jade Hall Smith and Julia Makivic. Smith and I crossed paths while they were students in my Physical Computing class at Goldsmiths University, London in 2017. Their class projects consistently aimed at creating interfaces for disabled family members, and occasionally for themself. They often selected materials like soft toys, touch, pressure, and light. After graduation, Jade and I transitioned into colleagues within the accessibility community, and we have kept in sporadic contact ever since.

Julia, another student from the same program and cohort, bases all her work on personal experiences and narratives where interfaces acquire a personal and emotional resonance. Julia became a part of the Alt Ctrl Discord community and is often showcased alongside me as a fellow artist. Like Jade, she tends to gravitate towards materials that are softer, or involve touch and light.

Both designers have a penchant for creating work that is deeply personal. For this project, Jade took on the role of lead designer while Julia focused on game development.

5.8.2.1 The Design Process

Julia and Jade opted to collaborate remotely through a sequence of Zoom calls scheduled on April 21st, 2022, and May 5th, 2022. Throughout the study, they continuously updated each other via a dedicated Discord thread, engaging in asynchronous discussions about their concepts. Within this thread, Julia frequently provided updates to Jade, primarily using sketches and videos. On August 8th, the two met in person, during which Julia handed over the physical prototype to Jade. This Discord also captures Jade’s feedback on using the interface they had created.

In the interim between Jade agreeing to join the study and its commencement, Jade announced her pregnancy. Upon receiving this news about Jade's health status change, I recommended they contemplate withdrawing from the study, adhering to standard ethical considerations. However, Jade expressed her desire to remain involved. Including a pregnant individual in a study is not standard practice. Yet, after thorough discussions about health and safety ramifications—and recognising that Jade wouldn't need to undertake any physical travel—the decision was made to continue. Shifting the entire design process to a remote framework eliminated potential risks associated with an in-lab environment and granted Jade the flexibility to engage at their own convenience. They were also advised they could withdraw at any point they chose to do so without any judgment or pressure to continue forward.

The data for thematic analysis consists of:

- A memo detailing the video recording of the meeting from April 21st, 2022.
- Notes Julia made from second meeting on May 5th, 2022.
- The discord stream of their design process and project which includes chat, drawings, and videos.
- Direct quotes from the video stream transcription which were relevant.

5.8.2.1.1 Meeting from April 21st, 2022

The video recording of this forty-minute meeting offers a rich conversation between Jade and Julia where they discussed their shared values, found common ground, and planned their barnstorming session May 5th. I was present at this meeting to introduce the project and the resulting conversation set the tone for their future collaboration. Where Robin and SK brought very different values into their processes, Jade and Julia were united on their values and process from the outset. The entire conversation has a convivial tone of shared resonances.

Jade's insights provide a multi-faceted look at the complexities of game design, especially in the realm of accessibility. Julia repeatedly resonated with Jade's thoughts and repeatedly asked about their lived experiences and validated their ideas in their first conversation. At one point Julia said, "Different options like customisable options is a good is a good idea. I don't know how to build that, but I think that's a good place to start!" Both brought in a shared sense of collaboration as a way forward. The time they took to explore Jade's lived experiences not only highlight the challenges but also offers pathways for a more inclusive and collaborative design process. By focusing on Jade's experience, Julia helped to foster a shared mutual sense of trust from the outset and this shared common ground set the tone for the rest of the conversation.

5.8.2.1.2 Meeting from May 5th, 2022

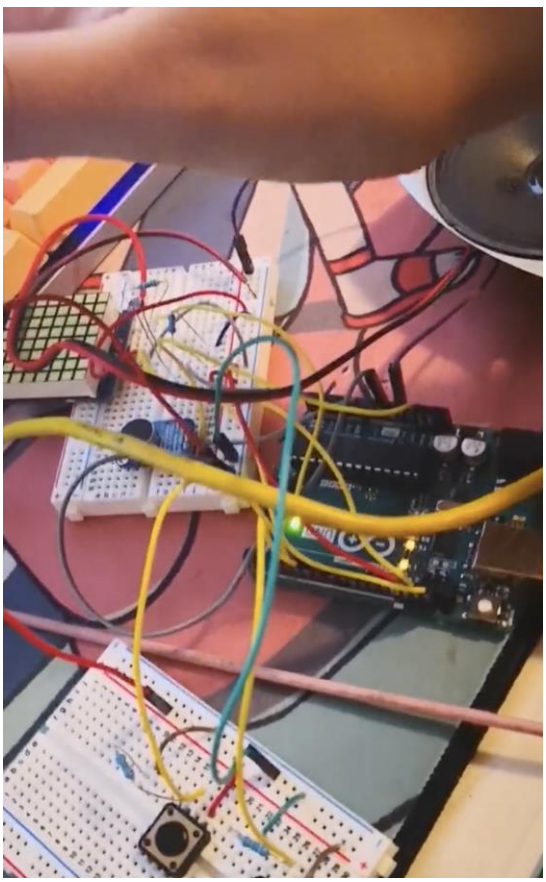
During their first design session, Jade and Julia concentrated on the tangible aspects of crafting a joint project. Their discussions culminated in a set of design considerations for the system in question. At the heart of their conversation was Jade's sensory sensitivities stemming from pregnancy and their aspiration to design a game fostering a bond with their unborn child. They envisioned an interface tailored specifically for a pregnant belly, acting as a medium to deliver soothing sounds to both Jade and the baby.

Jade expressed a desire for an experience reminiscent of theremins, with hand movements inducing sounds and possibly a voice component integrated. They also explored the potential inclusion of a proximity sensor. Central to their vision was the creation of a serene experience. They emphasised the importance of portability, enabling its use both at home and in the hospital. For Jade, the game shouldn't demand excessive effort or skill. They leaned towards a design that might exclude a screen but would incorporate voice interactivity.

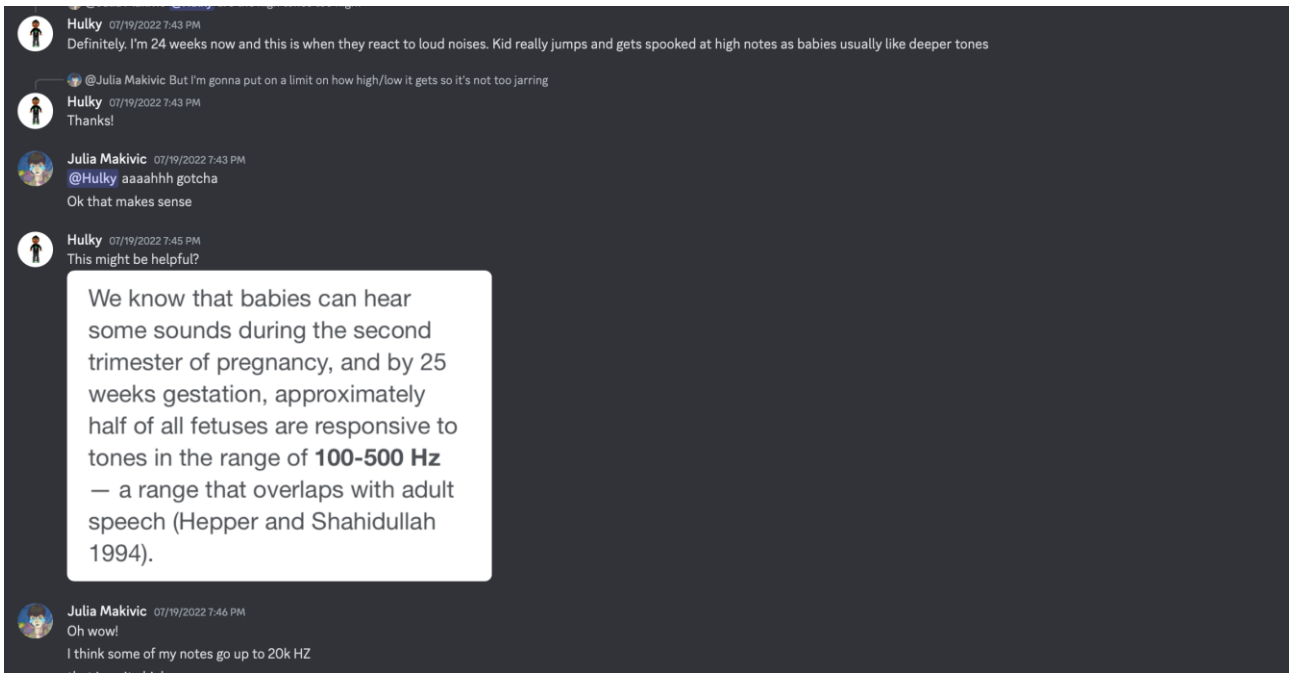
Aesthetically, they favoured games imbued with tranquil colours and designs. Preferences were geared towards unhurried games devoid of strident colours, pressure, or time constraints. Practicality was essential, with a focus on ease of transportation so Jade could bring it into hospital visits. Jade's sensory inclinations also played a pivotal role: they gravitated towards soft, velvety textures and had an aversion to coarse materials, tight fabrics, and the grating noise of static crackling. Their collaborative vision centred on an interactive music-making game for the baby, driven by gestures and auditory feedback.

5.8.2.1.3 The Discord Thread

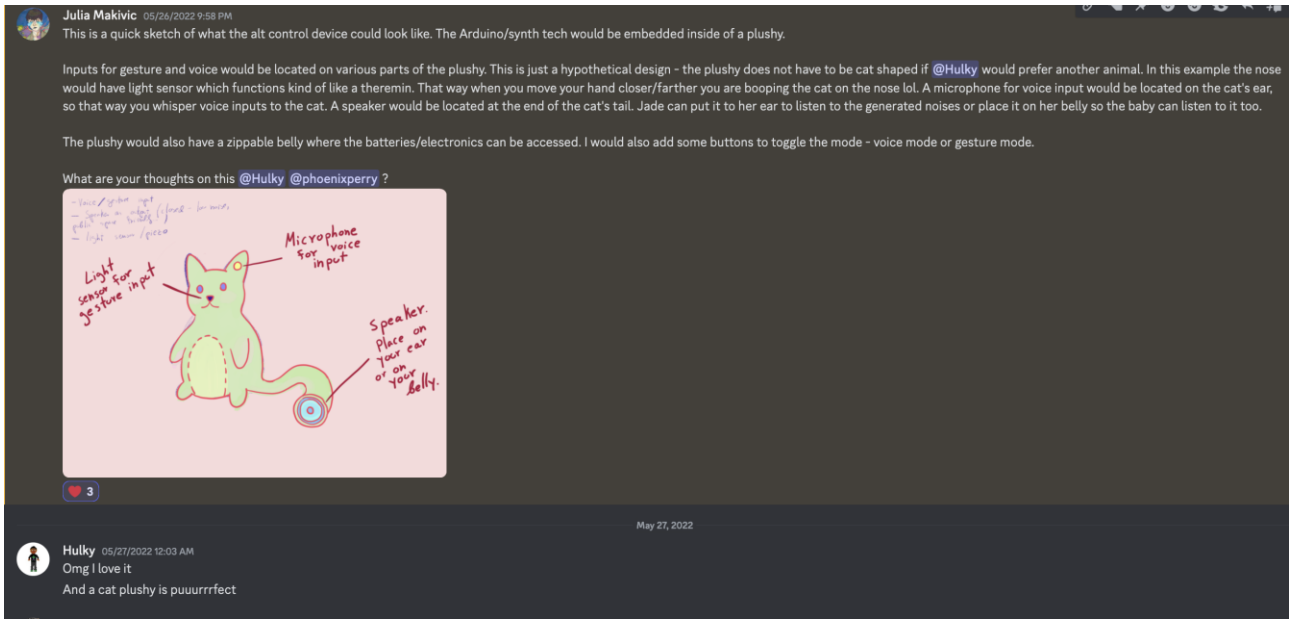
Jade revealed they were grappling with both COVID and morning sickness. From here, the conversation moved to Discord so Jade could participate asynchronously on their own schedule and when they felt able to do so. Despite these health challenges, Jade remained engaged, eager to contribute and sought any tasks they might be able to assist with during their recovery. Both Julia Makivic and I responded with genuine concern for Jade's well-being. Julia took the initiative to share that she'd be diving deep into research on prototyping materials in the upcoming week. She emphasised the collaborative nature of the project by letting Jade know she would reach out for her input when she had the project in progress. To support Jade's health, they became more of a director guiding the overarching creative vision and Julia began doing the practical task of engineering to bring Jade's idea to life.



As the conversation continued, Julia shifted the group's focus to the more technical aspects of the project. She began inquiring about the potential of producing synthesiser-like noises using Arduino and further solidified the team's collaborative approach by seeking feedback on the preferred sounds for the project. To keep everyone in the loop, Julia provided a link to her research on building the proposed device, actively seeking feedback and thoughts leading to positive remarks from Jade about her thorough research. Jade's only critical feedback was on the tones Julia had selected and she shaped the audio palette towards more lower tones within specific ranges based on the baby's reactions to sound.



A charming idea surfaced when Julia suggested incorporating a plush toy into the project design as its enclosure. Julia shared a sketch of the proposed interface woven into the cat with Jade who loved it.

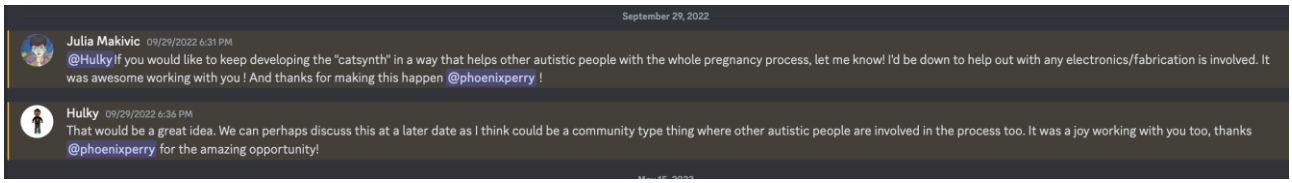


Throughout the entire exchange, the strong collaborative spirit of the team shone through. Julia shared progress and Jade shared feedback and they were there to support one another, emphasising the collective nature of their journey. A good example the collaborative spirt can be seen in this work-in-progress video https://www.youtube.com/watch?v=crD2Q2s1aiM In it, Julia shares the affordances she has made to ensure Jade and her baby are comfortable and explains how she's working to lower the tones as per the above input.

5.8.2.2 Outcomes

Julia delivered the completed cat, SYTHia, to Jade on August 6th, 2022, and Teddy, Jade's child and Jade responded positively.

After the exhibition, Jade and Julia engaged in a thoughtful conversation about the broader potential of their project. They considered the prospect of launching it on a commercial scale to benefit other autistic pregnant individuals. Significantly, Jade's idea of conceptualizing the endeavour as a community-based project focusing on lived experiences resonated. This suggestion wasn't just about market potential; it echoed the essence of their very first interaction with us. The emphasis on community-driven design based on lived experiences, which was a prominent theme during Jade's initial discussions, was once again brought to the forefront. This approach underscores the intent to create not just a product, but a solution that genuinely reflects and addresses the needs and aspirations of the community it aims to serve.



5.8.2.3 Values for Julia:

Kindness in Design: A Gentle Approach: Julia embodies a depth of understanding and compassion towards Jade's unique circumstances, particularly in light of Jade's health challenges. Her design methodology is anchored in authentic concern and well-being for Jade. Julia's emphasis on kindness and respect manifests in her design interactions, fostering a foundation of trust between the collaborators. Such a foundation paves the way for a playful interface that resonates deeply on a personal level for both.

Active Collaboration and Partnership: Throughout their conversation, Julia actively seeks Jade's insights, feedback, and opinions. This indicates her deep commitment to collaboration and her view of Jade not just as a partner in the project but as an equal contributor to its success.

Dedication to Material Research and Experimentation: Julia's proactive approach to diving into research on prototyping materials, and her interest in exploring new design

considerations, signifies her value on physical exploration of the design space and the importance of experimentation in bringing ideas to life.

Valuing Tactile, Emotional Interactions and Soft Designs: Julia demonstrates a deep appreciation for the nuanced design considerations around the tactility of an interface. Recognising Jade's sensory inclinations, she navigates towards designs that prioritise softness and sensory comfort. Her design considerations underscore her commitment to creating products that are both physically beautiful and emotionally resonant, emphasising the importance of soft, velvety textures and warm tones in their work. This shows Julia's intricate understanding of the subtle and transformative power of the qualities of softness in design.

5.8.2.4 Values for Jade

Contextual Adaptability in Accessibility: Jade's insights reveal a strong advocacy for game accessibility that genuinely caters to all, respecting individual differences without succumbing to a monolithic design. Grounded in their own lived experiences, Jade understands the importance of flexibility in design to address diverse needs. They emphasise that true inclusivity in design isn't about a universal approach, but rather a contextual adaptability that respects and responds to the nuances of individual experiences.

Lived Experience as an Asset: Jade's personal experiences greatly inform their design philosophy. They recognise that their lived experiences provide a unique lens through which they see the world, and this perspective enriches their design approach. It’s a testament to the value of integrating personal experiences into design for greater authenticity.

Community-Centred Design: Jade believes in the power of designing with and for communities. Drawing from their insights about game design and accessibility, Jade underscores the importance of ensuring that game interfaces are not just about individual experiences but about fostering community connections. They understand that true inclusivity comes from understanding and

Designing for Embodied Experiences: Jade deeply values the integration of lived, bodily experiences of disabled people into design processes. Recognising that every interaction is a tangible encounter between a person and the interface, Jade emphasises the importance of creating designs that are not only functional but also resonate with the sensory and emotional nuances of individuals. Their approach underscores the idea that design isn't just about the external interface, but about fostering a holistic, embodied engagement.

5.8.2.5 Thematic Analysis

Upon analysing the chat logs and the subsequent project, several themes from the previous discussion emerge:

Tailored Interfaces through Customisation, Flexibility, and Adaptability
Jade's desire for a game tailored to her pregnancy, focusing on sensory sensitivities, is evident. They sought an interface specifically for a pregnant belly, emphasising a connection with the unborn child. The emphasis on hand movements inducing sounds, voice integration, and the potential for a proximity sensor indicates the importance of a dynamic, adaptable design. A tailored interface for a pregnant person here points to the

much larger societal implications this kind of process could empower.

Innovation in Ideas around Access:
This process could be said to be an innovation in the ideas around accessibility. This approach does not serve to put Jade in a consulting role advising on designs after they are created but weaves her into the design workflow from the beginning of the process.

Personalising Accessibility in Game Design and Game Controllers:
Jade's inclinations, such as favouring serene colours and unhurried game pace, as well as avoiding coarse materials and jarring noises, stress the importance of personalising the game experience.
The vision of an interactive music-making game indicates the importance of personalized interaction in the game design.

Challenges with Universal Design can lead to valuing Individual, Bespoke Design Work:
Designing for specific sensory inclinations (like an aversion to certain textures or sounds) sheds light on the challenge of creating a universally accessible experience for neurodivergent individuals. Every person who is autistic might have their own preferences and designing for everyone here is simply just not possible without a level of deep flexibility and input on the possible outcomes. Verses design for everyone and arrive at a solution which would inevitably leave some people out, they choose to design around Jade.

Reimagining the Role of Accessibility in Game Design through Collaboration:
The interaction between Jade and Julia exemplifies a design process where accessibility is at the forefront, not an afterthought, of the entire experience end to end. Jade's health challenges with pregnancy, grappling with COVID and morning sickness, influenced the design process. The move to Discord allowed Jade to contribute based on her comfort and schedule, ensuring the design process was able to flow at an organic pace and not a pre-mandated schedule. This points to a design process with flexible timelines which supports multiple ways of working. Additionally, as a designer, Jade gave input and guided the project throughout its development.

Jade’s inquiries about synthesiser noises and feedback on preferred sounds and the idea of integrating a plush toy into the design highlight the collaborative spirit and adaptability of the design process. Julia’s work in progress video further sheds light on the ongoing feedback loop, emphasising the adaptability in design based on Jade's inputs. As a result, the entire controller is adapted for Jade through this process of collaboration and customisation.

Valuing Embodiment and Lived Experiences: This process was deeply rooted in Jade’s lived experience of pregnancy as well as her own disability. At every point in the design process, the conversations and process centred access through Jade’s embodiment.

Community-Centric Design Informed by Lived Experiences After the exhibition, the dialogue about making a community designed product available for other autistic pregnant individuals underlines the importance of designs that reflect community needs and lived experiences.

Affordable Accessibility and Intersectionality:
The idea of workshopping the project with the community in future to make it commercially available at an affordable price hint at the broader consideration of economics in assistive technology. This points to the economic realities present in the lives of many disabled

people who are often asked to pay additional costs for accessible interfaces that might not even be fit for purpose.

5.8.2.6 Conclusion

In summary, the discourse between Jade and Julia is a testament to the importance of collaborative, disability-centred design, especially when it comes to accessibility. Their shared vision, grounded in Jade's lived experiences and sensory sensitivities, not only resulted in SYTHia, which was tailored for Jade and her child but also set the stage for a design approach and project that could benefit many others in the community. Their interactions underscore the significance of adaptability, personalisation, and community-centric design in creating products that resonate deeply with their players as well as communities.

The design process between Jade and Julia epitomises collaboration between people with different abilities in game design, where everyone’s perspective and expertise are valued and utilised to shape the outcome. Jade's lived experiences offered a nuanced understanding of the intricacies of accessibility in game design, while Julia's technical acumen and open-minded approach provided the foundation for bringing those insights to fruition. Their dialogue underscores the importance of inclusivity, not just in the result, but in the design process itself. This synthesis of individual expertise and lived experience sets a precedent for future design endeavours, emphasising the need to centre user experiences and fostering an environment of mutual respect and collaboration within a design team stacked with designers of varying abilities.

5.8.3 Louise Hickman and Alistair

Louise Hickman and Alistair Aitcheson were paired based on their shared enthusiasm for interactive performance and direct audience engagement. I first encountered Louise Hickman at the *Bodies, Movement, and AI in VR Symposium* at Goldsmiths in 2021 (Gillies, 2021), where we were both panellists. The resonance between our works was immediate, and this led to an ongoing exchange of ideas and shared work online. Louise's critical eye and her fearless approach to challenging ableist practices in AI, often through provocative commentary and essays, struck a chord with me. Her performance work tends to embody a similar confrontational spirit, balanced with a sense of playfulness.

