

**What Does It Take To Be a Haptician? How Community
Can Empower Designers and Expose the Many Ways of
Being an Expert**

by

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The following individuals certify that they have read, and recommend to the Faculty of Graduate and Postdoctoral Studies for acceptance, the thesis entitled:

What Does It Take To Be a Haptician? How Community Can Empower Designers and Expose the Many Ways of Being an Expert

submitted by **Hannah Rachel Yuen Elbaggari** in partial fulfillment of the requirements for the degree of **Master of Science in Computer Science**.

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Abstract

Haptic design practices have grown from an engineering sub-field in the 90's to encompass areas of robotics, human-computer interaction, the creative arts, and more. Yet designing in the haptic medium remains complex and difficult to learn regardless of one's training, in part because access to specific knowledge, skill, and tools is currently limited outside academia and certain industries. Within academia, there has been haptic design and knowledge sharing but these efforts are often accessible only to designers in the STEM-aligned, technical sphere. Technological feats have enabled the field of haptics to grow; we are hearing it discussed in our everyday devices, courses, and projects. With the barrier to entry in the field lowering, challenges of haptic design are also shifting.

We explore the opportunity opening at this crux, one where we want to enable and empower hapticians to create and understand touch sensations by expanding the contexts of haptic design. We do so through a design justice framework and a feminist, participatory qualitative approach. Individuals remain experts in their own lived experiences, whether that be topical, experiential, or technical, but is there a way to embolden this specialized haptics knowledge for larger collaboration and knowledge sharing? We hypothesize that a suitably structured community resource could provide an empowering, inclusive, and reflexive design ecosystem for hapticians of diverse backgrounds.

Our research took two parallel paths: *understanding* the perspectives of “peripheral” hapticians and *designing* an online resource for community building for haptic design (N=6). In our *understanding* path, we learned that underrepresented hapticians need support in their interest areas, specifically through a welcoming community space. Additionally, we described obstacles still faced in the field and

presented eight social principles for haptic design. In our *designing* path, we applied our findings to create a haptic design resource (Haptics Commons) which we evaluated in a pilot study (N=6). We found that representing perspective hapticians as both practitioners (people with specialized skill) and explorers (people looking to learn) on a community platform gives promise to inclusivity and empowerment.

Lay Summary

Haptics is the design of technology for perceived sensations of touch. The field has grown from its engineering origins to encompass areas of robotics, human-computer interaction, creative arts, and more. However, haptic design and knowledge is still relatively inaccessible to people outside of technical spheres. What makes haptics complex to learn is the availability of the knowledge, skill, and tools. In this thesis, we explore the challenge of making haptic design accessible to people who are haptics-curious. Through an inclusive, justice-based framework, hapticians that felt underrepresented in the field talked about what would make them feel more supported. We propose a solution in the form of social haptic design principles and prototype a haptic design resource with the hapticians' feedback in mind. We found that when people feel supported through the structure of an inclusive community resource, we can welcome them to a group they might have felt was unapproachable.

Preface

Research is always a collaborative endeavour. All aspects of the research presented in this thesis involved collaboration to some extent. For all work, I took collaborative input from members of SPIN Lab on ideation and actualizing of the research through lab meetings and personal discussion. I am very grateful for everyone in this group.

A portion of developing this research approach (Chapter 1) is attributed to the think-piece I wrote for a series on touch topics with the University College of London, with collaborative edits from Lili Golmohammadi, Raquel Robinson, Unma Desai, and Dr. Karon MacLean [33]. Additionally, this chapter and motivation stems from previous work I have done with Hasti Seifi, David Gueorguiev, and Samantha Melnyk making knowledge of grounded force feedback devices more accessible through LearnHaptics [80].

I supervised a team of undergraduate researchers, including Tommy Nguyen, Angel Bao, and Erin Chong. Although work was heavily collaborative, I was the intellectual lead on all aspects of the study design, recruitment, protocol, pilot study, and interview study (Chapter 3). Undergraduate researchers on this team helped with the analysis, results and drafting of design principles from Chapter 3.

In Chapter 4, we present the two iterations of our prototype, HapHub and Haptics Commons. I took lead on the design of HapHub in our first, low-fidelity prototype. Following this prototyping structure, Tommy and Erin gathered requirements for the next iteration of prototyping Haptics Commons. With my supervision, Tommy and Erin drafted low and medium-fidelity prototypes of Haptics Commons. All researchers (Tommy, Erin, Angel, and myself) conducted the prototype evaluation, while Tommy and myself collaborated on analysis and results.

Research was conducted under the University of British Columbia's Behavioural Research Ethics Board (BREB), certificate #H13-01620: Investigation of Tools and Techniques for Haptic Design Processes.

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Rubia, I cherish our friendship. From taking courses together, playing poopaul, escaping reality, and mutual venting, we've come a long way. It has been an honor to be your desk buddy and I can't imagine going through this without you there sitting across from me. You have shared much wise knowldges with me and for that I am forever grateful.

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Another special thank you to my other lab mates Unma, Kattie, and Preeti, for all of us started this journey together and during the height of the pandemic, but look at us now. May our friendships be continuous virtually, locally, and long-lasting.

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Dedication

To my mom and dad, *Linda* and *Ahmed*,
who have inspired my ambitions.
And *Khalil*,
for being the smarter sibling.

Chapter 1

Introduction

The recognition of the diversity and plurality of knowledges requires the internal democratization of science itself. — Santos, Nunes, and Meneses (2007)

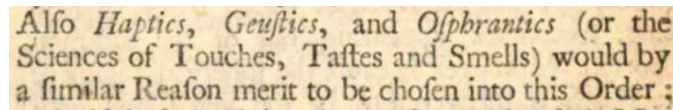
In this first chapter, we provide an overview of the thesis, starting with context and motivation. We then will discuss the research position of the thesis writer, our approach, research questions, and goals. We conclude this chapter with an outline of how the rest of the thesis will be organized.

1.1 Haptics, A History in Short

The earliest appearance of the word *haptics* I have found dates back to the 18th century [7]. The word haptics is often viewed as a synonym to the word tactile, sticking to the New Latin root of the word *hapticē*, which means “science of touch” [1]. Barrow and Kirby’s translated collection of mathematical lectures from 1734 considers the presence of different disciplines and their names in science. As the two scholars list off potential names for fields of study, the page capture in Figure 1.1 shows the first, albeit poorly translated, instance of the word “haptics”.

What does haptics mean? What does the science of touch mean? In this thesis, we will refer to haptic(s) as designing technology for perceived sensations of touch¹, in line with the way it has been applied in human-computer interaction

¹Rather than the way it has originated in psychology: as an active touch.



Alfo *Haptics*, *Geuſtics*, and *Oſpbrantics* (or the Sciences of Touches, Taſtes and Smells) would by a ſimilar Reaſon merit to be choſen into this Order ;

Figure 1.1: A scanned photo of Barrow and Kirby’s definition of Haptics from 1734.

(HCI). This can mean all of passive and active human and/or actuated touch as well as proprioceptive and tactile feedback. Haptics, before the current technological correlation to the term, began in psychology. It is possible to examine how cultural change is mirrored in books by looking at word frequency data from a large corpus of literature; according to Google Books Ngram Viewer² the words “haptic” and “haptics” have appeared only more frequently since 1990 (see Figure 1.2). There are instances of “haptic(s)” appearing historically. The aforementioned appearance of the word in the 18th century, a small peak in 19th century psychological discourse [45], and popularity slowly rising in the mid 20th century. Haptics began appearing in engineering contexts and the root word “haptic” boomed in popularity around the 1990’s – a paradigm shift to technology. For example, Figure 1.2 shows a sharp rise in popularity in the 1990’s, yet had a relatively level slope until much more recently indicating more widespread awareness, and potentially, more interest from the general public.

Why does this matter? Haptics has grown from a sub-field of mechanical engineering in the 90’s to encompass areas of robotics, human-computer interaction (HCI), the creative arts, and more. It has been able to expand the physical, psychological, and emotional salience of touch for well-being, development, and connection. Yet haptics remains complex and difficult to learn, regardless of educational background. Access to teaching materials a constant challenge. Additionally, there is no singular, dominant way to design haptics, taking into consideration the variability of devices, embodiment, and touch sensation possibilities [66]. While we all inherently know something about touch, few beyond a small number of specialists have taken this knowledge and applied it to the design of digitally mediated touch experiences. The consequences of this have been more recently examined and

²Google Books Ngram Viewer is an online visualization tool that uses individual language corpora of words used in books between the years of 1500-2019. <https://books.google.com/ngrams>

challenged by researchers, citing the monolithic approach [51] to haptic communication resulting current haptic interfaces as “colonized by mechanisms of coding and control” [66].