Alistair, on the other hand, displays a passion for pushing people beyond their comfort zones. Through his work with the Incredible Playable Show, he turns his audience into performers and even into game interfaces themselves.(“The Incredible Playable Show,” 2020) This willingness to experiment and a shared sense of playfulness connect him and Louise, which led to their pairing for this project.

5.8.3.1 The Design Process

Louise and Alistair convened four times and produced more information that the other two groups, using Zoom's transcription feature for each session. After every meeting, a memo was created, capturing the primary ideas and discussion points from the video. There are over four hours of recordings here. For analysis, memos from each session were combined with a shared Discord chat thread, photos, and videos. Subsequently, this data was coded and subjected to thematic analysis.

5.8.3.1.1 Meeting from April the 8th, 2022

During a conversation between Alistair and Louise, the duo engaged in an exploration of shared experiences, power dynamics in performance, and the intricacies of presence in performance and transcription technology. Alistair began by drawing a comparison between not being able to see a chat during a performance and Louise's experience without her hearing aid. He delved into a personal performance anecdote where he ate a bagel while wearing a morph suit, blinding him from the audience's reactions. This evoked a memory for Louise, who recalled a documentary she had seen. In this documentary, participants described a pornographic scene they had watched, and the act of recounting became the performance itself. This reflection seemed to resonate with both, emphasising their shared understanding of the vulnerability and dynamics in such performances.

The conversation deepened into the realm of power dynamics, with Alistair describing how he sometimes acts as a puppet on stage, as he allows the audience to control what he does next. Sometimes he can see the audience's specific reactions, sometimes he does not allow himself to view them. Louise responded by referencing a blind burlesque performer who reclaimed power by allowing the audience to provide audio descriptions of her actions. This opened a broader discussion on how power is wielded and relinquished during performances.

This sparked a conversation regarding the nature of presence and time. They explored the idea of “arriving in time” and the unique temporal experiences of words and language in live captioning. Louise highlighted the role of captioning in this context, musing about the synchronicity of words and how playing with the unspoken can enhance a performance's experience and thinks about how this nuance can be captured in real time captioning. The idea of captioning became central, with Louise reflecting on the serenity and presence it brings to the present moment. She thinks about how it arrives and disappears as a metaphor of staying with the present moment.

The dialogue then veered towards embodiment, specifically the 'missing body' in digital interactions. They discussed a laser-pointing game, which abstractly tackled the concept of embodiment in groups. The player’s understanding of where they are in the group fundamentally alters the information within the game, stressing he continuous interplay between the digital and physical self.

Group dynamics became a pivotal topic, especially how groups engage with the body through various interfaces, from games to transcriptions. Louise brought in a critical perspective from disability studies, expressing her dissatisfaction with captions when they are treated as a “distributed effort”, likening it to an exquisite corpse drawing. The concept of authorship, especially in media studies, was unpacked, with Louise discussing the loss of authorial intent when multiple individuals are involved in captioning. She is interested in more people who write captions claiming their authorial voice.

Towards the end, they speak about the potential of reimagining transcription and access technology as play. Louise considers how introducing emotion into captioning, pondering on the reception of a sarcastic transcription in live captioning. This meeting covers many subjects, from the shared vulnerabilities in performance to the intricate dance of power dynamics in performance and captioning, and from the philosophy of presence and time to the transformative potential of transcription and captioning.

5.8.3.1.2 Meeting from April the 22nd, 2022

During a discussion on the briefing document, Louise and Alistair considered the

importance of maintaining their individual working styles. Louise showcased her enthusiasm for prototyping, drawing inspiration from Alistair's previous text-based game. This game sparked a broader interest in the juxtaposition of real-time and text-based dynamics and the interplay between the notions of disappearance and arrival. A particular highlight was Alistair's shredding games, which Louise interpreted as a metaphor for transient speech.

Their discussion moved towards communication, where Louise presented a stenography engine, talking about the potential of personal dictionaries by showcasing how a video showing Stenographer's seemingly random keystrokes were transformed into coherent words. They discuss the possibilities of coded and decoded information, taking this a step further to discuss the potential of access technology not just as tools but as playful spaces that can reclaim authorship, ownership, and creativity.

The brainstorming evolved to reinterpret household items as communication devices, with Louise offering the whimsical example of how one could communicate one word in different tones of voice using chairs. She shares a text by Pullin and Cook that documents this interface, "Six speaking chairs (not directly) for people who cannot speak." (Pullin and Cook, 2010) Both designers were excited about crafting playful interfaces with everyday objects—like a book that alters its text upon interaction.

Their creativity became palpable when they started exploring their living spaces, seeking inspiration from common items like remote controllers and kettles. Louise's connection with tea led to an idea where hot water serves as an input mechanism. This spiralled into a broader idea where the entire house could act as an interactive keyboard, each part triggering unique responses. Speculations arose that the act of making tea could be used as way to communicate information.

Louise's reflections highlighted the importance of homes being adaptive to their residents, especially for disabled people. She introduced the concept of homes being not just functional but also playful—a departure from the purely utilitarian. As the conversation wound down, the playful "silly home" concept emerged, and Alistair whimsically suggested writing narratives on paper strips and then consuming them.

5.8.3.1.3 Meeting from April the 28th, 2022

During this brainstorming session, Louise delved into the concept of everyday objects becoming more playful within smart homes. She discussed reimagining accessibility, explaining how doorbells for the deaf that are connected to vibration or light, and considers how they could move away from functionality alone. She shared a video about how words or phrases could be expressed by tones. This led to thinking of doorbells as playful interfaces.

The duo grappled with ideating a concept, largely due to the vast differences in their lived experiences. A turning point was Alistair's probing question about an "alphabet of temperatures", leading to an intense discussion on mapping languages to accessibility.

Louise suggested using household items as tools for communication. They pondered on toasters, envisioning a way to send messages or express feelings via toast. Alistair focused on rules and goals, but Louise steered the discussion towards a more playful, free-form philosophical consideration and approach. Alistair grappled with the idea of establishing a connection between a player and an object, diving into the emotional implications of the game. Louise's perspective centred around design and disability, creating a tug-of-war of methods. Alistair attempts to apply game design methods and Louise is thinking about the cultural meaning and its relationship to the functionality of the object. She reflects on how she is coming from a functional approach rooted in design methods for creating assistive technologies. Louise re-imagined the toaster as an

experiential tool, while Alistair keep seeking ways to turn it into a game. Louise mused about a universe where toast could act as an interface, relaying the day's weather. Their contrasting views were evident, but they both agreed on the potential richness of their brainstormed concepts.

The kettle took centre stage, with Louise highlighting its symbolic significance in feminist movements, especially in the context of suffragist tea parties. Alistair explored the potential for sensors that could detect what was in a cup of tea. Louise proposed a broader, more philosophical angle, considering the environmental impact of water usage.

The dialogue culminated in the ingenious concept of the "kettle network" for covert communication, drawing inspiration from the suffragettes. Louise imagined a digital platform displaying one's kettle use, transforming every act of boiling water into a positive action. The meeting ended on a light-hearted note, with the duo spontaneously singing and deciding on action points for their next session.

5.8.3.1.4 Meeting from May 4th, 2002

The meeting’s recording kicks off with Louise setting a light tone with some silly signing. Alistair jumps in to discuss his progress with temperature sensors for their kettle prototype, detailing the materials and methods. Taking the lead on the design theory, Louise daydreams about the simple pleasure of brewing tea during meetings.

Their brainstorm revolves around the kettle's water, primarily its heat and quantity, pondering how it could translate into messages or text. They explore the idea that different water levels might represent various moods or intentions—like making just one cup might signify the need for co-working, while two cups could spark a conversation. The kettle's potential for two-way communication had them excited, imagining lists of responses and diving deep into the intricate details of data revelation and sharing.

Louise's thoughts drift to the bigger picture—how kettle data accumulated over a week might weave stories. Inspired by the colloquialism "Spill the tea," she visualises a network map of kettles, each illustrating unique interaction points, evolving based on its usage. This fascinating idea links to Alistair's mention of spirographs, instantly capturing Louise's imagination. The duo imagines this to chart kettle interactions, with different patterns symbolising different moments.

It's clear they've landed on this concept. Imagining kettles of varying levels—half, full, or near-empty—they delve into their hidden significance. This spirals into a plan to craft a manual of potential spirograph patterns, assigning meaning to each. It's smiles all around. They discuss next steps, with Alistair tackling the software and hardware. Louise, candidly admitting her limitations with coding due to her visual impairment and deafness, promises to post to the discord her notes so far. They revel in their collaborative spirit, both thrilled by the creative process. Louise then gives Alistair a sneak peek into her artwork that is in response to a friend’s film, proudly displaying a protest poster, reading "gathering our lives into knots." Collaboration has started to flow between the two.

5.8.3.1.5 The Discord Chat

In the project, Discord primarily functioned as a planning hub with minimal creative discourse. As the chat progressed, it evolved into a platform for Louise and Alistair to exchange snapshots of their ongoing work. The mutual appreciation and insightful feedback were evident as they exchanged textual and electronic prototypes. On June 6th, 2022, Alistair shipped a kettle to Louise, marking the commencement of their data-sharing experiments. The data visualisation featured four kettles: three with Alistair and one with

Louise.

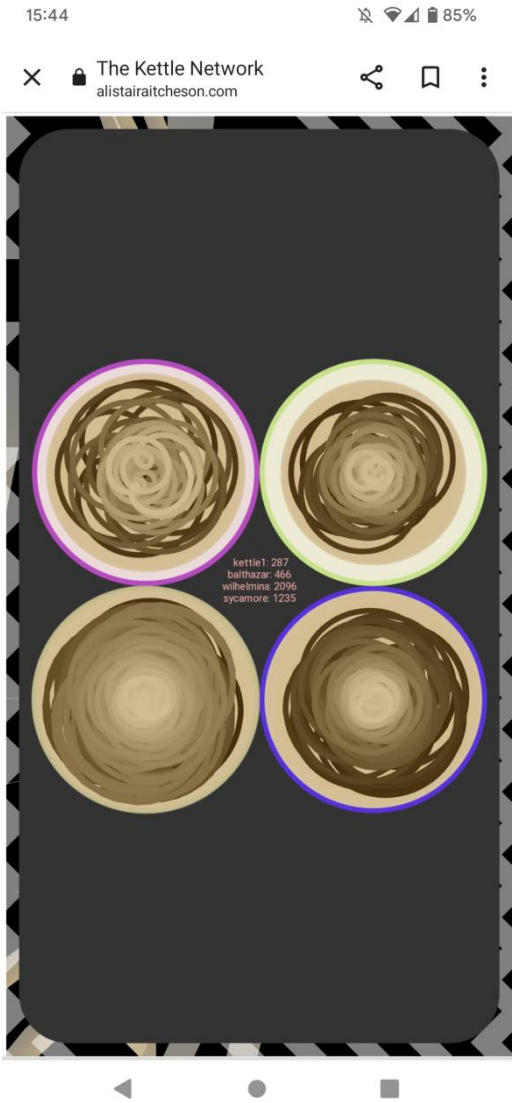


Figure 74 The Kettle Network Visualisation Prototype explorable at https://www.alistairaitcheson.com/kettles/

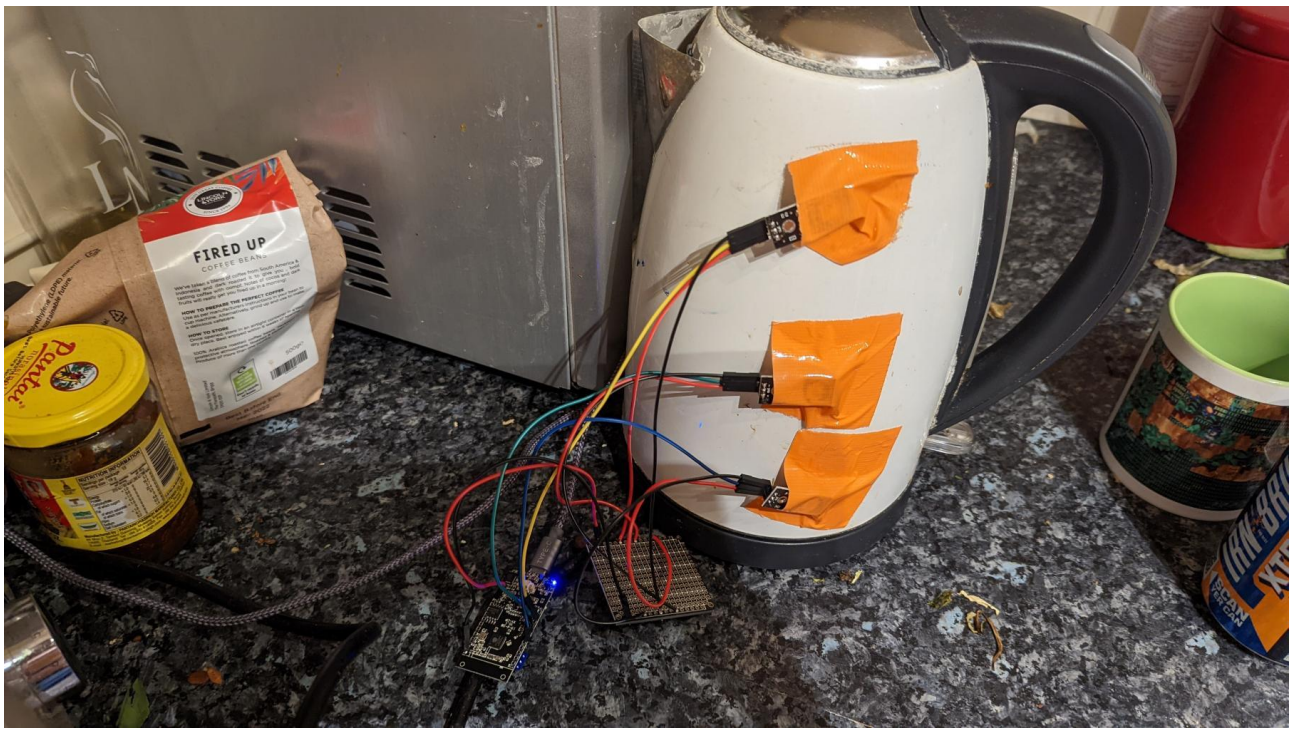


Figure 75 A Kettle Network Prototype Kettle

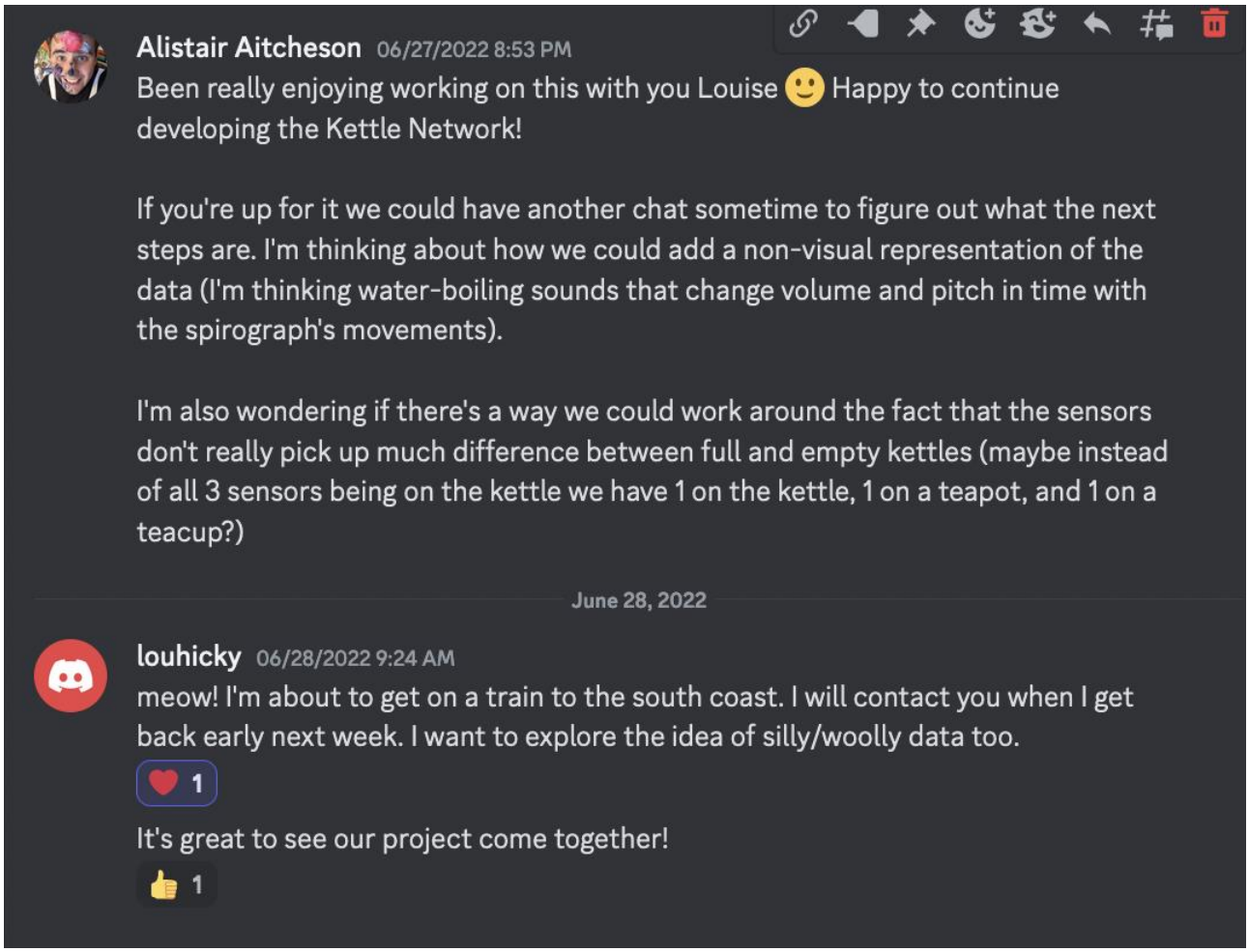
5.8.3.2 Outcomes

Louise Hickman described this project concept as such, “The Kettle Network has many entangled beginnings. How do we connect with others? How can we track our work/project through play? A kettle is a household object that is not normally associated with the clinical design of accessible products. We are looking at integrating play into the home. And yet, a kettle is not often associated with the Internet of Things. But we like networks. ‘Real-time’ networks: how do we subvert the on-demand time. Networks that are driven by ‘useless’ data of activism/social movements. We were inspired by the disobedience objects Exhibition at the Victoria and Albert Museum in 2014 - 2015. (Victoria and Albert Museum, 2014). Both were pleased with their prototypes as a place to end this phase of the design process.


Figure 76 The Tea Cup From Suffragettes Meetings (People’s History Museum, 2018)

In discussing future directions, the team pinpointed certain areas of improvement for their

collaboration, notably the sensors' inefficiency in detecting the kettles' water levels. Alistair was keen on exploring alternative, non-visual interpretations of the data. Both were particularly pleased with the notions of "silly data" and "woolly data." The idea of delving into accessible technology data without a strictly utilitarian objective was a significant conceptual outcome. Alistair voiced enthusiasm for extending their collaborative efforts beyond the project's current scope, and Louise too was keen on advancing the concept.



5.8.3.3 Values for Louise Hickman

Louise brings a rich, multifaceted perspective to design, rooted in criticality, philosophy, and socio-political awareness. Her values include inclusivity, playfulness, community engagement, and a deep understanding of the broader narratives and cultural meaning that designs and objects can convey. A significant artist and scholar in her own right, these values only reflect Louise's specific participation here. Her overarching scholarship is far more wide reaching, and as such I specifically want to clarify I am only looking at her values within the range of this study.

Holistic Approach to Assistive Technology and Design: Louise consistently emphasizes a broader, more encompassing view of design, which doesn't just limit itself to functionality but integrates art, philosophy, and activism.

Reimagining Transcription Technology: Louise believes in pushing the boundaries of transcription technology, especially in the context of accessibility. Instead of seeing technology as just a functional tool, she envisions it as an artistic medium.

Critical Accessibility Focus: One of the significant differences between Alistair and Louise is her critical approach towards accessibility. She seems to have a keen

understanding and empathy disabled people, which is reflected in her thinking.

Philosophical Underpinnings: Louise often frames her thoughts from a philosophical standpoint. For instance, she talks about sensing and the use of language when discussing objects. She's not just concerned with how things work but also why they exist and what they signify.

Community Engagement: Louise stresses the importance of community engagement in design. She believes in creating art that resonates with and actively involves the community, reflecting her values of inclusivity.

Empowerment and Activism: She recognizes everyday objects, like the kettle, as symbols of socio-political activism. Louise seems to value the power of common items in driving change and community dialogue.

Vulnerability as Strength: Through the discussion on performance, it's evident that Louise appreciates vulnerability as a strength, seeing it as an avenue for deeper connection and understanding.

Narrative and Context: Louise sees objects and designs not just as standalone items but as parts of a broader narrative. The emphasis on "storytelling", especially in the context of live captioning and audience interactions, underscores her belief in the importance of context.

Playfulness in Technology: The introduction of the concept of "Silly Data" indicates Louise's desire to incorporate whimsy and playfulness in design. This contrasts with the strictly utilitarian view of technology and data.

Materiality and Embodiment: She values the physical and tangible aspects of design, as evidenced by her and Alistair's interactions with everyday items. This hands-on approach reflects her belief in the importance of material engagement.

5.8.3.4 Values for Alistair Aitcheson

Critically Engaging with Functionality and Practicality through the Absurd: Alistair tends to emphasize the utility of an object or design within a game context, as exemplified by his query, "Why would I want to interact with this?". However, his inclination for embedding play through absurdity counters this pragmatism. An illustrative example is his "Man Eats Bagel" performance, wherein he endeavours to eat a bagel through a full-faced morph suit. This action juxtaposes the morph suit's practicality with absurdity.

Iterative Game Design: Alistair's design philosophy strongly aligns with iterative game design. His approach to design challenges typically integrates mechanics and interaction considerations at the forefront.

Hands-on Prototyping: Emphasizing the tangible aspects of design, Alistair's shift towards hands-on prototyping underscores his belief in the potential of prototypes to crystallize abstract notions into physical forms.