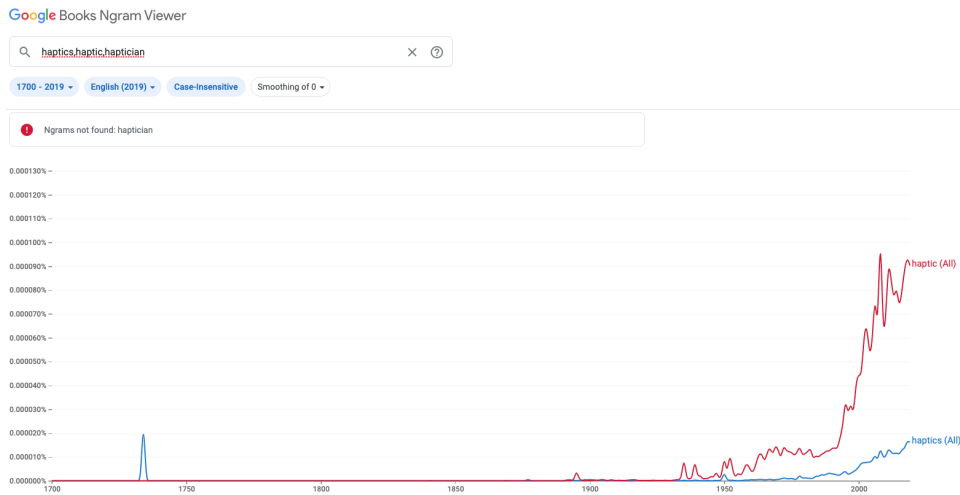


Figure 1.2: Google Books Ngram Viewer of the words haptics, haptic, and haptician. The Y axis indicates frequency, the X axis indicates year. Haptician was not a word found in this corpus.

Technology is not the villain in this story, although it may feel colored that way. In fact, technology has paved the way for a multitude of advancements in sensory experiences, including haptics. What has seemingly progressed some fields more than others resides in the accessibility to grasp specific knowledge, skill, and tools.

For example, western techno-modernity has been criticized for putting priority on particular senses, specifically audio and vision [66, 69]. Technology to design your own visual and audio experiences is at your fingertips with incredible advancements in technology like Adobe Creative Suite³. Why not touch? At what priority is touch in a western techno-modern point of view? What has been the demand for haptics in the past? Why is it challenging to learn haptics? How is haptics understood outside of its technical and perceptual capabilities? The way

³Adobe Creative Suite has a slew of applications available to people, most of which include visual and auditory editing softwares, although this normally comes with a high monetary cost, which is a notable barrier. Alternative, free programs to Photoshop (1987) were made after the programs popularity like Inkscape (2002) and Blender (2003).

that haptics is articulated and positioned within design ecosystems has an impact on how it can be conceptualized, progressed, and worked with. If we did not have tools like Adobe Photoshop (and access to digital displays, computing power, and hours of tutorials), it could be debated that over 90% of the world’s creative professionals would not know how to make digital works⁴. While some of this learning can always be accomplished through trial and error, access to visual and audio design have enabled many to create profound compositions without needing to know the computational or technological inner workings of the program.

Haptics isn’t there yet – there are field-specific challenges that are dissimilar from vision and audition. For example: there are many diverse access points for haptics (your entire body), a sense of kinesthetic closeness or contact (audio and vision can be experienced from a distance), and required textural, temperate, or moving parts (engineering and context matters for haptic devices). On the other hand, coding and engineering feats enabled the field of haptics to grow, we are hearing it discussed more and more in our everyday devices, courses [57], and DIY projects too [23]; the barrier to entry is lowering, challenges of haptics are changing. There is an opportunity opening at this crux, one that we consider in this thesis, where we can enable and empower others to create exquisite touch sensations through expanding the context of haptics that can take on a broader, social role in design.

1.1.1 Who is the Haptician?

The term *haptician*, also referred to as haptics practitioner, haptic designer, or haptic scientist, is a fairly recent term. A term first introduced in 2017 by Schneider et al. to refer to a person who is “skilled at making haptic sensations, technology, or experiences” and defined this way to capture the diversity of work, goals, and people who currently make haptics [72]. Schneider et al. also note that many hapticians do not have formal design training, but perhaps a specific subset of knowledge that relates to haptics and/or design e.g. perceptual knowledge or engineering. In reference to our corpus search (Figure 1.2), the term “haptician” returned an error

⁴Adobe fast facts has cited over 90% of the world’s creative professionals use Adobe Photoshop <https://www.adobe.com/about-adobe/fast-facts.html>.

of null, revealing no history of the term used in books pre-2019⁵.