Direct Engagement with Materiality: Alistair's response to Louise's demonstration of a remote control—by presenting his button-based interface—manifests his penchant for a direct interaction with materials. It showcases his appreciation for understanding their inherent characteristics and their consequent design potential.

Player Performance and Character in Games as a Space for Personal Expression: Alistair's performance, wherein he empowers the audience to dictate his actions via chat within a predefined behavior set, implies a reconceptualization of the player-character relationship in games. It signifies his belief in the game as a medium for expression, exploring and redefining the dynamic between player and character.

Agency and Power Dynamics: Alistair's engagement with power dynamics—particularly within the realms of performance and games—indicates his value for player agency. This becomes particularly salient as he transforms himself into a game character, delineating a game world's parameters, only to subsequently cede control to his audience. It's a literal manifestation of experimenting with power dynamics in a game setting.

Adaptability and Openness: Alistair's collaborative venture with Louise, which witnesses a transition from his individualistic approach to a more synergistic methodology, speaks volumes about his adaptability. It underscores his willingness to assimilate and adapt novel ideas into his game design philosophy.

5.8.3.5 Thematic Analysis

In technology and design, accessibility remains the paramount concern for assistive technology. However, the focus on accessible design revolves around use. The conversations between Louise and Alistair examine if there is space for play in functional design. Can access be re-understood using art making and is it a possible point for activism and community engagement? Their design discussions span a range of topics, from the reimagining of everyday objects to the intricate dynamics of performance, vulnerability, and power. By weaving these diverse strands together, this exploration uncovers new possible intersections of game design, activism, and accessibility. Using Thematic Analysis, the following overarching themes are present.

Reimagining Accessible Technology
A central theme throughout these conversations revolves around reimagining accessible technology not merely as functional, but as an artistic tool. Louise considers the prevalent utilitarian use of technology in accessible design, suggesting its potential for play, community dialogue, and broader engagement. They delve deep into the idea of authorship within live captioning, examining its ability not only to capture words but also have authorial intent, provide context, or assign new meanings to text interpretations. They contemplate how such technologies can become platforms for play, meditation, activism, and empowerment.

Code	Definition	Number of Occurrences	Characteristic Example
Transcription and Play/Authorship, Distribution, and Interpretation	Used when they are discussing how transcription or live captions are created and understood and what the role of the author could mean for live caption.	6	Louise talks about disability studies and captions as a distributed effort - she has never been satisfied by this because it becomes like an exquisite corpse.
Transcription and Play/ Emotion, Captioning, and Games	This subcode centres around examples of expressions of emotion and tone by the transcriber or	3	Louise talks about a game centred on captioning. Louise mentions a

	captioner in a text in games.		game animation as having a meditative quality.
Transcription and Play/Presence, Time, and Synchronicity	Used when Louise brings up how text can arrive and disappear. She considers how live captioning has a quality of grounding people into the present moment – this code has an almost meditative element to it.	7	As Louise and Alistair talk, this idea of “arriving in time” emerges and how time can be asynchronous for each person
Transcription and Play/ Reimagining transcription and Emotion	For focuses on how the tone, emotion, and embodied expression of a speaker can be lost in transcriptions of text. The two rethink how this information could be added back into the textual meaning.	6	Louise talks about the value of making transcription sarcastic. “What if? What if we had a sarcastic transcriber?”
Transcription and Play/Transcription tools reimagined as distributed through the smart home interactions	Used for imagining how text could be spread across multiple interfaces in a smart home	1	One piece of toast picks a doing word, the other a describing word at random in a toaster.
Creating Spaces for Play in Assistive Tech	Code for considering play in assistive technology.	6	Louise starts talking about at her experiences with access tech and thinking about how they could be made playful. She proposes considering how assistive tech could be a space for play, for reclaiming authorship - ownership – creativity
Softness and Rest as Protest	Use for Assistive technology and activism.	1	Louise considers how making a cup of tea in the Kettle Network can be for

			rest. She reflects on how rest can act of protest.
Speculative Fictions	Used for speculations	2	Louise says, “Speculative idea - each part of your triggers some response.” they think about Alexia and Suri commands for the home that could be like, "Hot water" but instead of making water temperature the AI changes an image.

Re-Claiming Commercial Objects as Interfaces for Sense Making, Empowerment, and Activism

Louise and Alister survey their homes and professional spaces, seeing them as grounds for imaginative pursuits and insights. Amidst discussions about common items like doorbells, remotes, and buttons, the idea of the 'Kettle Network' surfaces. Their focus turns to tea, emblematic of its deep-seated socio-political ties to activism. Louise highlights their differing perspectives, with Alistair stating, “A usual thing that I kind of go through is, why would I want to interact with this? And that's usually the question that I'm looking to answer as the designer.” Louise contrasts, “My approach is more like a philosophy machine. Right? Like, what does this tell us about our sensing? What does this tell us about the way we think and use language?” A tension becomes evident in their discourse, primarily due to Louise's critical accessibility focused design lens clashing with Alistair's conventional game design approach. This tension is explicitly addressed by Louise. Their collaborative journey results in a blended methodology, intertwining the materiality of objects within interactions. This hybridisation of approaches offers a rich territory for future exploration in game design methods.

Code	Number of Occurrences	Characteristic Example
The Everyday Object/Everyday Objects and Access	5	They look at ways the words or text could relate to certain temperatures and the amount of water in the kettle

The Everyday Object/ reimagining access with the smart home as play	11	Louise considers what if the house becomes the input method. She thinks about the home to point back to disability because disabled people have to adapt their home to suit them. A smart home for a disabled person could be playful vs utilitarian.

Performance, Vulnerability, and Power Dynamics

Performance remains a recurring subject of their shared stories, be it Alistair's Morph suit performance or Louise's use of a nude suit onstage. They spend over half an hour on this topic sharing stories of performances they have done in the past or have seen in their first conversation. One anecdote Louise shares of a project from a blind burlesque artis who lets their audience describe her actions to them, lead them to discuss the intricate balance between vulnerability and audience power dynamics. Speaking of the performer, Louise recounts, “They were on stage performing and the audience was describing what they were doing. One person commented, ‘Your skin is as green as spinach.' She's like, well, I'm like a burlesque performer and now I'm green spinach.” This performer leverages audience descriptions to consider the power dynamics between performer and the audience, drawing a parallel to the experience of being blind and relying on others for audio descriptions. Alistair and Louise both seem to resonate with this as they return to questions of power and agency throughout the study in their research.

Code	Number of Occurrences recounting performances	Characteristic Example
Power Dynamics and Vulnerability in Performance	6	Alistair talks about how he turns himself into a puppet for the audience to control. Louise talks about a blind burlesque performer and how she lets the audience create the audio description of her performance as she dances on stage.
Shared Experiences and Resonances in	2	Alistair’s audience sexualising him the comments he could

Performances		not read while wearing a morph suit during a live stream performance reminded Louise of a performance she saw where people described a porn they had seen to an audience.

Data Mapping as Point for Revisiting Utilitarian Functionality in Accessible Design
The interface they create allows players use their home to generate and share abstract data they visualise as creative spirograph illustrations. Players are granted the autonomy to interpret the generated spirographs, embedding their personal narratives and messages to send to friends. Louise provides an illustrative example of an almost-empty kettle possibly being used to symbolizing a desire for company and co-working. They use the smart home and its relationship to accessibility to subvert the fixed purpose data can have in strictly utilitarian technology. This leads to the concept of “Silly Data” which is defined as data that objects generate as being whimsical and playful.

Code	Number of Occurrences	Characteristic Examples
Data Mapping	11	Louise thinks about how different water levels in the kettle are different calls to action. For example, the water level being low could represent a call for coworking because it shows the player is alone and only making one cup of tea. Alistair considers "what would an alphabet of temperatures be like?"
Silly Data	9	The kettle’s output is different types based on usage. She ideates around the phrase, "Spill the tea" to inform people that you

		have hot gossip to share.
Reimagining access in the smart home as play	11	They spend several minutes talking about mapping data and thinking about maps and dictionaries of language in transcription software and data mappings in assistive technology. Louise returns to the earlier idea of allowing items in the home to write something -
Object Oriented Ontologies	3	Louise asks, “Louise "What does this object tell us about us?”

Material Engagement, Embodiment, and Access

Throughout the design process, there are numerous instances where the creators physically interact with their surroundings, displaying objects they could consider to each other via video conversations. In one such instance, Louise shows a remote control and Alistair responds showcasing a button-based interface he made for an old project. This physical involvement with items in their home ends up centring on a common kettle which culminates in the creation of the 'Kettle Network'. Additionally, as Alistair transitions to hands-on prototyping begins, he keeps Louise in the loop, they both consider the data's potential, discerning its epistemic value and the unique opportunities it can present to participants as a drawing.

Code	Number of Occurrences	Characteristic Example
Material Engagement/Prototyping to Understand Possibilities	5	This meeting talks about their prototype Alistair describes his prototyping materials and how he is progressing with temperature sensors for the kettle.
Sensory Preferences and Experience	3	They start talking about the missing

Preferences / Movement and Embodiment		body - making use of abstract notions of embodiment via a laser pointing game
Material Engagement	10	Louise expounds, “I love prototyping!”

Designing for Community Engagement

Both artists frequently underscore the essence of community in their craft. Their artworks often involve group participation. They conceive a multiplayer experience, scalable according to the user group. Nearing their collaboration's conclusion, Louise presents a painting, a response to a film crafted by a friend. Their commitment to creating art that resonates and engages their communities is a persistent motif in their discussions.

The dialogue between Louise and Alistair showcases the potential that lies in reframing the purpose and approach to assistive technology. Moving beyond mere functionality, their collaboration emphasizes the impact of integrating artistic expression, socio-political awareness, and community engagement. As they navigate the confluence of their diverse perspectives and design methods, they point to a path forward for game designers and crip activists alike. Their shared journey serves as a testament to the power of interdisciplinary collaboration and a clarion call for a more inclusive, imaginative, and holistic approach to design in the digital age.

Code	Number of Occurrences	Characteristic Example
Designing for Community	1	Alistair lands on the idea of turning the tea pot into a 2-way communication back and forth between people to send messages.
Multiplayer Games and Community	5	Louise centres on creating kettle networks and she comes up with the kettle network and this idea of “Kettling.”
Thinking about Community	2	Louise and Alistair look at ways the kettle communication could be two ways with list of responses.
Group Dynamics	3	They start talking about games that

and The Collective		are played by groups of people all at once in a collective play experience.

Collaborative Tension and Methodology Mismatch
In their third conversation Louise and Alistair come to an impasse. A clear tension arises between Alistair's goal-oriented game approach, where he's constantly seeking a goal, and Louise's playful, open-ended exploration, which is informed by design philosophy and her lived experiences. This tension pushes both designers to think beyond their comfort zones, redefining what 'winning' or 'achieving' means in a design context. Louise's perspective often weaves in cultural and historical narratives, turning objects like kettles into symbols of protest and empowerment. This enriches the design process, turning it into a dialogue not just about functionality, but also about identity, history, and social change.

Louise also brings to the forefront the potential of everyday objects to be re-envisioned as tools of access. Instead of looking at specialized equipment, she taps into the ubiquitous and familiar to create exploratory access solutions. From doorbells to toasters, the emphasis is on transcoding and reimagining sensory experiences. A significant portion of their journey revolves around Alistair's struggle to understand and incorporate Louise's lived experiences into the design process. At one point she points out a design he proposes would be inaccessible to her as a deaf person. This underscores the importance of having disabled designer in the room when thinking about assistive technologies, highlighting the challenges (and eventual rewards) of bridging diverse perspectives. Through dialog towards the end of the conversation they build a shared conceptual reference point and begin to design with enthusiasm, humour, and play infusing their final conversations.

Code	Definition	Number of Occurrences	Characteristic Example
Clash of Methods	This marks moments of tension in the design process	6	Alistair starts with, "Why would I want to interact with this?" He looks for how to "win the object or experience" Louise says she starts with, "What does this object tell us about us?"

In summary, the conversations and design process between Louise and Alistair shed light on the transformative potential of interweaving artistry, socio-political awareness, and assistive technology. They challenge the conventional paradigm that confines assistive technology to mere functionality. Instead, they propose a vision where technology becomes a canvas for expression, play, community engagement, and activism. Through their discussions, the two bring to the forefront the richness of interdisciplinary collaboration, with Louise's insights on the lived experiences of disability and the potential of everyday objects complementing Alistair's game design perspective. The project they

create underlines the significance of inclusivity, adaptability, and the power of viewing objects not just as tools but as conduits of history, meaning, and social change. Their collaborative process and creative problem solving shows the power of building multidisciplinary teams to innovate and reimagine how assistive technology could be experienced within the larger cultural landscape.

5.9 The Exhibition

The group collectively presented their work in a Livestream entitled, “Beyond Screens- Alt+Ctrl: Criptastic Hacking and Video Game Controllers”(*Beyond Screens - Alt+Ctrl*, 2022) to the public via Indiecade’s Alt Ctrl live stream hosted by Alistair Aitcheson[6]. This stream was on October the 4th, 2022 and lasted and hour and twenty-six minutes. In this workshop, all three groups presented their projects and discussed the processes and outcomes detailed above. This exhibition served as a way for the group to give each other feedback and as an opportunity for community celebration. In addition to the participant’s invited to the stream was Caleb Kraft of The Controller Project and Dr. Rebecca Fiebrink. These two outside perspectives gave feedback and input to the teams and advice about moving the projects forward if they considered doing so in future.

Figure 77 Screenshot from the YouTube IndieCade Channel Documenting the Event.

The exhibition began with an icebreaker: a communal Padlet where participants jotted down their design values implemented during the project. Several prominent values echoed those previously mentioned for all three groups. These included crip time, a desire for subversion, simplicity, bonding, shared interface enjoyment, silly data, access intimacy, and multi-player connectivity. This Padlet was integrated into the coding process as a crucial first-hand source. Reviewing it igniting discussions across all three groups.

[6] The stream can be viewed here: https://www.youtube.com/watch?v=g0zGx94ws3U

During the live stream, each team showcased their design processes and outcomes. While this session didn't shed new light on the designers' methodologies or values, it corroborated several findings with the participants. It also provided a platform for them to discuss their projects across their teams and with community figureheads like Calab. The stream's atmosphere radiated celebration and crip joy. In essence, it emphasized the profound impact of integrating crip designers into game design teams from the beginning, rather than merely incorporating them at the project's end as consultants. The interfaces highlighted weren't made accessible as mere add-ons; they were built with accessibility at their core. This exhibition elegantly encapsulated the study.

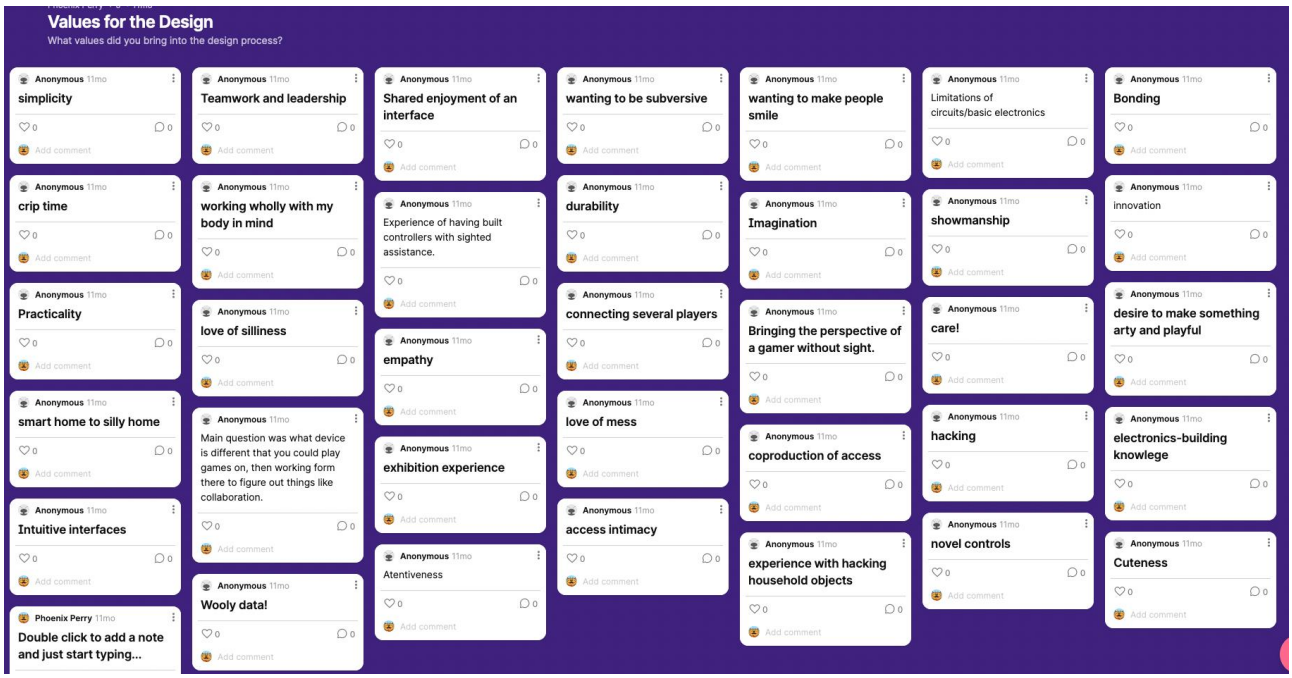


Figure 78 The Shared Padlet Collecting Design Values.

5.10 Shared Values and Methods

The research question in Chapter 1 askes what values and design methods crip designers consider when creating Alt Ctrl hardware games and playful experiences? These questions can be understood in relation to the designers within this study. For the purposes of clarity, I have broken the groups into the Alt Ctrl Game Designers and the Crip Designers to look at each group's values. However, as the Crip Designers lead the Design Process, I have focused on the working design methods in each of the three teams above holistically.

5.10.1 Values of the Crip Designers

1. **The Importance of Embodiment and Lived Experiences in Design Processes**:
    - Crip designers understand their embodiments of disability play a crucial role in the ideation phase. Their lived experiences give them insights into challenges and nuances that others might overlook. By grounding their design processes in these embodied experiences, they can ideate solutions that are deeply aligned with the real-world needs and desires of people with disabilities.
2. **Designer Positionality Informed by the Limitations of Assistive Technology**:
    - While assistive technologies have provided invaluable support to many, they are not without limitations. Crip designers, being closely familiar with these

limitations, are uniquely positioned to design beyond these constraints. By critically evaluating where current assistive technologies fall short, crip designers can propose innovative solutions that push boundaries and set new standards in accessibility.

3. **Creating Design Work that Values their Personal Abilities and Experiences**:
    - Crip designers place significant value on their personal abilities and experiences. By designing with this lens, they create outcomes that celebrate their abilities rather than trying to conform to a universal one size fits all standard. Such designs could resonate deeply with others who share similar abilities, offering them solutions that feel tailored to their unique experiences and abilities, rather than generic or one-size-fits-all access solutions.

5.10.2 Values of the Alt Ctrl Game Designers

1. **A Passion for Prototyping and Material Research and Experimentation**:
    - For Alt. Ctrl game designers, the process of design is as significant as the outcome. They recognize the importance of hands-on exploration, where prototyping and experimenting with materials become the driving force behind design. This passion means they are constantly pushing the boundaries of what's possible, trying out new materials and techniques to discover interface possibilities and game mechanics.
2. **Adaptability and Collaboration**:
    - Alt. Ctrl game designers value the ability to adapt, iterating on their designs based on feedback, challenges, and the ever-evolving landscape of gaming. Collaboration is key, as pooling knowledge and expertise from various disciplines can lead to more holistic and impactful games.
3. **Openness to Experimentation and Creativity**:
    - Alt. Ctrl game design is inherently experimental, pushing the limits of traditional gaming interfaces and experiences. For these designers, creativity isn't just a skill—it's a mindset. This openness to experimentation means they aren't confined to the norms of mainstream game design interfaces. Instead, they constantly make interfaces that are not only pushing the bounds of games but also are meaningful to them as creators.

5.10.3 Shared Methods

A Design Process Which Integrates Design and Accessibility (48 codes) *An approach that seamlessly blends the nuances of design with the principles of accessibility, ensuring that the outcome is meaningful experience.*

Subcategories:

- **Innovation in Ideas Around Access:** Pioneering approaches and new solutions that challenge conventional notions of accessibility arose repeatedly specially as they were rooted in the lived experiences of the limitation of the assistive technology presently being used.
- **Game Design Innovation:** Creating novel game mechanics and narratives that are intrinsically inclusive happens organically when 50% of the design team is working from a place of lived experiences with disability.
- **Interaction Centred Interfaces:** Focusing on interaction-first designs, where the interface itself encourages deeper inclusive engagement and conversations around access.

- **Integrated Game and Controller Design:** Ensuring that game controllers are not just assistive but are an organic part of the game, enhancing the gaming experience.
- **Inclusivity and Accessibility:** Advocating for design that not only meets accessibility but also promotes inclusivity at its core as an intrinsic part of the design process.
- **From Universal Complexity to Modular Adaptability:** Recognizing the uniqueness of each player, the emphasis shifts from pursuing a one-size-fits-all interface to crafting a modular design. This approach champions flexibility and adaptability at the point of use, prioritizing individualized experiences over broad generalizations."

Individual Centred Design (21 codes) *This method revolves around personalizing designs based on individual needs and lived experience rather than broad generalizations, ensuring a more personalized experience.*

Subcategories:

- **Personal Design:** Creating tailored solutions that cater to an individual's unique requirements and preferences.
- **Kindness and Care:** Approaching design with genuine concern, ensuring that the solutions are not just functional but also emotionally resonate.
- **Proactive Accessible Design:** Anticipating potential barriers and designing in a way that proactively addresses them.
- **Understanding and Empathy Rooted in Lived Experience:** Demonstrating a deep understanding of the player's experiences and challenges and designing from a place of empathy rooted in lived experience.

Empowerment (12 codes) *Designing with the intention of not just providing access but also empowering players to feel a deep sense of personal empowerment with interfaces.*

Subcategories:

- **Designing for Positive Emotion:** Creating designs that evoke positive emotions, reinforcing the player's send of self-worth.
- **Through Tool Use:** Empowering designers by providing them with tools that enable greater agency and participation in the material phases of creation.
- **Through Participation:** Ensuring that disabled designers are active participants in the design process from the outset, valuing their feedback and insights.

A Clash of Design Methods between Disabled Designers and Alt Ctrl Designers (12 codes) *Highlighting the occasional differences in approach between Crip and Alt Ctrl designers and how these clashes were resolved.*

Subcategories:

- **Collaborative Learning:** Embracing differences, learning from one another, and jointly refining the design approach.
- **Adaptive Creative Process:** Modifying and adapting the design approach based on mutual insights and learnings.

Designing for Group Dynamics, Bonding, The Collective Body (10 codes)
Understanding the importance of group interactions, communal understanding, and the strength of collective experience in the design process. All three case outcomes were created for multiple players to experience.
Subcategories:

- **Soothing:** Designs and interfaces that provide a sense of relief or alleviation, especially in group settings. The elements incorporated aim to reduce tension or distress among participants, fostering a harmonious environment.
- **Bonding:** Elements specifically crafted to forge connections between players. This encompasses shared experiences and activities that allow for mutual play.
- **Calming Design:** Choices specifically aimed at inducing a state of calmness. This might mean avoiding overly stimulating sounds, focusing on simplicity, or creating space for a cup of tea with a friend.
- **Softness:** This entails both a tactile and metaphorical softness. In a tactile sense, it could relate to the materials used in the controller or interface. Metaphorically, refers to gentle overall gentle engagement.
- **Rest as form of Protest:** Emphasizing the importance of rest and recuperation as a counter to the often-frantic pace of mainstream gaming. In a world that constantly demands attention and action, choosing rest can be a revolutionary act.

Material Engagement (8 codes) *Deep involvement with the physical materials used in the design, understanding their properties, possibilities, and limitations.*

Subcategories:

- **Material First Approach:** Starting the design process with a focus on the materials, guiding the subsequent design decisions.
- **Prototyping to Understand Possibilities:** Using prototypes to explore the potential of different materials.
- **Tactile Engagement:** Focusing on the tactile experience, understanding how different materials feel and interact with the user.

Other Less Significant Methods:

- **Using Metaphors in the Design:** Leveraging metaphors to convey complex ideas or to create more relatable designs.
- **Design Activism and Reclaiming Power:** Using design as a tool for activism, championing the rights and concerns of marginalized groups.
- **Experimentation and Speculative Fictions:** Venturing into experimental designs or speculative futures to challenge current norms.
- **Shared Affinity as a Basis for Design:** Using shared experiences or interests as a foundation for design, ensuring deeper resonance with the target audience.

5.11 Conclusion:

This research dives deep into the nuances of Crip Game Design, challenging the limitations of prevailing design frameworks like User-Centered and Human-Centered Design, which can overlook the needs of disabled people.(Costanza-Chock, 2020) Through a participatory approach, the study closely observed the values, methods, and collaboration between three accessibility experts with lived experience of disability and

three Alt Ctrl Game designers. By mapping their values and design methodologies, the research seeks to uncover common threads that might inform a forward-looking framework for Crip Game Design, with potential implications for the broader realm of game design.

At the University of the Arts, London Creative Computing Institute, Sightless Kombat and Robin Baumgarten embarked on a collaborative process face to face during an intensive day-long workshop. As they brainstormed, their distinct design philosophies surfaced, highlighting the need for a shared direction. While Robin entered the workshop anticipating a collaborative design exercise, Sightless Kombat presented a preliminary concept. This juncture led Sightless Kombat to share his experience of exclusion from traditional game jams, while Robin explained how such jams influenced his design ethos, particularly his practice for crafting games based on specific hardware affordances.

In search of a mutual focal point, SK introduced the idea of incorporating a physical tube, which provided a tangible object for them to jointly explore. This tactile engagement acted as a catalyst, streamlining their design process. The duo soon found themselves exploring the potential of sensors and haptic technologies to augment the tube's game-play capabilities. Their animated brainstorming bore a detailed blueprint of potential controller features, capturing the essence of their combined insights. This collaboration eventually birthed a prototype: a versatile tube adaptable to various games for either single or multiplayer use, offering both sighted and blind players a level playing field.

Jade Hall Smith and Julia Makivic's collaboration unfolded with a gentle and compassionate cadence, grounded in Jade's personal experiences. During the study, Jade became pregnant, and to accommodate this, their entire collaboration spanned three Zoom sessions and a consistent Discord thread, culminating in Julia delivering *SYTHia* to Jade. *SYTHia*, a plush cat embedded with a sound synthesis unit, is activated by gestures and touch.

The design process was deeply influenced by Jade's lived experiences of autism and chronic fatigue. Their primary goal was to craft a portable toy that would enable Jade to connect and bond with her unborn child, Teddy. The interface was collaboratively designed, reflecting Jade’s preferences for soft, comforting interactions – a sharp contrast to the prevalent tension-driven mechanisms in many modern games. Moreover, they integrated tones that Teddy could discern while in the womb, known for their calming effect on unborn children. Throughout the collaboration, Julia kept Jade in the loop, sharing her prototyping process on Discord. Jade's feedback and insights were instrumental, ensuring the design was a harmonious blend of both their visions.

In the concluding case study, Louise Hickman teamed up with Alistair Aitchenson to conceive *The Kettle Network*. Over four Zoom meetings and an ongoing Discord conversation, their partnership initially found harmony through their mutual approach to live performance. Yet, as the design phase commenced, a divergence in approach surfaced. Louise perceived Alistair's design methodology to be goal-centric, contrasting her own emphasis on the cultural significance of objects, especially as they resonate with disabled narratives.

Their open discourse on this disparity gradually paved the way to an integrated approach, amalgamating both perspectives. This approach not only provided players with a loose objective but also ensured the game mechanics remained tethered to the activist underpinnings of tea-making. *The Kettle Network* manifested as a digital nexus of kettles in various households connected online, symbolized by spirograph-style illustrations on a website. These drawings, in essence, became a language—each pattern potentially

signifying a distinct message between participants. For instance, a simpler design might hint at solitude, signalling a desire for communal activities like a co-working session.

Further conversations led them to the concept of "silly data". This idea champions the notion that disabled individuals can subvert the predominantly utilitarian ethos of standard assistive tech within smart homes. As their collaboration neared its end, Alistair expressed a keen interest in supporting the project's continuation, should Louise opt to pursue it further.

Concluding their journey, the group showcased their interfaces during a live stream, hosted by Alistair Aitchenson on the Alt Ctrl IndieCade platform.(*Beyond Screens - Alt+Ctrl*, 2022) This exhibition wasn't just a mere display; it was an enriching conversation that allowed the creators to share the outcomes. Beyond just presenting their work, it provided a platform for them to share insights, reflect on their collaborative journey, and engage in meaningful discussions spurred by feedback from the community. The atmosphere was celebratory, marking a significant moment of unity and pride in their outcomes.

5.11.1 Themes

When examining the shared values of the crip designers, several predominant themes surfaced. Foremost among them was the importance of embodiment and lived experiences in shaping the design process. These designers consistently anchored their practice in their personal encounters with disability. This perspective was further honed by the constraints and capabilities of assistive technology, both from their personal experiences and their research. Across all three cases, a consistent trend was evident: the creation of games tailored to their abilities and experiences. This approach not only ensured accessibility for them but also challenges traditional power imbalances between them and other players.

In contrast, the values of the Alt Ctrl Game Designers adhered towards more iterative design processes Their design processes were deeply entrenched in material research and experimentation. A standout trait shared by all three was their adaptability, showcased by their readiness to collaborate with individuals who had diverse approaches. Additionally, their propensity for exploration and creativity was unmistakable. Faced with new ideas, technologies, or paradigms, they exhibited a remarkable agility and adaptability, always eager to delve into and expand upon the understandings of others.

Upon analysing the shared methods used by all three groups, several significant ways of working emerged, pointing towards the foundation of a potential framework. Central to every method observed was the inclusion of perspectives and designers who were deeply committed to producing accessible outcomes. This commitment manifested in diverse ways: ideas were born from personal experiences with the limitations of assistive technology, while thinking gravitated towards addressing the challenges of constructing adaptable interfaces.

These designers operated from a point of individual positionality, recognizing their lived experiences as expertise. In two of the three collaborations, a moment of contention arose when traditional game design paradigms clashed with the lived realities of being a disabled designer. These impasses were surmounted through open dialogue, tangible engagement with prototypes, and the discovery of mutual understandings.

This holistic inclusion, coupled with the creation of interfaces that resonated with their personal experiences, resulted in a palpable sense of empowerment. There was also a unanimous emphasis on fostering group dynamics, bonding, and collective experiences. Be it the tube that facilitated shared gameplay for SK and his father, Jade's sound-emitting plush cat deepening their connection with Teddy, or Louise's playful representation of communal tea-making experiences, each designer underscored the intrinsic value of community. They crafted projects not just for individual empowerment but to strengthen connections and relationships within their communities.

6 Discussion: Towards a Crip Game Design Framework

6.1 Introduction

At this point, this thesis moves lays the groundwork for a possible future framework that would benefit the game design community. It aims to provide insight into ways of working which would facilitate crip game design methods that are deeply inclusive and move the community conversation beyond assistive technology consultations either during or at the end of the design process. As was identified from the literature review gap around crip game design, there is room to explore new working methods. As was evident by the failures of UCD to consider disabled experiences, as was pointed out in *Design Justice*, there is room to suggest and generate alternatives.(Costanza-Chock, 2020) As was seen in the Crip Technoscience Manifesto, when disabled people become authors of technology, powerful perspective around assistive technology become to bear.(Hamraie and Fritsch, 2019)

From my own design values and methods to those of the designers who participated in the study above, this chapter will pull common threads and connect patterns in this thesis to explore what crip values and methods were present during this research. This chapter will take an informed exploration of what will serve as a first step in answering the final research question asked in this thesis: How can the values and methods of designers with lived experiences of disability inform a future framework which might have relevance to games designers?

6.2 Similarities in the Values of my Creative Practice to the Participants of the Crip Game Design Study

As outlined in the methodology section, the guiding values underpinning *Bot Party* stem directly from my personal experiences with disability. These experiences drove me to challenge and play with established social norms and expectations. The scenarios I crafted are deeply reflective of my life with a disability. They aim not only to create prosocial community engagements but also to foster a sense of shared joy. My work is a journey into player agency, emphasizing their interconnectedness with one another. At its core, it is an exploration of embodied interactions marked by elements of playfulness, sensitivity, intimacy, softness, and connection. My design process has been deeply iterative, stretching over several years. It led me to adapt various facets – from my workspace and my approach to even my self-care routines. The ultimate outcome, *Bot Party*, isn't just a game. It's a reflection of my world – an accessible experience designed from my positionality, enabling me to engage with groups from my gaming and creative circles.

When considered in relation to the study presented in Chapter 5, it's evident that the primary values guiding the design processes across all teams and this research were deeply anchored in lived experiences and positionality. Our first-hand experiences with the shortcomings of traditional assistive game controllers provide a fertile design foundation for envisioning alternatives attuned to our distinct experiences and perspectives. Every project responds to an individual's lived experiences by presenting games crafted specifically with the abilities of each creator in mind. By critically analysing the inadequacies inherent in these interfaces and processes, we open the door to imagining and realizing alternative designs. When we are included or are leading design processes, the results are reflective of a deep understanding of the limitations of the industry's present approach.

Moreover, when reflecting upon the Alt Ctrl designers, it's clear that we operate from a confluence of shared values. My design process exhibits a parallel enthusiasm for prototyping, as evidenced by the three distinct iterations of the game incorporating custom hardware. This is coupled with hands-on material explorations. Similarly, my design journey is far from solitary. It intertwines with the insights and contributions of four other creators. This collaborative spirit, mirrored by direct audience engagement and willingness to experiment, has been instrumental in my work. Feedback learned from these interactions has been invaluable, guiding the evolution of the game and culminating in an award-winning project.

Taken together, a harmonized set of values emerges, reflected not just in my personal endeavours but also in the Exploration of Crip Game Design study. This synthesis presents a profound array of considerations for crafting games that prioritize deep accessibility. Assembling design teams comprising disabled designers—those deeply anchored in their lived experiences of disability and acquainted with the limitations of current assistive technologies—and pairing them with designers dedicated to material experimentation and open to embracing fresh perspectives can foster an environment that goes beyond mere inclusion. It paves the way for genuine equality in the game design process.

Presently arising from scholars, activists, poets, podcasters, and storytellers, crip worldmaking, as described by Muller is a process of “imagining and inventing” and is at times a “literal reshaping of spaces, always with an aim toward imagining more bodies, minds, and behaviors in those spaces.” (Mills and Sanchez, 2023) He draws from Hamraie’s concept of “alter-livability” to help concretize crip world-making.(Mills and Sanchez, 2023, p. 280) Alterlivability arises in relationship to ideas of livability described by Tsing which consider how humans can live in a rapidly shifting post human, post capitalist ecology. Hamraie forms alterlivability out of the idea of livability to imagine how we materialize livable worlds. These ideas all draw from Kafer’s illumination of crip futures built from crip experiences. In Feminist, Crip Queer she proposes that disabled people are people who have arrived in the future, often having achieved an integration with technology that abled bodied people have yet to experience.(Kafer, 2013) In her work she discusses ways which assistive technology, such as wheelchairs, ventilators, and implants are opportunities to understand the complex, political and nuanced implications which meet at the intersections of technology, ability, and the body.

This framework embodies a crip epistemology, representing the unique ways in which disabled individuals perceive and understand the world. This research, conducted by a disabled researcher within their own community, contributes to the development of a crip world-making endeavor, offering a potential approach to game design that paves the way for an “alterlivability.” The framework suggests ways in which the design of game worlds and playful environments can be influenced by crip positionalities, ultimately contributing to the creation of more inclusive and humane worlds. It is formulated by integrating themes identified through thematic analysis in the preceding study (summarized below) with the designer values, thus laying the foundation for a set of guiding principles to considered from the outset of a game design process.

Deep Listening is a method created by composer Paulene Olivares to be able to hear beyond sound to arrive at the deeper meaning – to listen to ecologies and of both music and the moment. Defined by composer Pauline Oliveros as listening that “digs below the surface of what is heard … unlocking layer after layer of imagination, meaning, and memory down to the cellular level of human experience” (Oliveros, 2005) There are resonances here to crip epistemologies which advocate for substantial inclusion of lived experiences and positionality to inform design on a foundational level.

6.3 Similarities in the Design Processes and Methods

My methodology for creating *Bot Party* was an expansion on Smith and Dean's Iterative Cyclical Web.(Smith and Dean, 2009) This extension was twofold: it not only enveloped my intrinsic values and positionality but also integrated a materially anchored, iterative design ethos. This approach was amplified by an exhibition-led prototyping strategy, which leveraged audience feedback and interactions to shape the game's design.

Playing *Bot Party* with others wasn't merely an activity—it was an empowering and joyful journey. Past feelings of exclusion from mainstream console and controller-based games fuelled a passion for innovating and crafting inclusive gameplay experiences. Through *Bot Party*, the distinction between the game and its controller dissolved, giving rise to an interface that prioritized interaction.

Significantly, I positioned myself at the epicentre of crowd interactions in the design process. This was not only a symbolic act but also a literal one, ensuring the game was an authentic experience and expression of interpersonal connections. Above all, *Bot Party* aimed to cultivate an environment that promoted prosocial interactions and amplified the positive emotions stemming from group dynamics.

The study delineated in Chapter 5 revealed that all three teams mirrored aspects of my own design journey, though in a collaborative setting. A distinct divergence between this collective study and my creative process which I led, was the convergence and subsequent clash of diverse design methodologies. These conflicts were ameliorated through a cooperative learning experience, wherein team members gleaned insights from each other's distinct approaches. They fine-tuned their collaborative method to accommodate the variances in individual workflows.

6.4 Future Framework Values

Lived experiences of disability, intrinsically diverse and multifaceted, present a reservoir of insights, values, and methods that can vastly enrich the landscape of game design. Integrating these experiences into the fabric of the design process could not only foster inclusivity but pave the way for creative possibilities not yet explored. Based on both personal reflections on my process and the invaluable inputs from participants in the Crip Game Design study, the following recommendations can be suggested for a forward-looking framework in game design:

1. **Prioritize Design Team Diversity from the Outset of the Design Process**: Begin by assembling a design team that incorporates disabled designers, ensuring they play central roles right from the project's outset. Moreover, strive to include voices from traditionally underrepresented and marginalized backgrounds. This will mean promoting and accepting different working styles, working locations, times and durations, and timescales for each person. At present, disabled designers are often brought in at the end of the design phase only to advise on access. This misses an opportunity to include assistive technologies and critiques of them in the design process itself.
2. **Foster Shared Values of Care**: Initiate dialogues that centre around identifying and harmonizing shared design values. Such discussions serve to solidify common ground and foster a sense of collective purpose. In crystallizing these shared values, it's imperative to emphasize and prioritize input from historically marginalized groups. These insights, born out of systemic exclusion, offer invaluable perspectives that can fill gaps often missed by mainstream design

paradigms. These values are beyond a set of values to weave into the game but rather frame a working ethos born from care and listening.
3. **Embrace Embodied Positionalities**: As the design values unfold, it's essential to allow the lived experiences and personal narratives of team members to inform and enrich the conversation. Embracing individual positionalities ensures a holistic understanding of the creative process.
4. **Elevate Expertise from Lived Experience**: Designers who've directly experienced exclusionary practices or the limitations of assistive technologies should be seen as subject matter experts. Their nuanced understanding adds unparalleled depth to the design discourse, making their insights essential for an inclusive approach.
5. **Craft a Values Touchstone for the Studio Culture**: Condense the team's shared values into a foundational internal statement of care. This document serves as a guiding light throughout the design process, ensuring that the team remains aligned with its inclusive principles.

By possibly initiating the design process with these foundational guidelines, there's a potential that the resultant games will not only be more accessible but will also resonate deeply with disabled people in the audience. By prioritizing equality at every step, from team composition to the integration of lived experiences, the result becomes a tapestry of diverse values and perspectives. By cultivating an environment where traditionally marginalized voices are not only heard but celebrated, the design process itself becomes a testament to the power of collective creativity.

6.5 Starting Points to Consider for a Method

Based on the findings from this research, a prospective framework for shaping the design process could encompass the following parts of a methodology:

6.5.1 Incorporating Accessibility into Design Work from the Ground Up

The design and accessibility aspects shouldn't be treated as separate entities. Instead, right from the project's inception, accessibility should be treated as a fundamental feature, on par with any other essential design element. This paradigm shift requires moving beyond the traditional viewpoint of accessibility as a mere afterthought or purely utilitarian, to one where the intricate nuances and lived experiences with assistive technologies shape and influence the core game design. This approach allows the shortcomings of existing assistive tools to catalyse creative solutions for inclusive access.

For projects aiming to cater to a vast spectrum of abilities, the challenges of creating universally adaptable designs could be addressed by providing both hardware and interface customizations tailored by the player. Integrating starting game loops at the project's outset can empower players to configure their control systems, enhancing their play experience.

6.5.2 Focused Inclusivity: Designing with Purpose

Rather than the overarching, and often elusive, goal of designing for everyone, adopt a focused approach. This shift challenges the status quo by recognizing that designing for everyone often inadvertently creates experiences which are better for some than others. By centring the design around personal experiences, particularly those related to disability, the process becomes more informed. While mainstream accessibility practices remain crucial, there is a potential for achieving a deeper layer of inclusivity that values and addresses specific abilities. Such an approach could manifest in highly customizable systems or games tailored explicitly for an audience. For instance, a game that uses sign language as its primary mode of communication, relegating audio translations as an optional feature, might resonate deeply with Deaf players. Similarly, as Louise Hickman

proposed, reimagining the role of a live captioner in a theatrical setting to possess agency and even display sarcasm could redefine the boundaries of traditional captioning norms in her design sessions above.

6.5.3 Consider Creating Empowerment

The game design process could evolve embracing the broader hope of instilling a sense of personal empowerment. This principle, grounded in nurturing both a positive emotional response and a feeling of ownership, could manifest in several ways:

- Designing for Self-Worth: Craft experiences amplifying disabled players' sense of self-worth and reinforcing their inherent value. For example, a controller could not merely be an access point, but also a celebration of individual abilities and experiences.
- Empowerment Through Game Creation: Equip designers, especially those with disabilities, with advanced and adaptable methods that grant them augmented agency to modify the design process. By doing so, they not only participate in the material aspects of creation but also shape it, transforming their lived experiences into tangible design processes.

6.5.4 Designing for Group Dynamics, Bonding, Care, and The Collective Body:

Engaging in a game or an interactive experience can be more than an isolated endeavour; it should feel like being part of a tapestry of shared moments, collective understanding, and mutual care. This is particularly poignant in the context of disabled communities, where mutual support and shared experiences are often the linchpins of resilience. Designing for these dynamics underscores the need for holistic, inclusive experiences that are rooted in collective narratives and shared endeavours.

- Embracing Collective Care: In disabled communities, care isn't merely a personal act but a collective endeavour that binds members together. By designing experiences that emphasize collective care, we can create spaces where players not only engage with the game but also with each other in supportive, nurturing ways. This design ethos mirrors the interconnectedness and mutual support found in disabled communities, where local networks of care play a pivotal role.
- Fostering Collective Experiences: Reflecting upon the study outcomes, it is evident that shared experiences are a potent tool in game design. By crafting scenarios for multiple participants, the focus shifts from individual achievements to collective narratives. The joy derived from such experiences is multifaceted, rooted in mutual understanding, shared challenges, and collective victories.
- Strengthening Bonds through Shared Experiences: More than the mechanics or the storyline, it's the shared moments, the challenges overcome together, and the mutual celebrations that create lasting bonds. Designing with this in mind amplifies the strength of community ties, allowing players to resonate with the collective strength they share, much like the bonds solidified through shared experiences in local communities.
- Celebrating the Collective Body: Every individual brings a perspective and embodied knowledge. Yet, when they unite, they craft a collective, weaving individuals into a rich tapestry of group dynamics. The design could celebrate this collective body, recognizing its nuances and dynamics.

In sum, moving beyond solitary player perspectives and embracing the beauty of group dynamics, mutual care, and shared experiences designers could create gaming environments that mirror the strength, support, and bonds within disabled communities.

6.5.5 Crip Time Applied as Ethos:

The concept of crip temporality, as referenced in Chapter 5, commonly known as Crip Time, acknowledges and respects the varied paces at which disabled individuals move, work, and exist in the world, challenges the often relentless and exhaustive demands of modern work cultures. (Serlin and Hickman, 2019b) By integrating this concept into game design processes, there's a profound opportunity to reimagine and reshape how work is approached.

- Countering Crunch Culture: The gaming industry, notorious for its crunch culture where workers often experience gruelling hours and burnout, can greatly benefit from the ethos of Crip Time. By recognizing that productivity isn't about incessant work but about meaningful work, design processes can become more compassionate and effective.
- Acknowledging Varied Paces: Every individual has their own rhythm of working, and this rhythm can vary from day to day based on numerous factors, including health, mental state, and external pressures. Accepting and working with these rhythms, rather than against them, can lead to a healthier work environment and better end products.
- Rest as a Revolutionary Act: Prioritizing rest and acknowledging Crip Time inherently focuses on the holistic well-being of designers and developers. This promotes a culture of respect, understanding, and mutual care.

Incorporating the principles of Crip Time into the game design process is not just about changing work rhythms but about redefining what productivity and creativity mean. It's about ensuring that the process is as enriching and fulfilling as the outputs.

6.5.6 Understanding Born through Material Engagement

Beginning with a focus on materials and rapid prototyping, designers can delve into the myriad possibilities inherent to a particular set of sensors, shapes, or concepts. Prototyping serves as an avenue to explore these potentials, and tactile engagement can further enrich the understanding of a potential design. Such an approach which reconsiders the controller in relation to the game mechanics opens up possibilities for epistemic actions to be considered in the process. (Kirsh and Maglio, 1994)

6.6 Conclusion

In the unfolding realm of game design, the potential of a Crip Game Design Framework suggests a path toward deeper inclusivity. Rooted in the values and lived experiences of individuals with disabilities, this framework challenges traditional approaches, underscoring the invaluable insights that crip perspectives can offer in crafting comprehensive and impactful gaming experiences. With tenets that advocate for the early inclusion of disabled designers, validation of lived experiences, working in alignment with Crip Time, promoting care via collective experiences, and emphasizing material engagement, this framework signals a reconsideration of game design's prevailing paradigms. Moving beyond mere accessibility and functionality, it gestures towards a realm of empowerment and personal connection. Yet, it's essential to regard this proposed framework not as an absolute guide but as a fluid structure which, after examination, will be placed as a living document on GitHub where the community can influence and propose changes or offer feedback, adaptable and evolving with continued interaction and critique. Shifting from common design practices like those spoken about by Jade Hall Smith and Sightless Kombat where accessibility experts are hired at the end of a game’s design phase and limited only to assistive features to a more purposeful and anticipatory inclusion could not only enhance game accessibility but also potentially enrich the broader discourse on inclusivity within the gaming community.

7 Discussion

7.1 Reiteration of Research Questions

To initiate, this thesis explored pivotal questions, each striving for a comprehensive understanding of the Alt Ctrl game design and development process from the vantage point of a disabled practitioner's lived experience. Firstly, when a disabled creator reimagines game controllers, is it possible for them to envision alternatives to conventional console controllers? Secondly, which values and methods drive my creative process, and what outcomes do they produce?

To investigate these questions, I designed, prototyped, produced, and iterated the Alt Ctrl game *Bot Party* across four distinct versions of hardware. I built each version from scratch, including the development of a sensing system that detects touch interactions between players. As the game evolved and garnered positive feedback, I began to understand its transformative effect on my relationship with my disability. It provided an opportunity for me to engage in the industry in a way I had not experienced before. I crafted a game that levelled the playing field, allowing me to play alongside others in groups seamlessly. This process was both empowering and rewarding, kindling a sense of profound inclusivity within me.

Venturing beyond personal introspection, I sought to understand how other disabled artists and creators would conceptualize new forms when supported by an established Alt Ctrl developer. What principles would they prioritize, and how would they approach the development of new interfaces and games that transcend traditional control systems? The resulting study on Crip Game Design looked at three sets of creators exploring this process in their own way, each producing distinct values and themes, however, there were obvious overlaps that began to emerge as the study progressed. In the culmination of this inquiry, I juxtaposed my values and methods against those of other creators. This comparison laid the groundwork for a set of recommendations, hinting at a potential future Crip Game Design Framework. Such a guide could be invaluable for studios and designers aiming to craft deeply accessible games that embed the lived experiences of disabled designers verses the standard accepted practice of adding on assistive features at the end of a development cycle.

7.2 Interpretation of Findings

Disability is not an anomaly; it's an intrinsic aspect. Consider a tree – a tree that grows around obstacles or through urban streets. Would you label such a tree as disabled? Embracing the social model of disability suggests that society, not individual shortcomings, creates disabling conditions. Disabled individuals challenge prevailing norms, offering alternative ways to shape society. They become agents of change, advocating for inclusive pathways and possibilities that diverge from the norm.

The outcomes of this thesis challenge prevailing industry norms and have far-reaching ramifications. Conventional practice often treats assistive technology as an accessory, an afterthought. Yet, the four cases presented here demonstrate the profound contributions disabled designers can make when they're integrated into the initial design process. Their lived experiences can infuse design teams with invaluable insights during brainstorming and ideation stages.

The implications emerging from this thesis suggest a reimagining of playful experiences, toys, and games that recontextualize the hardware within the fabric of game mechanics, metaphors, and narratives in relation to community and care. Instead of being mere

utilitarian control mechanisms, these interfaces can seamlessly blend into the tapestry of daily life and interactions. A striking instance is *SYTHia*, the music-playing plush cat that fosters bonding between parents and unborn children. This project elevates technology to a deeply human role in players' lives. Another illustration is *The Kettle Network*, where the simple act of making tea morphs into a playful, metaphorical message to friends – transforming the smart home from mere utility to a realm of playful engagement with community.

Figure 79 The cat synth, SYNTHia showing the buttons, speaker and sensors embedded in the cat plushie.

The findings allude to potential tensions and disruptions that could arise from such a profound inclusion of disabled individuals within game studios. Conversations may transcend the realm of goals and mechanics, delving into the phenomenological implications of hardware itself. As Louise Hickman aptly phrased it, the question becomes, "What does it mean?" This points to a paradigm shift where game design becomes a vehicle for probing deeper questions about human experiences, accessibility, and the transformative power of reimagined interfaces.
Disabled game creators could also emphases collective bonding, strengthen face to face interactions, and encourage prosocial behaviour if the work within this thesis is any indication of what might come out of a larger study. All four games herein are multiplayer experiences.

One of the most compelling discoveries is the synchronization between development processes involving disabled designers and the concept of Crip Time. Consider the transformative potential if companies actively sought out disabled designers as part of a comprehensive diversity and inclusion initiative. The industry's culture would inevitably require a significant shift to accommodate their contributions. The pace of Crip Time could challenge and counter the rampant crunch culture that often plagues game studios. Imagine a scenario where industry professionals embraced sustainable work speeds – could this counteract the burnout and controversies that frequently emerge from AAA

studios? Notably, in 2018, employees at Rockstar were enduring 20-hour workdays, a situation that propelled discussions about unionization within the field to combat crunch culture ("Inside Rockstar Games' Culture of Crunch," 2018). Crip Time might emerge as a beacon of optimism, fostering a healthier and more sustainable work environment.

Material engagement through prototyping materials can revolutionize the way we perceive game design. The implications of the Krish and Maglio study, which employed Tetris to demonstrate how players think through the affordances of their interfaces, have yet to be fully integrated into game design. (Kirsh and Maglio, 1994) The potential of controllers to shape the actions they afford and subsequently influence a player's ability to solve a puzzle or complete a task offers a remarkable avenue for rethinking game design holistically. Tactile engagement opens doors for methods for Blind designers to participate in design processes, an aspect currently underexplored in the industry. Embodying play through the physical prototyping process can yield intriguing interaction models. This is evident in the case of *Bot Party*, where the interaction with an oscilloscope revealed new interactions which the entire game was designed around. Moreover, in the design phase, SK and Robin's engagement with a tube sparked a flurry of game ideas, highlighting the fertile ground that tactile engagement can create for innovative gameplay concepts.

7.3 Methodological Reflection

In this thesis, a blend of methodologies was adopted, enabling designers from the Crip Game Design study to incorporate their own approaches. Thematic analysis played a pivotal role in shaping my interpretation of the data herein. However, the use of NVivo as a software tool proved to be challenging in terms of accessibility. Engaging with it was both arduous and physically taxing. If given the chance to approach this thesis again, I would consider coding directly in Excel or another tool with superior accessibility features. One method I used that could have been employed more effectively is autoethnographic design. Had I maintained more comprehensive notes throughout my development cycles, I might have captured subtle nuances and insights beyond just technological observations. While my development blog largely centres on the technology and my learnings from it, it provides limited reflection on my personal experiences in engaging with the tools. Nevertheless, the process of prototyping and showcasing works in progress effectively broadened my understanding of the design space, reflecting the success of Smith and Dean’s Iterative Cyclical Web and my modifications to it by iterating between exhibition and practice.

Within the Crip Game Design study, Participatory Design emerged as a notably inclusive and equitable methodology when engaging with disabled communities. This approach ensured that participants not only had a meaningful voice but also received due recognition for their input and innovations in the research. Operating under the auspices of the UAL Challenge Lab allowed me to guarantee that all intellectual property generated during this study remained with the designers. Throughout the design process, tensions surfaced between traditional goal-based game design techniques and the methods required by disabled designers. However, these tensions fostered a rich exchange of insights and perspectives. Often, disabled designers would share their lived experiences, sparking discussions that culminated in new directions and design choices. If disabled designers gain broader inclusion across the industry, this study offers insights into how teams can evolve, bridge gaps, and establish mutual understanding.

7.4 Contribution to Knowledge and Practice

The obvious contributions to practice in this thesis are the game *Bot Party*, which had over

3000 players and was nominated for a GDC Award as well as winning the Goldsmith's Early Career Researcher award. The numerous exhibitions of this game were covered in the *Bot Party* chapter. The Crip Game Design study herein was streamed live on IndieCade's twitch channel and offers online documentation or any designer seeking to consider how disability could intersect with game controller deign. As well as these obvious contributions, it is the aim of this researcher to refigure this thesis into multiple papers and possibly a book over the coming year. Beyond the public impact, this process has enriched my own knowledge of disability and allowed me to share that experience with six other people via the study herein. **The contribution of this research is twofold, it is the creative work and the obvious impact in had on with players and the resulting proposed Crip Game Design Framework. This framework can now be used by other designers as a guiding set of concepts to include when creating a Crip Games.**

7.5 Limitations of My Study

This research is not without its inherent limitations. The most evident of these is the scale. Presumably richer perspectives will continue to emerge if I continue to do work closely with people with very different disabilities and life experiences and goals. This would provide opportunities to refine the design framework. Also, the research around my own creative work was centred on four iterations of a single title for rigorous and comprehensive exploration over an extended period. Such a concentrated approach allowed for a depth of understanding, but it also inadvertently limited the breadth of my investigation.

At the project's inception, there was a spark of interest in a secondary haptic-only game prototype. This prototype presented a fascinating tangent, potentially offering insights into alternative game experiences and interactions. However, as *Bot Party* began to gain traction and its success overshadowed other projects, resources, energy, and time were reallocated to its development. Consequently, the secondary prototype was shelved. Exploring multiple avenues concurrently might have provided a richer, more multifaceted perspective. Yet, the popularity of *Bot Party* naturally demanded priority and became the focal point of my investigation.

The Crip Game Controller study, while insightful in its current form, could arguably benefit from a more expansive sample size. A larger, more diverse participant pool might unearth a broader spectrum of experiences, challenges, and potential solutions, thereby leading to different, possibly more applicable outcomes and recommendations. The current sample size, while significant in the depth of engagement, may not capture the entire breadth of experiences within the disabled gaming community.

Further, real-world application and validation this possible theoretical framework could offer invaluable feedback and insights. Partnering with an established game studio, willing to operationalize and test the proposed framework, would have provided a unique vantage point. Such a partnership would not only assess the framework's viability but also evaluate its practical implications, challenges, and benefits within a live game development environment. And while this research suggests a realm of rich possibilities in game design, we must also acknowledge the often-harsh realities of the industry. Budget constraints, shifting market demands, and resource allocation are pragmatic factors that can influence the adoption and success of any new framework or methodology.

7.6 Implications for Future Practice

The conclusions drawn from this thesis naturally pave the way for a myriad of potential explorations and evolutions in the world of game design. Primarily, two overarching paths beckon: the advancement of *Bot Party* and other games through subsequent iterations and

feedback, and the initiation of a comprehensive study embedded within a game studio, leveraging the insights from the proposed future framework to inform and develop it into an actual working method.

Bot Party is about to enter fourth iteration, labelled *Bot Party* v4, the SK version. Currently in its nascent stages, a haptic expansion of the game presents interesting possibilities. As of August 2023, the circuit boards have been manufactured and returned, and are ready for assembly and exploration. This synthesis might culminate in the creation of a unique hybrid controller—a fusion of SK's tube concept and the *Bot Party* design. Such an amalgamation, previously discussed between SK and me, could result in a new game.

Moreover, an alternative rendition of *Bot Party* remains relatively uncharted. A scaled-up interface was tested during an open day for Now Play This in 2019. Although this large-scale adaptation did not progress beyond its initial test phase and is not explored in the main body of the thesis, it holds promise for diverse application areas. A collaboration that I currently find intriguing is with a gallery in Leeds. The envisioned project involves the use of shipping containers as game controllers. As players connect these containers, they can potentially influence and sculpt the auditory and visual experiences inside—effectively turning static structures into dynamic sensory platforms.

In the backdrop of all these developments, there’s the *Thrum* prototype, shelved due to the success of *Bot Party*. What haptic-only interactions can be crafted, especially when engaging groups of players? Looking into such realms could uncover new perspectives and game mechanics. Haptic patterns in relation to robotic physical motion are something that I would very much like to explore in future games.

8 Summary

The research embarked upon in this thesis delves into the intricate domain of game controllers, crip technology, and game design. The literature review methodically examines the converging fields pertinent to the research's focal points.

Initially, the thesis scrutinizes the historical relationship between game controllers and Human-Computer Interaction (HCI), exploring the consequent impact on disability. This investigation also addresses the prevalent trope of the "technological cure" within the scope of HCI. Shifting the lens to User-Centered Design (UCD), the research delineates its evolution in the context of console game controller design. Given UCD's evident shortcomings in producing universally accessible controllers, the research pivots to community-derived solutions, spotlighting initiatives such as The Controller Project.

A deeper dive is taken into the inherent limitations posed by mental models in console controllers. Drawing from crip literature, particularly the works of writer Leduc, the research critically assesses UCD, likening it to a design fairy tale.(Leduc, 2020) This exploration further demystifies the often-misunderstood concept of affordance in UCD, reverting to Gibson's original definition, which more comprehensively accommodates the disabled experience.(Gibson, 1979)

Liz Jackson's revelations on the pitfalls of design thinking and its tendency to produce superficially appealing yet fundamentally flawed disability solutions, such as the feel-good disability dongle, are critically examined. In response, the research foregrounds intersectional feminist and disabled perspectives, revealing fresh insights into the convergence of technology and disability. Sherry Turkle's pioneering work in robotics is harnessed to propose a novel perspective, positing malfunctioning, or unpredictably behaving robots as embodying disabled characteristics. This theory segues into a broader discourse on robots as caregivers and the depiction of disabled individuals as cyborgs. Challenging these conceptions, the thesis introduces the concept of the cripborg, underscoring the essentiality of community, solidarity, and care over mere technological dependence in the crip community.

The narrative then pivots to the transformative feats of crip hackers, prompting the reader to envision a future where such innovation is applied to game controllers. Delving into HCI, the thesis explores the notions of Embodiment and Entanglement with Crip HCI, questioning the feasibility of introducing activist affordances in controllers. This inquiry culminates in an analysis of Alt Ctrl games, assessing their potential to harmonize with procedural rhetoric, metaphor, and activism in the gaming realm.

The thesis moves on to the case study game, *Bot Party*. Throughout its evolutionary journey, it has undergone pivotal transformations, each iteration enhancing its interaction dynamics and reinforcing its commitment to inclusivity. Beginning with *Baby Bot*, the analogue synthesiser prototype acted as a foundational model, setting the stage for more intricate, value-driven versions by obtaining invaluable feedback. Its successor, *Bot Party (Prototype Two)*, embraced added depth, taking sonic cues from its precursor, and conceptualizing them as metaphors for human connectivity. As the iterations continued, the design integrated touch-centric mechanics with open-ended auditory experiences, exemplified in *Bot Party (Prototype Three)*.

The collaboration with a disabled player, Sightless Kombat, marked a watershed moment in the game's evolution, birthing the *Bot Party: Sightless Kombat Version*. This version emphasized tactile interactions, incorporating haptic motors to diversify player experiences beyond the visual realm. This innovation, combined with hardware advancements and a switch to 3D-printed bots, ensured a more accessible and efficient design.

Bot Party stands as a testament to the potential of digital games to foster positive human interactions, valuing the experiences of disabled designers and players, and elicits joy

through embodied play. Its design trajectory, heavily influenced by player feedback and rigorous playtesting, encapsulates the essence of bespoke Alt Ctrl gaming. As *Bot Party* ventures into future design explorations, it underscores the indispensable role such games play in the broader gaming ecosystem, emphasizing touch, wellbeing, and embodied play.

The next study compares my design process of creating *Bot Party* with the process of other disabled designers. Through an inclusive and participatory approach, collaborations between accessibility experts with personal experiences of disability and Alt Ctrl Game designers were observed. These collaborative efforts ranged from Sightless Kombat and Robin Baumgarten's intensive workshop that resulted in a versatile gaming tube, to Jade Hall Smith and Julia Makivic's creation of SYTHia, a plush cat designed for prenatal bonding, and finally, to Louise Hickman and Alistair Aitchenson's 'The Kettle Network', which conceptualized tea-making as a communal online activity.

Each collaboration, while unique in its objectives, exhibited mutual respect, an open exchange of ideas, and a shared commitment to inclusivity. The collaborations underscored the power of embodied experiences and the influence of personal encounters with disability on design teams. The Alt Ctrl Game Designers, meanwhile, brought a foundation rooted in material research, showcasing their adaptability and willingness to share their perspectives to move design conversations forward.

Central to the study's findings was the emphasis on individual lived experiences as a form of design expertise that could transform ideas around accessibility. There was a recurring theme of addressing assistive technology's limitations while focusing on crafting adaptable interfaces. Despite moments of contention arising from the clash of traditional design paradigms and the realities of disability, collaborative achievements were reached through open dialogue, hands-on prototype engagement, and mutual understanding. The projects weren't just about individual empowerment; they championed community bonds, underscoring the value of collective experiences.

The final contribution in this document is a set of possible considerations that could be valuable for a design crip game design framework. The emerging concept of a Crip Game Design Framework offers a transformative perspective on inclusivity in the game design domain. Grounded in the authentic experiences of disabled individuals, it reimagines traditional game design paradigms by emphasizing early integration of disabled designers, valuing lived experiences, adhering to Crip Time as an answer to crunch culture, championing collective experiences, and prioritizing hands-on material engagement. However, it's vital to view it as a flexible, evolving untested and emerging guide, adapting in response to ongoing dialogue and critique. By transitioning from the conventional approach of incorporating accessibility experts only towards a project's conclusion to a proactive, holistic inclusion, the framework has the potential not just to elevate game design but also to broaden the conversation around inclusivity in the gaming world. The hopeful next step in this research is to study the impact of these proposals within the context of a game studio to iterate it as a crip game design methodology.

Through this research, it’s clear there is a significant gap in the prevailing game design methodologies. Traditional paradigms often relegate assistive technology and the perspectives of disabled designers to consultants brough in after the design work is finished to consider assistive features. In contrast, inn this research the untapped possibilities and profound contributions of integrating disabled designers from a project's inception became palpably evident. Not only do their insights enrich the design process during ideation, but they also offer a pathway to reimagine game hardware, melding it seamlessly with game narratives and mechanics. Yet, while the potential is vast, this research is not without its limitations. The representativeness of the sample in the Crip Game Controller study could also be broadened to capture a more diverse spectrum of the

disabled gaming community. Nonetheless, the very limitations point towards exciting future avenues of investigation.

Looking ahead, further iterations and innovations with *Bot Party* could explore haptic interactions and perhaps merge with SK's tube controller design to become another Alt Ctrl game. Other prospective explorations, such as the revival of the *Thrum* prototype, hint at untapped territories in haptic-only interactions. This research, with its blend of challenges and discoveries, signifies not just an end, but a springboard into a future brimming with opportunities new games.

9 Personal Reflections and Final Thoughts

In drawing this thesis to a close, it’s imperative to articulate the profound ableism I've confronted throughout this journey. The challenges ranged from having a designated lab set up in a manner that was explicitly hostile to my disability, to university staff undermining the legitimacy of my condition, categorizing it as “self-ascribed” even in the face of formal NHS documentation that confirms my genetically inherited condition.

To understand the broader landscape of this struggle, consider the Higher Education Statistics Agency’s revealing data: only 0.9% of academic staff identify as disabled. In contrast, the disability status of a significant 11% remains undisclosed (Higher Education Statistics Agency, 2022). Such statistics gain gravity when one juxtaposes them against the fact that roughly 16% of PhD students declare a disability (HESA, 2022). The discrepancy hints at a disconcerting reality: a discernible decline in the declaration or acknowledgment of disability as students transition to staff roles within academic institutions.

My position as a senior member of the academic staff is, against such odds, nothing short of a marvel. Those of us who have openly declared our disabilities in this sphere are so rare that we might as well be mythological entities. We are outliers, on the brink of invisibility. This stark underrepresentation raises a critical concern: is most funding allocated for disability research in Higher Education being channelled predominantly to abled researchers?

Confronting this issue head-on, I am currently drafting a funding proposal to establish a comprehensive UK alliance in Higher Education, dedicated to addressing this pressing challenge. It signifies the future trajectory of my research. The academia sector, riddled with inherent biases, persistently sought to undermine the fruition of my work. Yet, during these systemic hurdles, I discovered pockets of support: non-profit labs and a handful of academic allies within my institution who genuinely believe in the potential for change.

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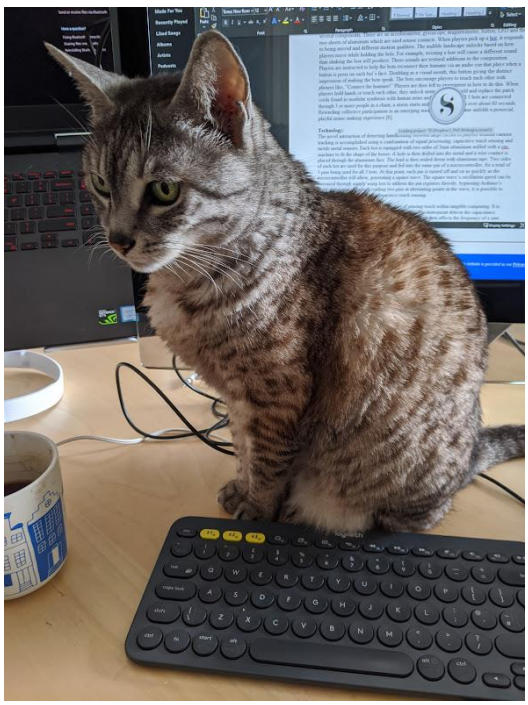

Figure 80 Tiny supervising my initial Bot Party writing.

Bibliography

♡ – çÿbẹȓ̃twẽȇ, n.d. URL http://cybertwee.net/ (accessed 6.8.23).
ABOUT – IndieCade [WWW Document], 2023. URL https://www.indiecade.com/about/ (accessed 6.20.23).
AGH Museum -- Mindlink [WWW Document], 2023. URL http://www.atarihq.com/museum/2678/mindlink.html (accessed 9.28.23).
Ahmed, S., 2021. Complaint! https://doi.org/10.1215/9781478022336
ALT CTRL Game Jam, NYU Poly, Oct 19-21 | Make: [WWW Document], 2012. . Make DIY Proj. Ideas Mak. URL https://makezine.com/2012/10/13/alt-ctrl-game-jam-nyu-poly-oct-19-21/ (accessed 9.19.20).
Anamnesia, 2010. Jeff Minter mini-documentary.
Ansari, A., 2017. Politics & Method. Medium. URL https://aansari86.medium.com/politics-method-cd4cc2c8f5e6 (accessed 4.21.23).
Arcangel, C., 2002. Super Mario Clouds [WWW Document]. Cory Arcangels Off. Portf. Website Portal. URL http://coryarcangel.com/things-i-made/2002-001-super-mario-clouds/ (accessed 9.19.20).
Avedon, E.M., Sutton-Smith, B., 2015. The Study of Games. Ishi Press International.
Banzi, M., 2014. Getting started with Arduino, 3rd edition.. ed. Sebastopol, Calif: Maker Media.
Bardzell, S., 2010. Feminist HCI: Taking Stock and Outlining an Agenda for Design. Presented at the CHI 2010: HCI For All, Atlanta, GA, pp. 1301–1310.
Baumgarten, R., 2020. Wobble Sphere [WWW Document]. Robin Baumgartens Game Exp. URL https://wobblylabs.com/projects/wobblesphere (accessed 9.15.20).
Beyond Screens - Alt+Ctrl: Criptastic Hacking and Video Game Controllers, 2022.
bielskyte, monika, 2023. PROTOPIA FUTURES [FRAMEWORK]. Protopia Futur. URL https://medium.com/protopia-futures/protopia-futures-framework-f3c2a5d09a1e (accessed 4.26.23).
Blikstein, P., 2013. Digital fabrication and ‘making’in education: The democratization of invention. FabLabs Mach. Mak. Invent. 1–21.
Blue Ribbon Winners [WWW Document], 2011. . Mak. Faire. URL https://dev.makerfaire.com/blue-ribbon/ (accessed 9.19.20).
Bogost, I., 2010. Persuasive games: the expressive power of videogames. MIT Press, Cambridge, Mass.
Booth-Malnack, K., n.d. The Biological Basis of Nervous Tissue Repetitive Strain Injuries in eSports Competitors 44.
Brown, T., 2008. Design Thinking. Harv. Bus. Rev.
Burnham, Van., Baer, R.H., 2001. Supercade : a visual history of the videogame age, 1971-1984. MIT Press.
By, 2022. Why You’ve Never Heard About Nintendo’s U-Force. Hackaday. URL https://hackaday.com/2022/09/05/why-youve-never-heard-about-nintendos-u-force/ (accessed 9.28.23).
Caillois, R., 2001. Man, play, and games. University of Illinois Press, Urbana.
Carney, D.R., Cuddy, A.J.C., Yap, A.J., 2010. Power Posing: Brief Nonverbal Displays Affect Neuroendocrine Levels and Risk Tolerance. Psychol. Sci. 21, 1363–1368. https://doi.org/10.1177/0956797610383437
Castle, K., 2023. Toasters, pulleys, wheels and giant hats: the coolest Alt Ctrl games at GDC 2023. Rock Pap. Shotgun.
Center for Universal Design, n.d. Center for Universal Design NCSU - About the Center - Ronald L. Mace [WWW Document]. URL https://projects.ncsu.edu/ncsu/design/cud/about_us/usronmace.htm (accessed 9.16.20).
Chang, V., 2022. CripTech Incubator [WWW Document]. LeonardoISASTwith Ariz. State Univ. URL https://leonardo.info/program/criptech-incubator (accessed 6.15.23).

Code Liberation Foundation, 2019. The Code Liberation Foundation [WWW Document]. Eventbrite. URL https://www.eventbrite.com/org/4653154663?ref=eofblike (accessed 12.17.19).
Console Games Genre Trends In The Last 5 Years, 2021. . Gameopedia. URL https://www.gameopedia.com/genre-trends-in-console-games-in-last-five-years/ (accessed 5.19.23).
Cory Arcangel | Super Mario Clouds [WWW Document], 2020. URL https://whitney.org/collection/works/20588 (accessed 9.11.20).
Costanza-Chock, S., 2020. Design justice: Community-led practices to build the worlds we need, Information Policy Ser. MIT Press, Cambridge.
Criado-Perez, C., 2019. Invisible women: exposing data bias in a world designed for men. Chatto & Windus, London.
Cuboniks, L., 2015. Xenofeminism: A Politics for Alienation | Laboria Cuboniks [WWW Document]. URL https://laboriacuboniks.net/manifesto/xenofeminism-a-politics-for-alienation/ (accessed 6.8.23).
Cyberfeminism Index [WWW Document], n.d. URL https://cyberfeminismindex.com/ (accessed 6.13.23).
Dam, R.F., Siang, T.Y., 2022. What is Design Thinking and Why Is It So Popular? [WWW Document]. Interact. Des. Found. URL https://www.interaction-design.org/literature/article/what-is-design-thinking-and-why-is-it-so-popular (accessed 4.21.23).
Dare, E., 2020. Teaching Machines: platforms, pedagogies and the wicked problem of design thinking. Post-Pandemic Univ. URL https://postpandemicuniversity.net/2020/07/29/teaching-machines-platforms-pedagogies-and-the-wicked-problem-of-design-thinking/ (accessed 4.21.23).
Davison, F., 2022. The QuadStick Story [WWW Document]. QuadStick. URL https://www.quadstick.com/our-story (accessed 6.6.22).
designboom, martin hislop I., 2017. the scewo electric wheelchair can climb stairs independently [WWW Document]. Des. Archit. Des. Mag. URL https://www.designboom.com/technology/scewo-electric-wheelchair-climb-stairs-independently-03-28-2017/ (accessed 9.28.23).
Dinkins, S., 2014. Conversations with Bina48 [WWW Document]. STEPHANIE DINKINS. URL https://www.stephaniedinkins.com/conversations-with-bina48.html (accessed 6.16.23).
Dix, A., 2004. Human-computer interaction, 3rd ed.. ed. Pearson/Prentice-Hall, Harlow.
Dokumaci, A., 2023. Activist Affordances: How Disabled People Improvise More Habitable Worlds. Duke University Press.
Finkelstein, V., 2007. The 'Social Model of Disability' and the Disability Movement. Disabil. Stud. Arch. UK 1, 15.
Fitts, P.M., Jones, R.E., 1947. Analysis of Factors Contributing to 460 "pilot-error" Experiences in Operating Aircraft Controls. Army Air Forces Headquarters, Air Material Command, Engineering Division.
Flanagan, M., Howe, D.C., Nissenbaum, H., 2005. Values at play: design tradeoffs in socially-oriented game design, in: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, CHI '05. Association for Computing Machinery, New York, NY, USA, pp. 751–760. https://doi.org/10.1145/1054972.1055076
Foddy, B., IndieCade, 2014a. Indiecade East 2014: State of the Union - Bennett Foddy (Keynote).
Foddy, B., IndieCade, 2014b. Indiecade East 2014: State of the Union - Bennett Foddy (Keynote).
Form8 Records, 2002. Air Portual Show [WWW Document]. URL https://www.form8.com/gallery/index.html (accessed 6.2.23).
Frauenberger, C., 2020. Entanglement HCI The Next Wave? ACM Trans. Comput.-Hum. Interact. 27, 1–27. https://doi.org/10.1145/3364998
Frauenberger, C., 2019. Entanglement HCI The Next Wave? ACM Trans. Comput.-Hum. Interact. 27, 2:1-2:27. https://doi.org/10.1145/3364998

Gamasutra - Atari: The Golden Years -- A History, 1978-1981 [WWW Document], 2020. URL https://www.gamasutra.com/view/feature/132160/atari_the_golden_years__a_.php?print=1 (accessed 9.10.20).
Gibson, J.J. (James J., 1979. The ecological approach to visual perception. Houghton Mifflin, Dallas ; London.
Gibson, Kathleen R., Gibson, Kathleen Rita, Ingold, T., 1993. Tools, Language and Cognition in Human Evolution. Cambridge University Press.
Hamraie, A., Fritsch, K., 2019. Crip Technoscience Manifesto. Catal. Fem. Theory Technoscience 5, 1–33. https://doi.org/10.28968/cftt.v5i1.29607
Harraway, D., 1985. A Cyborg Manifesto: Science, Technology, and SocialistFeminism in the Late Twentieth Century. New York; Routledge.
Hayles, N.K., 2017. Unthought: the power of the cognitive nonconscious. The University of Chicago Press, Chicago.
Hello Robot [WWW Document], 2021. . Hello Robot. URL https://hello-robot.com/about (accessed 11.22.21).
Hendren, S., 2020. What can a body do? how we meet the built world. Riverhead Books, New York.
Hickman, L., 2020. The Avery Review | "On the Basis of Safety": The Forced Intimacies of Accessible Air Travel [WWW Document]. URL https://www.averyreview.com/issues/48/on-the-basis-of-safety (accessed 6.16.23).
Hihara, S., Notoya, T., Tanaka, M., Ichinose, S., Ojima, H., Obayashi, S., Fujii, N., Iriki, A., 2006. Extension of corticocortical afferents into the anterior bank of the intraparietal sulcus by tool-use training in adult monkeys. Neuropsychologia, Visuomotor Functions of the Posterior Parietal Cortex 44, 2636–2646. https://doi.org/10.1016/j.neuropsychologia.2005.11.020
Hogeveen, E., 2017. Feminisms of the Future, Now: Rethinking Technofeminism and the Manifesto Form. C Int. Contemp. Art 20–27.
Horn, G.V., Kimmerer, R.W., Hausdoerffer, J., 2021. Kinship: Belonging in a World of Relations, Vol. 1 - Planet. Center for Humans and Nature.
Huizinga, J., 2016. Homo ludens : a study of the play-element in culture.
Human Centered Design: Toolkit, 2011. . IDEO.
Hunicke, R., LeBlanc, M., Zubek, R., 2004. MDA: A Formal Approach to Game Design and Game Research. January 2004.
Incubate Arcade 2016, 2016. . Zo-Ii - Play. Cult. Games. URL https://www.zo-ii.com/project/incubate-arcade-2016/ (accessed 9.20.20).
Jackson, L., Haggard, Alex, Williams, Rua, 2022. Disability Dongle | Platypus. Disaiblity Dongle. URL https://blog.castac.org/2022/04/disability-dongle/ (accessed 10.18.22).
Johann Sebastian Joust [WWW Document], 2020. URL http://jsjoust.com/ (accessed 9.19.20).
Johnson, M.L., McRuer, R., 2014. Cripistemologies: Introduction. J. Lit. Cult. Disabil. Stud. 8, 127–147.
Kafer, A., 2013. Feminist Queer Crip. Indiana University Press.
Kean, S., Hall, J., Perry, P., 2011. Meet the Kinect: An Introduction to Programming Natural User Interfaces. https://doi.org/10.1007/978-1-4302-3889-8
Kirsh, D., Maglio, P., 1994. On Distinguishing Epistemic from Pragmatic Action. Cogn. Sci. 18, 513–549.
Konix Multi-System Archive, 2019. Slipstream: The Konix Multi-system Archive.
Kraft, C., 2022. About – The Controller Project. URL https://thecontrollerproject.com/about/ (accessed 6.6.22).
Kultima, A., Sandovar, A., 2016. Game design values, in: Proceedings of the 20th International Academic Mindtrek Conference, AcademicMindtrek '16. Association for Computing Machinery, New York, NY, USA, pp. 350–357. https://doi.org/10.1145/2994310.2994362
Lakoff, G., 2003. Metaphors we live by. University of Chicago Press, Chicago.
Leduc, A., 2020. Disfigured: On Fairy Tales, Disability, and Making Space. Coach House Books, Toronto, CANADA.

Lees, M., 2016. What Gamergate should have taught us about the “alt-right” [WWW Document]. the Guardian. URL http://www.theguardian.com/technology/2016/dec/01/gamergate-alt-right-hate-trump (accessed 9.20.20).
Logitech G920 & G29 Driving Force Racing Wheel - UK [WWW Document], 2022. URL https://www.logitechg.com/en-gb/products/driving/driving-force-racing-wheel.html (accessed 6.6.22).
Maker Movement | Deloitte US | Center for the Edge [WWW Document], 2016. . Deloitte U. S. URL http://www2.deloitte.com/us/en/pages/center-for-the-edge/topics/maker-movement.html (accessed 7.5.16).
Malafouris, L., 2013. How Things Shape the Mind. MIT Press.
Maturana, H., 2002. Autopoiesis, Structural Coupling and Cognition: A history of these and other notions in the biology of cognition. Cybern. Hum. Knowing 9, 5–34.
McGee, C., 2021. The Ergonomics of Esports, in: Migliore, L., McGee, C., Moore, M.N. (Eds.), Handbook of Esports Medicine: Clinical Aspects of Competitive Video Gaming. Springer International Publishing, Cham, pp. 151–165. https://doi.org/10.1007/978-3-030-73610-1_5
McLuhan, M., 2008. The Medium Is The Message, in: Communication Theory. Routledge.
McRuer, R., 2006. Crip Theory: Cultural Signs of Queerness and Disability. NYU Press.
Mignolo, W.D., 2007. Introduction. Cult. Stud. 21, 155–167. https://doi.org/10.1080/09502380601162498
Mills, M., 2020. Mara Mills talks to Sara Hendren about design and disability [WWW Document]. URL https://www.artforum.com/books/mara-mills-talks-to-sara-hendren-about-design-and-disability-84333 (accessed 4.24.23).
Mills, M., Sanchez, R., 2023. Crip Authorship: Disability as Method. NYU Press.
Moore, S.L., Tillberg-Webb, H.K., 2023. Ethics and Educational Technology: Reflection, Interrogation, and Design as a Framework for Practice. Taylor & Francis.
Morawe, V., Reiff, T., 2004. //////////fur//// art entertainment interfaces | PainStation 2.5 [WWW Document]. URL https://www.fursr.com/projects/painstation-2-5 (accessed 9.28.23).
Morozov, E., 2014. To Save Everything, Click Here: The Folly of Technological Solutionism. PublicAffairs.
Murray, J.H., 2017. Hamlet on the holodeck: the future of narrative in cyberspace, Updated edition.. ed. MIT Press, Cambridge, Massachusetts.
Myers, J., 2002. Air Portugal. Frieze.
Norman, D.A., 1988a. The Design of Everyday things. Basic Books, New York.
Norman, D.A., 1988b. The Design of Everyday things. Basic Books, New York.
Norman, D.A., Draper, S.W., 1986. User Centered System Design; New Perspectives on Human-Computer Interaction. L. Erlbaum Associates Inc., USA.
Oliver, M., 1996. The Social Model in Context, in: Oliver, M. (Ed.), Understanding Disability: From Theory to Practice. Macmillan Education UK, London, pp. 30–42. https://doi.org/10.1007/978-1-349-24269-6_4
Open Frameworks, 2023. about | openFrameworks [WWW Document]. URL https://openframeworks.cc/about/ (accessed 6.16.23).
Pagulayan, R., Keeker, K., Wixon, D., Romero, R., Fuller, T., 2003. User-Centered Design in Games. Hum.-Comput. Interact Handb 883–906. https://doi.org/10.1201/b11963-39
People’s History Museum, P.B.R.-, 2018. Suffragette tea set on display at People’s History Museum. Peoples Hist. Mus. URL https://phm.org.uk/blogposts/suffragette-tea-set-on-display-at-peoples-history-museum/ (accessed 8.22.23).
Perfect Woman, 2020. . UCLA Game Lab. URL http://games.ucla.edu/game/perfect-woman (accessed 9.11.20).
Perry, P., Fox-Gieg, N., 2011. Nightmare Kitty.
Phoenix Perry - |Embodied play design and building a female developer community" - Open Hardware Summit 2013, 2013.
Picard, R.W., 2000. Affective computing, First paperback edition. ed. The MIT Press, Cambridge, Massachusetts London.

Pullin, G., Cook, A., 2010. Six speaking chairs (not directly) for people who cannot speak. Interactions 17, 38–42. https://doi.org/10.1145/1836216.1836226
Quijano, A., Ennis, M., 2000. Coloniality of Power, Eurocentrism, and Latin America. Nepantla Views South 1, 533–580.
Ravishankar, R.A., 2020. Why You Need to Stop Using These Words and Phrases. Harv. Bus. Rev.
Reeves, B., 2018. How Flash Games Changed Video Game History [WWW Document]. Game Inf. URL https://www.gameinformer.com/2018/12/22/how-flash-games-changed-video-game-history (accessed 6.16.23).
Rusch, D.C., 2017. Making deep games: designing games with meaning and purpose. CRC Press, Taylor & Francis Group, Boca Raton, FL.
Russell, M., 2019. Capitalism and Disability: Selected Writings by Marta Russell. Haymarket Books.
Salen, K., Zimmerman, E., 2003. Rules of Play: Game Design Fundamentals. The MIT Press.
Samba de Amigo Maracas Controller [WWW Document], 2023. . Sega Retro. URL https://segaretro.org/Samba_de_Amigo_Maracas_Controller (accessed 9.28.23).
Samuels, E., 2017. Six Ways of Looking at Crip Time. Disabil. Stud. Q. 37. https://doi.org/10.18061/dsq.v37i3.5824
Sandahl, C., 2003. Queering the Crip or Cripping the Queer?: Intersections of Queer and Crip Identities in Solo Autobiographical Performance. GLQ J. Lesbian Gay Stud. 9, 25–56.
Schönfelder, L., Lu, P., 2014. Perfect Woman | ZKM [WWW Document]. URL https://zkm.de/en/perfect-woman (accessed 9.28.23).
Scott, J., 2014. A dictionary of sociology., Oxford dictionary of sociology, Fourth edition / edited by John Scott; previous editions also edited by Gordon Marshall.. ed, Oxford paperback reference. Oxford University Press, Oxford, United Kingdom.
Serlin, D., Hickman, L., 2019a. Toward a Crip Methodology for Critical Disability Studies. Interdiscip. Approaches Disabil. Look. Future Ed Katie Ellis Rosemarie Garland-Thomson Mike Kent Rachel Robertson Routledge.
Serlin, D., Hickman, L., 2019b. Toward a Crip Methodology for Critical Disability Studies. Interdiscip. Approaches Disabil. Look. Future Ed Katie Ellis Rosemarie Garland-Thomson Mike Kent Rachel Robertson Routledge.
Smith, H., Dean, R.T., 2009. Practice-led Research, Research-led Practice in the Creative Arts. Edinburgh University Press.
Smith, N., 2022. A new Israeli tank features Xbox controllers, AI honed by ‘StarCraft II’ and ‘Doom.’ Wash. Post.
sparkfun/MaKeyMaKey, 2018.
Spektor, F., Fox, S., 2020. The ‘Working Body’: Interrogating and Reimagining the Productivist Impulses of Transhumanism through Crip-Centered Speculative Design. Somatechnics 10, 327–354. https://doi.org/10.3366/soma.2020.0326
Swink, S., 2008. Game Feel: A Game Designer’s Guide to Virtual Sensation, Morgan Kaufmann game design books. Taylor & Francis Ltd.
The artwork formerly known as PainStation [WWW Document], 2020. URL http://www.painstation.de/history.html (accessed 9.19.20).
The British Design Council, 2021. History of the Double Diamond - Design Council [WWW Document]. URL https://www.designcouncil.org.uk/our-resources/the-double-diamond/history-of-the-double-diamond/ (accessed 6.15.23).
The Double Diamond - Design Council [WWW Document], n.d. URL https://www.designcouncil.org.uk/our-resources/the-double-diamond/ (accessed 6.15.23).
The Games of Jane Friedhoff and Phoenix Perry [WWW Document], 2014. . NYU Game Cent. URL https://gamecenter.nyu.edu/event/the-games-of-jane-friedhoff-and-phoenix-perry/ (accessed 6.13.23).
The Incredible Playable Show [WWW Document], 2020. URL https://playable.show/ (accessed 9.20.20).

The US military will fight the next big war with Xbox-style video game controllers, 2023. . Task Purp. URL https://taskandpurpose.com/tech-tactics/us-military-video-game-controllers-war/ (accessed 4.17.23).
Thompson, C., 2021. How Processing And P5 Got Newbies Into Coding. Medium. URL https://clivethompson.medium.com/how-processing-and-p5-got-newbies-into-coding-dd3853a7adb (accessed 6.16.23).
Trammell, A., 2023. Repairing Play: A Black Phenomenology. MIT Press.
Trusspublished, S., 2023. Quick Tips: What is control voltage and how does it work? [WWW Document]. MusicRadar. URL https://www.musicradar.com/how-to/quick-tips-control-voltage (accessed 7.11.23).
Turkle, S., 2011. Alone Together: Why We Expect More from Technology and Less from Each Other. ReadHowYouWant.com.
Uvnäs-Moberg, K., Handlin, L., Petersson, M., 2015. Self-soothing behaviors with particular reference to oxytocin release induced by non-noxious sensory stimulation. Front. Psychol. 5.
Victoria and Albert Museum, D.M. webmaster@vam ac uk, 2014. Disobedient Objects: About the Exhibition [WWW Document]. URL http://www.vam.ac.uk/content/exhibitions/disobedient-objects/disobedient-objects-about-the-exhibition/ (accessed 8.22.23).
Viktoria Modesta - Prototype, 2014.
Weise, J., 2020. Common Cyborg, in: Disability Visibility. Knopf Doubleday Publishing Group, Knopf Doubleday Publishing Group, pp. 64–73.
Whiteford, N., 2016. Oh Baby, Baby10 – Build A Classic Analog Music Sequencer. Hackaday. URL https://hackaday.com/2016/01/14/oh-baby-baby10-build-a-classic-analog-music-sequencer/ (accessed 9.20.20).
Wilson, D., Sicart, M., 2010. Now it's personal: on abusive game design, in: Proceedings of the International Academic Conference on the Future of Game Design and Technology, Futureplay '10. Association for Computing Machinery, New York, NY, USA, pp. 40–47. https://doi.org/10.1145/1920778.1920785
Yankelevitz, K., 2011. Quad Control | Adaptive Devices for Independent Living and Recreation [WWW Document]. URL https://web.archive.org/web/20160808223116/http://quadcontrol.com/ (accessed 6.6.22).
Yergeau, M., 2012. Disability Hacktivism [WWW Document]. Hacking Classr. Eight Perspect. URL http://www2.bgsu.edu/departments/english/cconline/hacking/#yergeau (accessed 11.21.22).

Full Technology Disclaimer

This thesis was written entirely by this researcher, but I do want to disclose I used six forms of AI when editing and revising for grammar and revision of sentence structures. These include Dragon Dictate, Grammarly, ChatGPT, Whisper.ai, Otter.ai, and Word's own inbuilt grammar AI tools interchangeably. That said, no content herein is generated from prompts other than this one, "Revise this text and maintain citations." Or simply, "Revise." My process included pasting my original writing into the LLM then seeing what it would return. Occasionally, it was useful and would help me consider ways I could improve the readability but more frequently it not helpful on its own, but it would give me a litmus test of what I could improve structurally. Grammarly was used in a very similar manor to revise and restructure my sentences.

Here is an example:

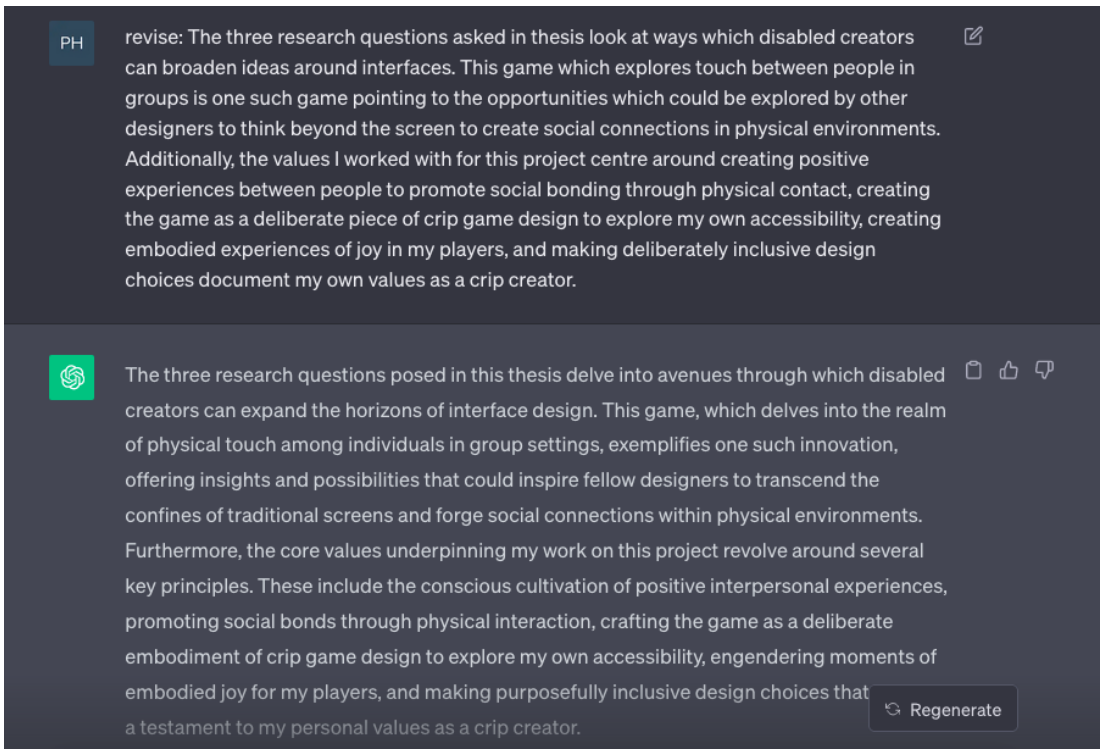

Figure 81 ChatGPT example

Here it what ultimately found its way into this thesis as my revised paragraph:

> The three research questions posed in this thesis consider the values and design methods disabled creators use to move towards a crip game design framework. This game, which delves into the realm of physical touch among individuals in group settings, exemplifies one such set of values, offering insights and possibilities that could inspire fellow designers to transcend the confines of traditional screens and forge social connections within physical environments through creating game specific systems. Furthermore, the core values underpinning my work on this project revolve around several key principles. These include the conscious cultivation of positive interpersonal experiences, promoting social bonds through physical interaction, crafting the game as a deliberate embodiment of crip game design to explore my own accessibility, engendering moments of embodied joy for my players, and making purposefully inclusive design choices that consider disabled players.

I found feeding my original text in, getting the reply then re-writing my copy using some of the sentence structure to help me think more deeply about my work and my writing.

It should go without saying all ideas herein are my original work. As this document has many versioned copies and was written on the cloud, any completely unedited paragraphs are likely available upon request errors and all. Also, all of the code and engineering work herein was created before ChatGPT and no code or engineering diagrams were edited with it. Given the rise of LLMs, I just wanted to be extremely specific on how I used AI as a helpful copy editor for the thesis and speech to text ai to speak good parts of this document.

Appendix A: UX Document for *Bot Party* Version Three

Author: Phoenix Perry
Date: February 25th, 2018

Idle Mode

The bots are resting on the console. There are two mode buttons. The rainbow LEDs inside the bot are just cycling colors. Occasionally, the bots make adorable sound cues to invite people to play. All Leds are lit. From this state, we also detect if people pick up bots. If bots are picked up, a cue plays inviting them to select a mode.

Game Modes

There are two modes, Free Play and Little Secret Ciphers

1. Free Play Mode

Actions: User(s) pick a bot(s) enabling the following behaviors:

- Pressing the bot's face button and getting an audio cute to touch another person holding a bot.
- Rotating or moving a bot at multiple speeds which will change the rate of a sound which will play or control a set of effects on a pre-existing sound.
- Touching another person holding a bot which will generate an excitement sound in the world.
- When all of the bots are connected through people, there's a major excitement sound which should continue playing as long as people remain connected.
- It is possible people can be in between people holding bots. Of all the possible interactions, this one is the richest in terms of emergent group dynamics. This event would be considered a network.

Other actions / in game behavior that have been seen to consider:

- While this game is ideally a local multiplayer game, a person can also play it by themselves by stacking the bots.
- Also, people have been seen touching the bots together vs holding hands. This is true of 2 and 3 bots.

Sounds:

3 button sounds (What do we want to say here?)
3 motion sounds
1 large excitement sound when all boxes touch
3 interbox box touch sounds

2. Little Secret Ciphers

Training Mode

Bot Leds flash and bots say, “Attempting to train Human Intelligence, HI. Training mode initializing.”

If only one bot is picked up, there’s an audio cue which states, “Two other humans required”.
If two bots are picked up, there’s an audio cue which says, “One other human required”.

Once all the bots are held, training mode starts. An audio cue plays, “Hi. Training beginning” All the Leds fade off then only the two which should touch quickly fade up.

Training touches then happen in the following order: Bot 1 - 2, Bot 2-3 then Bot 1 -3.

Finally, all 3 people are cued to touch and it makes a big event sound. Now the ambient background music starts, and the game loop begins.

Game Play States

Opening Section

The background music fades in. The bots which are required to touch have their leds faded up and other bot leds turn off.

Game Loop: The Leds for the boxes which need to be connected come on. Each individual play has a timer which starts when the leds come on. The bot’s leds slowly begin to fade. Players have until the leds are off to make the contact. When contact is made the leds go full strength (500ms - 1second??) then all leds turn off and the next play starts.

Failure: If players fail to connect, they are bounced back to the training mode.

Touch sounds should be clearly audible above any backing sounds.

Time: 30 Seconds

Intermediate Section

The touch challenges are slowly increasing as the plays continue.

Time: 30 Seconds

Bridge Section

When players reach the bridge of the song, there’s an audio cue to shake the bots, “Shake us up!” Once all three players shake the bots, it enables the motion sounds.

Time:~ 20 seconds or until all the bots get a shake

Buildup:

Sound effects for bot movement are on, music intensifies.
Now the game enters the home stretch, with motion sounds on player touch each other at a comfortable, but slowly ramping, speed and are also allowed to contribute to the music score by shaking the bots.

Time: 45 seconds

Resolution:

The game hits the finale! There's one final last group touch that plays the BIG sound that plays until the players release hands. The bots make happy noises and thank their human intelligences for helping out. The lights around the bots flash on and off a few times in an LED chain

"Hi's thank you! Our information transmission is complete" (Stuff like this)

Time: ~ 15 - 20 seconds

RESET

Sound fades down, lights fade off. The the game returns to idle mode.

Time: 20 seconds

Round structure:

Training mode: 45s-1m - no music

Opening section: 30s - of just basic music, nothing quick, no speed changes.

Intermediate section: 30s - of starting to pick up base.

Bridge: 15s or until all 3 boxes are shaking - Shaking event where the music kinda drops away and sound effects are introduced

Buildup: 45s - Sound effects for bot movement are on, music speeds up more

Resolution: 15s - Big finale, adorable bot talking (edited)

Sounds:
Training has no background sound, pings.
Background music starts in game intro mode, builds to intermediate mode.
Bridge (minimal background)

- Includes 3 motion sounds triggered by shaking boxes a variable speed (think filter sweeps or notes - dead obvious)

Build to ending.
Finale
Button sounds (character giggles - critter sounds)
Three sound effects - (to process)

- success sound (ping)
- failure sound, victory (screech)
- fanfare for ending (thank you, bot cheering, happiness)

Dialog is what we are sending.

SLC Voice lines needed
Training Mode
"Engaging Human Intelligence training mode. Humans touch when bots light up." (start)
"Basic tests successful. Testing advanced technique." (before all-connected)
"Humans operating within parameters." (end)

“Remember, humans. Touch when bots light up.” (nudge line)

Opening section
“Beginning transmission.” (start)
“Transmission rate insufficient. Engaging protocols for increased throughput.” (10s before end)

Intermediate section
“Transmission rate increased.” (start)
“Transmission optimal. Activating accelerometers...” (end)

Bridge
“Humans, moving and twisting bots increases bitrate.” (start)
“Move and twist us, humans!” (nudge line)
“Re-engaging transmission protocols.” (end)

Buildup
“Beginning last transmission part.” (start)
“Transmission complete. Just one more time, humans!” (pre-all-connect for the last time)

Resolution
“Information transfer complete. Thank you, humans! You broadcast [number in binary] gigabytes. [pause] Translation: [number in decimal] points.” (end) *
“Bitrate low. Reconsider human intelligence training protocols.” (low score)
“Human performance… adequate.” (medium score)
“Humans operating at optimal efficiency!” (high score)

*This requires recording numbers zero, one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, fourteen, fifteen, sixteen, seventeen, eighteen, nineteen, twenty, thirty, fourty, fifty, sixty, seventy, eighty, ninety, hundred.

General sounds
A success sound.
A failure sound.
Final fanfare
Menu Sounds

Pick us up!
Humans, can you help?
Touch me
Hi, help us connect.

Appendix B: Inspiring Games with Bespoke Controllers

1. Brainstorming techniques: Memory, Presence, and Metaphor

What follows are four possible brainstorming techniques for inspiring embodied physical experiences. Three are design tools to guide and inspire a process. The fourth is allows you to generate your own design process. Pick one for the purpose of this workshop.

After you do your brainstorming session, please ping me for a short interview on zoom. It will only be 20 minutes of your time. It would be ideal to do this before you start designing to collect the best information while it's fresh in your minds.

2. Invoking movement memory through word play

Using the below words, you can pick a verb/adverb or adjective match. You can also add your own words this list, edit it, or make your own before starting. Select one word from each list. You can do this by choosing a word that speaks to you or by using a random number tool generator you can get to here:

Verbs as Mechanics for possible mechanics

1. Whisper
2. Shout
3. Burn
4. Twist
5. Shake
6. Jump
7. Spin
8. Turn
9. Press
10. Release
11. Hold
12. Balance
13. Move
14. Stop
15. Stay
16. Go
17. Sit
18. Stand
19. Cast
20. Recall
21. Remember
22. Forget
23. Feel
24. Speak
25. Call
26. Respond
27. Draw
28. Dance
29. Listen
30. Buzz
31. Crawl
32. Blow
33. Suck
34. Shake
35. Hide
36. Reveal
37. Touch

38. Slam
39. Break
40. Assemble
41. Solve
42. Bind
43. Release
44. Stack
45. Listen
46. Bend
47. Pull
48. Shred
49. Pluck
50. Reach
51. Tuck
52. Tap
53. Stuff
54. Dig
55. Fill
56. Protect
57. Hug
58. Slap
59. Grow
60. Build
61. Destroy
62. Feed
63. Fall
64. Catch
65. Place
66. Drop
67. Strum
68. Pop
69. Draw
70. Throw
71. Bury
72. Roll
73. Occupy
74. Slide
75. Duck
76. Add your own!

Adjectives and Adverbs

1. Slowly
2. Soundly
3. Long
4. Short
5. Slow
6. Quick
7. Soft
8. Hard

9. Wild
10. Languid
11. Swift
12. Now
13. Then
14. Later
15. Fast
16. Up
17. Down
18. Right
19. Left
20. Angrily
21. Joyfully
22. Sly
23. Now
24. Yesterday
25. Today
26. Tomorrow
27. Carefully
28. Recklessly
29. Considerately
30. Collaboratively
31. Competitively
32. Together
33. Alone
34. Rhythmic
35. Asynchronous
36. Private
37. Public
38. Beautifully
39. Funnily
40. Sadly
41. Happily
42. Expressively
43. Grandly
44. Circular
45. Sharp
46. Graceful
47. Flamboyant
48. Gentle
49. Abrupt
50. Cautious
51. Curious
52. Proud
53. Awkward
54. Clumsy
55. Perfectly
56. Fierce
57. Quick
58. Heavy

59. Jerky
60. Swift
61. Wide
62. Narrow
63. Frenzy
64. Brave
65. Free
66. Mechanical
67. Habitual
68. Add your own!

Game Design Prompts:

1. What was your emotional response to this combination?
   How did it make you feel?
2. Now using your body move in a way that feeling makes you want to move – don't worry about how it looks. Draw that motion on a piece of paper. What shape did it take?
3. What is a story you can tell around this feeling?

   When did you last feel it?
   When did you first feel it?
   What is your first memory of it?

Instructions:
Build a short game or playful experience (around 2 minutes if you need a definition for short, but please don't let that stop you from making one shorter, open ended, or longer things) using the above story/experience and the drawing you made to inspire you. Use any game engine and hardware you want to build your prototype with. Bring meaning of the narrative through designing a movement to express it. Integrate the interaction into the games' story. Consider how gesture and movement could be used to tell the story. How do you embed them into the experience?

3. Embodied Experience Presence Data

Sound, Sight, Touch, Taste, Sound, are what we consider as our main senses, however, as pointed out by Christopher Eccleston, we have ten more and they include Balance, Movement, Pressure, Breathing, Fatigue, Pain, Itch, Temperature, Appetite, and Expulsion.

Game Design Prompts:
How do you perceive and understand one of these sensations?

Can you remember a moment when this sense suddenly brought you into the present moment and was the focus of your awareness? Briefly jot down this experience.
Have you ever had an experience where you have misinterpreted this sense, for example lost your balance because you misjudged your footing? Briefly jot down this experience.
Have you ever had an experience where this sense is heightened? Briefly jot down this experience.

Instructions:
Build a short game or playful experience (around 2 minutes if you need a definition for short, but please don't let that stop you from making one shorter, open ended, or longer things) using the above experience to inspire you. Use any game engine and hardware

you want to build your prototype with. Can you share one of these experiences through play with someone else?

4. Embodied Metaphors as Mechanics

We often use the space around our bodies as a space for metaphor. For example, consider the phrase, “What’s up?” You are not asking someone what them is above them in that moment, but rather how are doing. Another such example as is the phrase, “It’s up for grabs.” This does not mean something is physically above you to grab.

Game Design Prompts:

Brainstorm some similar metaphors that have leaked into your vocabulary. How do they make sense in terms of your experience? Jot down this data

Does one of these metaphors strike you as a subtle variation of meaning you could expand upon? How could you turn this into a game mechanic? Make a note of your ideas.

Build a short game or playful experience (around 2 minutes if you need a definition for short, but please don’t let that stop you from making one shorter, open ended, or longer things) using the above metaphor to inspire a game mechanic. Use any game engine and hardware you want to build your prototype with.

5. Make Up Your Own Process

Maybe you have another idea in mind. If so, all I ask is that you document your process either on video, audio, or with your own preferred methods. Consider answering this question as you go, “How did you generate your game design idea? Please describe the process.”

Appendix C: Crip Game Design Study Participant Bios

Louise Hickman

Louise Hickman is an activist and scholar of communication, and uses ethnographic, archival, and theoretical approaches to consider how access is produced for disabled people. Her current project focuses particularly on access produced by real-time stenographers and transcriptive technologies in educational settings. She uses an interdisciplinary lens drawing on feminist theory, critical disability studies, and science and technology studies to consider the historical conditions of access work, and the ways access is co-produced through human (and primarily female) labour, technological systems, and economic models and conditions.

Louise is currently a Research Associate at the Minderoo Centre for Technology and Democracy at the University of Cambridge. Louise previously worked as a Senior Research Officer at the London School of Economics and Political Science Department of Media and Communications and at Ada Lovelace Institute's JUST-AI Network on Data and AI Ethics. She continues to co-convene the JUST AI's working group on rights, access and refusal. An academic, artist, activist, she earned her PhD in Communication from the University of California, San Diego in 2018, and held a postdoctoral position in the Feminist Labor Lab at UC San Diego.

Since 2016, Louise has also worked as an access consultant and speaker for Parkeology, a U.S. based public art program.

Alistair Aitcheson

Alistair Aitcheson is an independent game developer in Bristol, specialising in playful installations, custom-made game hardware, and interactive performances. He sees his games as a springboard for real-world social interaction and loves to encourage players to bend rules and make the technology their own.

His work includes The Incredible Playable Show, an interactive stage show which has been performed across the UK, Europe and the USA; and Artholomew Video's Stream Challenge, a series of interactive livestreams where viewers take part in improv and creativity challenges.

His work has been nominated for awards at international games festivals including A MAZE and ALT.CTRL.GDC and won awards at the IndieCade Festival in 2015 and 2017.

He began developing games in 2001 and began his one-man studio in 2010 after graduating with a first class Masters degree in Mathematics with Study Abroad from the University of Warwick.

As well as his own projects he works as a freelance designer-developer. He currently produces maths-learning games for the edTech company Sparx Limited.

Jade Hall Smith

Jade is an advocate of disabled and intersectional people, who makes games to raise awareness and promote diversity. With a MA in 'Independent games and playable experience design' from Goldsmiths, they create games about disability and mental health, as well as looking at ways to make accessible games and playable experiences for autistic people.

Julia Makivic

Julia Makivic creates web-based narrative games and alternative controller games using Raspberry Pi, Arduino and various sensors. Her games explore what it means to have an emotional exchange with a computational system and how our emotions are mediated by technology.

Sightless Kombat

SightlessKombat (SK) is an accessibility consultant and gamer without sight (GWS). He has worked to make games more accessible across a range of platforms. He is an accessibility advocate for mainstream videogames as well as being a Winston Churchill Fellow. His work as an accessibility consultant ranges far and wide, from product reviews to studio visits, as well as discussions with everyone from single person indie developers to triple A publishers. Additionally, he speaks at conferences and events around the globe as an advocate for accessibility.

Robin Baumgarten

Robin Baumgarten is a German interactive artist and experimental game developer based in Berlin. Coming from an AI and commercial game development background, he is now building interactive installation art and award-winning experimental custom controller games such as Line Wobbler and Wobble Garden.

Appendix D: Alt Ctrl Game Developer Interviews

1. Questions

How has your game practice intersected with other communities outside games? (Making communities, Hackerspace? Galleries?)
What inspired you to start making games with custom or hacked hardware?
What was your first game where you made a bespoke interface out of custom-built hardware? When did you make it and where did you exhibit or share it?
What was the first custom built or hacked hardware game you played by another creator?
What interests you the most in creating custom built interfaces for games?
How do you think making your own custom interfaces can change or improve a game?
What is your process in coming up with ideas for a custom-made interface for a game?
Is there anything you want to say about the community around hardware games?

2. Robin Baumgarten

Hey Phoenix!

Here are finally some answers to your questions!

How has your game practice intersected with other communities outside games? (Making communities, Hackerspace? Galleries?)
Since I've begun building experimental hardware games, I've started going to London maker communities (first the London Hackspace, then briefly the Machines Room, now South London Makerspace). I now use their facilities exclusively to build my installations and have built closer ties to the members in these spaces. It's also interesting to see what artists are doing in the interactive installation world, which is older and more established than hardware games, yet there isn't too much intersection.

What inspired you to start making games with custom or hacked hardware?
It's fun to experiment with different means of in- and output and I also enjoy playing around with microcontrollers, sensors and LEDs. It's a nice change of pace from purely working on software and feels like a welcome break to do something hands-on between larger software-only projects. For a while, I started doing hardware-only projects during Game Jams, and these days it's all I do.

What was your first game where you made a bespoke interface out of custom-built hardware? When did you make it and where did you exhibit or share it?
A Dozen Sliders was my first custom controller, which used a motorized, touch sensitive slider as interface, and a series of multiplayer mini games. Link: http://wobblylabs.com/projects/sliders
It was built in late 2013, then shown at the first alt.ctrl.gdc in 2014, as well as the Game Science Center after that.

What was the first custom built or hacked hardware game you played by another creator?
I don't remember! Maybe JS Joust if it counts?

What interests you the most in creating custom built interfaces for games?
I'm most interested in experimenting with strange sensors and finding surprising and satisfying tactile interactions (like springs!) and combining that with fitting game mechanics to build games that not only interact well with the hardware, but also use the hardware as an integral and vital part of the gameplay.

How do you think making your own custom interfaces can change or improve a game?

Making custom interfaces enables us to expand on how we can shape the experience for the player. We're not only confined to what a normal computer or console can in- and output, but we've got a whole arsenal of interfaces inspired by electronics, mechanics, robotics and whatever strikes our fancy to our disposal. Pushing further, we can even build games that are impossible to build with existing (unaltered) platforms.

What is your process in coming up with ideas for a custom-made interface for a game?
I'm usually working the other way round, i.e., not having a game in mind that I want to build an interface for. Instead, I like to start with a sensor, an interaction, or maybe a random tactile detail I discover in everyday life and build a playful prototype around this detail. I then build upwards to try to find a game concept that uses that interaction in its core. Of course, this doesn't always work out, and it's part of the experimental process to iterate, improvise, and discard if necessary.

Is there anything you want to say about the community around hardware games?
The hardware game community is still small, but rapidly growing and as such there aren't any major hubs or even collectives specializing on hardware games yet. I'm glad to see initiatives such as alt.ctrl.GDC grow and gaining momentum, and more traditionally software-only game festivals embrace the experimental hardware culture.

Your definition of alt.ctrl looks interesting. It's tough to have 'alternative' in a definition for a category, which makes it rely on a 'default', and thus can shift over time as previously alternative controllers become mainstream. Which might not be a bad thing, but it opens up an interesting time-dependence of what's considered alt ctrl. The first joystick would have definitely been alt.ctrl.

I'll think a bit more about the periphery (heh) of alt ctrl, and where to draw the line. Your two definitions make sense to me though!

Talk soon!
Robin

3. Jerry Belemy

How has your game practice intersected with other communities outside games? (Making communities, Hackerspace? Galleries?)
The game, or platform, that brought me back to the game industry was the Choosatron, an interactive fiction game console that uses a thermal printer for the output. Because it was a game, a form of storytelling, a creative platform for writing and designing games, and it used a WiFi capable microcontroller, it hit this amazing, sweet spot in the Venn diagram of communities. It was invited to literature/narrative events, game events, hackerspace and IoT events, museums, and even schools. For a brief period, kids could take a class where they built their own Choosatron and got to write stories for them. I don’t think this is common, however, though physically based experimental games do lend themselves to crossing community boundaries. Once I was introduced to these other worlds, it made it easier to explore where other custom hardware games might find an audience.

What inspired you to start making games with custom or hacked hardware?
Back in 2011 I believe, I was working at Clockwork, a really awesome digital agency in Minneapolis, MN. I was primarily running their mobile effort but was also given the opportunity to work on more experimental projects, one being a large Casino installation. Three of us wrote a piece of software that could sync visual simulations across hundreds of displays, 384 in the final install, though we didn’t focus on content. We worked with a team in New York that was developing the actual content, but they also did installations with custom electronics in their other work. I asked them what they used for prototyping,

and they told me about Arduino microcontrollers. I had heard of them and wanted to experiment with one but never seemed to get around to it. Without my asking, they mailed me one the week later and that really inspired me. Because it was a gift I felt that I owed them in a way, to follow through. So, I went through every component on Adafruit.com and Sparkfun.com A to Z, making note of parts I thought were really interesting. One was a thermal printer, another a coin acceptor, and within a few days, I had decided to make an interactive fiction arcade machine. The Choosatron was born! The first versions all required quarters to play which I thought was absolute fun!

What was your first game where you made a bespoke interface out of custom-built hardware?
It's funny how many answers go right back to the Choosatron, but that was really it. I was really fortunate to have the first hardware project that was built to be purely for myself to make such a strong connection with people all over the world. I ended up running a Kickstarter that raised over $75,000 USD, which blew me away. It opened a lot of doors for me, and I realized I had a chance to get into the game industry and not just be 'yet another game designer'; at the time the experimental hardware scene was a lot smaller. I also knew that if I didn't keep creating new work I might lose momentum and not really find a place, so I focused on exploring custom hardware game space not just as an artist and for myself, but as a designer.

When did you make it and where did you exhibit or share it?
I suppose I've already answered a lot of this, but it was 2011 or 2012 when I built the first version using an Amazon shipping box as the Choosatron form. The first time I brought it to a friend's house I realized how difficult it is to keep games like this working and spent 30 minutes figuring out which wires had popped out in transit. Then I was invited to a local literary event and so built a more robust model. At the time I was overworking myself a bit so had a month off work planned to go to London and recoup a bit. I brought the parts for a Choosatron so that I could tinker if I got bored, showed it to some folks at a story conference a friend invited me too, and I ended up traveling around for three weeks speaking at meetups, and even at a school to a few classrooms of kids. It was then I realized how much I loved all of it; not just the designing, but talking to people, teaching, doing my best to encourage and inspire. I kept getting told to "do a Kickstarter!" so caved and did it. I could talk for hours about the good and bad of that, but I was able to ship the Choosatrons, though the software and creation side was really lacking.

The first festival it was accepted into was Fantastic Arcade in Austin, TX. This is when I realized how much I loved the indie game community. That was followed by the first Alt.Ctrl.GDC which I've been involved with every year since! Actually, this year, 2019 is the first I don't have a project accepted or built the award for the winners. There are Choosatrons in a few permanent exhibits in Berlin, and they've been all over the world at this point, I can't even list them all. I've made a lot of hardware games since, but that one will always be particularly special to me.

What was the first custom-built or hacked hardware game you played by another creator?
I believe this would have been at the first Alt.Ctrl.GDC event in 2013. There are two games specifically that I remember playing first. There was Canabalt 100P by Jonatan Van Hove (or Joon), and A Dozen Sliders by Robin Baumgarten. The first was a midi keyboard plugged into a modified version of Adam Saltsman's game Canabalt, I think the first endless runner game, but there were tiny runner dudes for every single key on the keyboard. You would swipe your hand down the keys and the long line of runners would make a beautiful sine wave of jumps. It was simple, elegant, and a completely new experience. Robin's was all about the custom hardware, using touch sensing linear actuators (sliders able to position themselves) for various mini games, for single or multiple

players. It was weird and fun to interact with, even before getting to the actual gameplay. Both of those creators are great friends of mine today. We've all admitted how each other's work was so inspiring to the rest; there's something really lovely about that.

What interests you the most in creating custom-built interfaces for games?
They are so fun to discover! I say this from both a designer and a player standpoint. Discovering the form of a custom interface should take is a really exciting process for me. For instance, rotary phones were the staple when I was growing up, but if you think about their interface, turning the dial to input numbers, it is really weird. It exists because of constraints at the time it was designed. The process of designing a new context for such a strange input, how it can become a new experience for people to explore, that brings me a lot of joy. Sometimes it is recontextualizing something that exists, sometimes trying to explore an entirely new kind of interaction. There is a wide spectrum between those two that is a design play space I love to explore.

How do you think making your own custom interfaces can change or improve a game?
I've written and talked before about the boundaries and bleed of an experience. That is to say, where does the player first interact or enter an experience, and how does that experience bleed into the world before that point in time? You can use it to acclimate a player, to help them shed the real world for your world, temporarily set aside their busy thoughts and stresses, and open themselves up to something new. Having physical interfaces that bleed the experience of the game can be a powerful way to achieve this. Instead of grabbing a mouse or homogenized game controller, I grab the heavy metal of a tank controller or squishy form that mimics my pressure digitally… It is hard to name examples because by their nature what makes them special is how unique they are. In a perfect world, every game would have a controller, interface, or extension built just for it. It can align you with your game self. Sometimes it can even make a game harder to play, but more fun in the process, other times making it more intuitive. Most of my games can't exist without the custom hardware and the digital aspect is incredibly simple, so the focus is on immersive the player in what they can touch. Texture, temperature, the dimensionality, even smell can help center you there. We don't often think of this, but proprioception, our awareness of where our bodies are in space, is central to our experiences. The advantages of that can be largely lost when represented only digitally, bodies rigid with only the occasional twitch.

What is your process in coming up with ideas for a custom-made interface for a game?
It usually begins with a new component I'm excited to work with, like a special set of LEDs or a water pump, or a really interesting artifact that I've found, like an old telephone or 1950s TV set. Either way, that component or artifact becomes the anchor for the rest of my design, helping constrain the overall direction. It may be further constrained by outside factors, such as a desire to submit to a certain event or install in a particular space, affecting some of the more practical decision. I've always been a storyteller, so I tend to create a narrative that the artifact exists within, world build a bit, even if that story is never fully evident to the players. It helps me make consistent design decisions as I build.

Is there anything you want to say about the community around hardware games?
It's exciting. Even setting aside the custom hardware, I think designers are able to tap into a lot more creativity simple by working not just with their minds but their bodies as well. It feels very holistic and motivating; there is an energy I feel from other people creating in this space. It is still a relatively new community, though growly quickly, and I've found people to be really supportive of each other. The fact that it is difficult to commercialize directly also tends to increase the vibe toward creation for the sake of creation, experimentation, and new experiences. I think to be in this community to have to respect the many overlapping skills involved, both technically and creatively, which perhaps means

the people in it have a healthier respect for creators of all kinds. I hope everyone feels welcome in it and I hope I can help more people of all types to feel welcome.

4. Kaho Abe

How has your game practice intersected with other communities outside games? (Making communities, Hackerspace? Galleries?)
My residency at Eyebeam, which is an art and technology non-profit, gave me the support to pursue a more rigorous career in making games. It also allowed my work to exist in the media art world and provided access to a space that allowed experimentation and exploration. I am grateful to have received art grants, and was able to show my games at galleries, events and museums. Because Eyebeam was also considered a hackerspace, I also became interested in hacker spaces, and visited quite a few while traveling.

Aside from Eyebeam, my game practice has has existed in the academic world as well as in academic research. I've taught two graduate classes that are based on my practice — Beyond the Joystick and Costumes as Game Controllers — at the NYU Game Innovation Lab. In addition, I have also collaborated with Katherine Isbister on her HCI research, and had a glimpse of the academic research world as the Artist in Residence at the Game Innovation Lab.

I also explored the informal youth education world, designing, and teaching an after-school program with Ramsey Nasser called Playable Fashion, based on our practice as independent game developers. We were able to teach it as an after-school program, as well as in parts as weekend workshops. We also integrated the curriculum with a local public school, and also were commissioned by the NYC Public Schools to have some of the content appear as possible teaching material accompanying the Computer Science standards that were introduced a couple of years ago.

Games and theater have intersected in spaced like immersive theater. 2 Years ago, Ramsey and I, we approached the crossover between theater and games from the games side. We had a mini residency at Culture Hub, which is a black box art space at the legendary La Mama Theater in NYC. For a week, we worked with the staff at the space to incorporate their theater lights and their quadraphonic sound system to the game code, so as the game state changed so would the whole space. As a result, we showed Selfie Stick Deathmatch which was a gladiator type game involving selfie sticks and selfies, heightening the excitement with dramatic lights and audio.

I knew that when I became a full-time artist and designer of physical games, since it was not an area that was well developed, there weren't a lot of paths that I could follow. Instead, I knew it was important to me to be as creative with my career as I am with my work — basically, to not hesitate to seek out and explore different places and communities where my games could possibly exist. This approach has been incredibly rewarding as I also get to meet amazing collaborators and incredibly supportive people, which I am grateful for.

What inspired you to start making games with custom or hacked hardware?
I was previously a fashion designer, and in 2003, I went to graduate school at Parsons School of Design to learn specifically how to embed electronics into clothing. So, I was already learning how to make circuits and use sensors and such, when I took a game design class. Game design absolutely blew my mind and satiated my brain in a way that it never had been. I loved it and therefore combined both area of interests to make games with custom hardware. I made my first iteration of Hit Me! in parallel to making my thesis which was a wearable technology project. I hacked a doorbell for Hit Me! to borrow its

wireless communication capabilities because I was a student and wireless components were extremely expensive at the time. They are way more affordable now, thanks to the open hardware movement.

What was your first game where you made a bespoke interface out of custom-built hardware? When did you make it and where did you exhibit or
share it?
I made the first iteration of Hit Me! in graduate school in 2005. It was made with a Basic Stamp II micro controller, a hacked GE wireless doorbell system and the game itself was coded in Lingo using Macromedia Director. The plastic boxes were attached to fabric hats. I showed it at the Newschool Auditorium in NYC, as a tournament, with injury waiver forms and a trophy for the winner. Here is some documentation
http://kahoabe.net/hitme_archive/hitme_archive.html

What was the first custom built or hacked hardware game you played by another creator?
In graduate school, probably around 2004, I was in a programming class taught by Zach Lieberman, and he showed us an interactive piece he made using a CCTV camera, an early version of the OpenFrameworks library, and computer vision. While it was not a game in the traditional sense, it was certainly a playful experience, and also a beautiful use of a security camera! I had never seen anything like it, and the physicality involved in the interaction was so open and experimental, it was the very definition of “play”.

What interests you the most in creating custom built interfaces for games?
I can use simple sensors and embed them into objects, and the controller can then continue to tell the story of the game in the physical world. By having full control over the code of the micro controller, I can fine tune the nuances of the interaction and the gesture made by the player. I can also design interactions not only based on the technology used but also by applying rules to the game that create physical limitations or constraints. This combination of physical and digital can provide infinite ways to balance games. I basically can build whatever I want, and that creative freedom is the most exciting thing about making custom interfaces.

Another exciting thing is that custom interfaces can create wonderful opportunities for people to engage with each other. Different people come to play my games — sometimes they are siblings, best friends, lovers and strangers. What is cool to me is that the interfaces become a starting point, and then the games is a system — and on top of this system, the fun, playful behavior between players emerges.

How do you think making your own custom interfaces can change or improve a game?
It kind of boggles my mind that people play so many games using the same traditional controller. How interesting is that really… the same game controller for every game?
I think custom interfaces, can make game play more interesting, it can make the experience more novel and can tell a story about the game in the physical world. I think the physical experience can be more instinctual, playful and immersive.

What is your process in coming up with ideas for a custom-made interface for a game?
I like to explore the physical gesture/mechanic that the player is to make in the game. Not just studying the movements but getting into them, acting them out. I also think about the physical object, its affordances, as well as its role in the broader narrative. Also, I consider what it might look like to the spectator, who is often the next player. I make a ton of shitty, tech-less prototypes usually from found objects or items I can find at a thrift store or at Michaels, and test them rigorously, before finally making something that is wired up and ready to be played.

I probably don't talk about this enough but it's also important for me to consider durability. I usually travel with an emergency kit — soldering iron, parts and even copies of my controllers, so if anything happens, I can quickly replace, or fix them on the spot. It's fun to duct tape stuff together sometimes, but then again, having people asking you constantly when the game is going to be running again, while you are soldering teeny tiny parts together can be stressful. So, at some point I realized the importance of taking the time to design something that could withstand rough use. The goal is after all to have as many people enjoy it as possible within the time that is given.

Is there anything you want to say about the community around hardware games?
The community around hardware games is great. I love meeting the developers, playing their games and talking shop. Maybe it's just me, but making art can be truly isolating sometimes, to the point where I get a cloud of loneliness hanging over me while I work on solo projects. Events and festivals that welcome custom hardware games are super important, cause it's not easy to meet fellow hardware game developers when you have a physically large project that is hard to move, or a space is needed to run it. Also, these games will never have the same exposure as a downloadable game, so, I am always grateful for these opportunities. As a game designer, it is not just a chance to show my work but also to play games and meet community members. I am also grateful for those who play the games. I think due to the nature of hardware and that it can break easily, a certain patience is required from those who play.

6. Dobotone

How has your game practice intersected with other communities outside games? (Making communities, Hackerspace? Galleries?)

It intersected surprisingly well! When we make games, we just think in the players, in the individual persons, no matter where they come from, if they play other games or not, if they're developers, makers, artists in general, or not. We just try to affect everyone in the same way. And the same happens with spaces or communities. We're not making the games for any of them in particular. But what happened with both with NAVE Arcade and DOBOTONE, is that each of the communities you mention felt our games as their own. And in a way, they are, because our games have a little bit of everything they're interested in, separately. We don't feel we belong to any of them in particular, but we're happy to be accepted in all of them.

What inspired you to start making games with custom or hacked hardware?

Well, it was kind of accidentally. In 2010 we started working on NAVE as a game for the web (it's made in flash) but playing it on a keyboard didn't feel like the right way. So, we started to use a gamepad (with a joy-to-key program). That led to a game balance and difficulty that was a little different to the one with keyboard, and, as that was the way we were actually playing it, we knew we could not go back to the keyboard configuration. So, we decided to make the game as a downloadable standalone program, for being able to automatically configure the gamepad when you executed the game. But in 2012, we were invited to show "anything" at GameOn! El arte en juego, a yearly exhibition here in Buenos Aires about art and games, so we decided that we would showcase NAVE in an arcade cabinet, mainly for two reasons: First, to fulfill the fantasy of making our own arcade-cabinet game, and second, and equally important for us, we didn't want to be there taking care of the computer, teaching people how to play, which keys to press or not to press (it was a two-week-long, all-day-long, showcase). What that experience made us discover is that not only the game was meant to be played on a stand-alone arcade machine, without us consciously knowing about it, but that we enjoy designing dedicated physical interfaces

that are part of the game itself and that are the best way of communicating the players with the programs and vice versa.

What was your first game where you made a bespoke interface out of custom-built hardware?

Answered in question no.2.

When did you make it and where did you exhibit or share it?

Answered in question no.2.

What was the first custom built or hacked hardware game you played by another creator?

Classic arcades, no doubt. We belong to the golden arcade video game era and custom arcade cabinets have always been our main inspiration for designing dedicated hardware. Beyond that, we didn't have any other contact with other hardware games creators, at the time. Later, after making NAVE, when we attended to the first alt.ctrl.GDC showcase in 2014, we started to meet other kind of hardware games and their creators. That gave us a whole other perspective and that influenced us in "closing" the concept of DOBOTONE, our party game console, which we started to work on right after NAVE Arcade was finished in 2012.

What interests you the most in creating custom built interfaces for games?

The main interest for us, as mentioned before, is creating the right physical interface to allow the players play our games in the best way possible, which, for us, is a self-explanatory way that emerges of the mere fact of enjoying the manipulation of whatever the hardware is. At the same time, we also discovered that the exact opposite is also very exciting for us: trying to make the best game that could be played on an existing hardware, even if it's not a hardware originally destined for games. Ultimately, most of these games are played in public spaces, where, normally, there's no intermediaries between the players and the games (e.g., in the standard way, internet service or retail stores,), and, most important, make people interact with each other in person, even if they are total strangers, which is one of the things that drives us the most towards making physical interfaces.

How do you think making your own custom interfaces can change or improve a game?

Answered before? Let me know if you want me to go deeper.

What is your process in coming up with ideas for a custom-made interface for a game?

Well, in our case, it depends on the context. For example, the approach with DOBOTONE was almost the opposite as the one with NAVE. DOBOTONE started as an interface that "would be cool to play games with".

Nearly a week after NAVE's cabinet was finished, we had some spare color buttons (NAVE is all black and white) left from the project, and Maximo started to fool around with them, grabbing each one with each hand, pressing them with the thumbs, as a pushbuttons. He felt that we could make small trashy games to play with friends, with a few two-button controllers, simply made with tape and wire.

A couple of years later, we had the chance to build another arcade cabinet for a showcase, and we thought of making a big arcade, with a big screen, using the DOBOTONE idea (no knobs on the console, still, just party games played with two-button controllers). But it turned out that an LCD screen, as big as the one we felt was necessary, was too expensive, so we thought of making an arcade without screen. That made us realize that feature would make it a console. And then... party games… parties… sound mixers… party console with knobs and buttons, to alter the gameplay, which became a central part of the general gameplay itself.

So now, the upcoming hardware projects we have in mind are approached in both ways. Some of them are about making the best controller for the games and some about making a game from an interface we feel could lead to a cool game. In both ways, our main goal is still making a good game that is best played with custom hardware.

Is there anything you want to say about the community around hardware games?

We've found that there's a lot of camaraderie among hardware gamemakers. Maybe because it's a pretty small community, and we all feel very excited of new hardware games coming out, which leads us to trying to help each other. We certainly have a palpable, special bond that links us and that brings us together in one way or another.

ABOUT VIDEOGAMO

Videogamo is an Argentine video game studio born in 2010, based in the city of Buenos Aires, specialized in dedicated-hardware games. Its two most relevant works are: NAVE Arcade (2012), a space-shooter game that can only be played in its own arcade cabinet, saving highscores since its launch, and that toured different parts of Argentina and Chile, aiming to travel all around the planet; and DOBOTONE (in process), a game console designed for parties in which each controller works with only two buttons and which has a built-in control board that allows players to modify, in real time, some variables of the games, such as gravity, speed or the size of the playground. This latest work has already been showcased in cities such as Buenos Aires, Toronto, Los Angeles, San Francisco, Washington, New York, London and Tokyo, where it won the Best Experimental Game Award in the 2016 edition of the Sense of Wonder Nights showcase at the Tokyo Game Show.

THE DEVELOPMENT TEAM

Máximo Balestrini

Programmer and game designer. Born in 1977, in Buenos Aires, Argentina.
Main Tasks: Programming, Electronics and Software & Hardware Design.

Hernán Sáez

Game Designer and Filmmaker. Born in 1978, in Haedo, Buenos Aires, Argentina.
Main Tasks: Graphics, Sound and Software & Hardware Design.