Indeed, the diversity of work, goals, and people are captured in Schneider et al.'s definition. One of the authors of this same paper has told me verbatim, “*I promise you, in 2017 our def was considered pushy and idealistic.*” Five years later, does the pushy and idealistic definition of “the haptician” represent the diversity it has set out to represent? Hapticians have been researched for either what they do know or what they do not know: expert and novice, respectively. An expert haptician rarely means an expert in all sub-genres of haptic knowledge, yet expert haptician participants’ experience in haptics has not been explicitly qualified beyond device creators and interaction designers [63, 79]. Novice hapticians, defined as “designers new to at least one of haptics or design practice,” similarly have been researched, but are primarily represented in participants that have a specific background of knowledge – either computer science, engineering, or music technology [78]. Both levels of expertise that have been researched in haptics reflect a technological background that inadvertently narrows “the haptician” to a specific technological scope. Diversity is then put to question through examining the ways “the haptician” has been represented. There is still a lot to understand about the other types of hapticians.

It is safe to assume that these terminologies were used to reference how much exposure someone has to haptics, yet they do not provide enough context to understand dimensions like expertise. Looking at Figure 1.3 as a thought experiment, many contexts contribute to the construction of a haptician, yet where they gain experience and expertise can vary greatly. We rethink experience level labels in haptics to include some other hapticians, typically non-STEM or non-design, people like makers and artists. In particular, and in this thesis, we explore a way to represent hapticians that do not identify as within the currently represented scope, what we call *peripheral hapticians*. We ultimately hope that the term *peripheral haptician* disappears as the community becomes more cohesive, yet in this thesis we will focus on this group to include alternative haptic knowledges.

⁵Although this search returned a null result, this corpora search was limited to Google’s search engine tool which may also have presented limits in its search of the term. From our own searching, the term “haptician” primarily occurs in academic journals and conferences; no books to our knowledge.

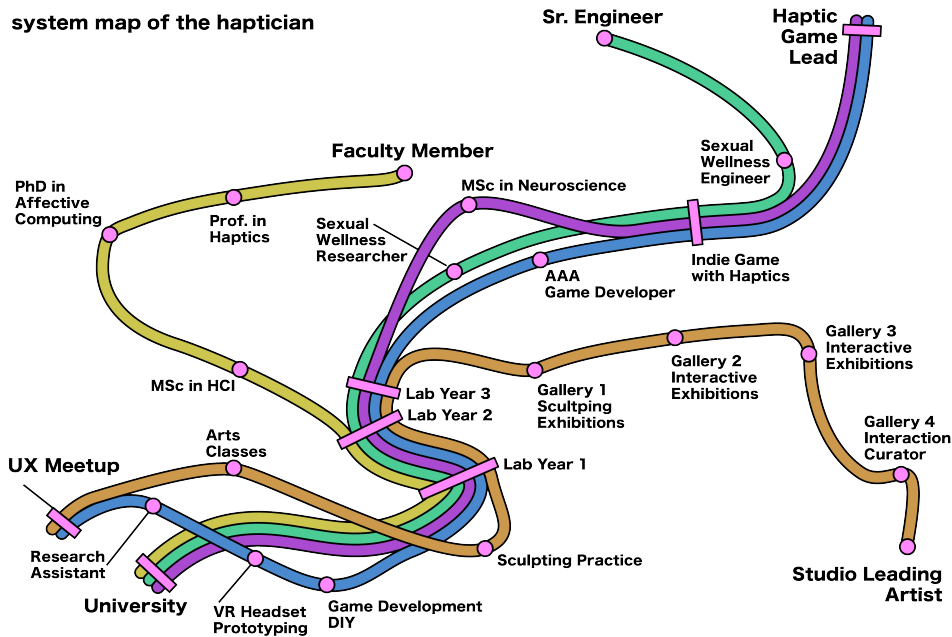


Figure 1.3: The system map of the haptician shows current, representative pathways of experiences hapticians have taken in the past and is inspired by conversations I have had with hapticians before. Hapticians can come from many different backgrounds, sometimes navigating away and closer to each other in their work. Lived experiences and situational knowledge is different based on each personal journey. This map aims to show the current snapshot of pathways hapticians have taken.

1.1.2 The Access Gap

Accessibility and empowerment for designers within the field of haptics starts at who has access to the knowledge and hardware. Currently, access to haptic resources outside of academia and other Northern, capitalist systems are limited. People along the periphery of haptics are then required to seek out resources that prioritize specific “traditional” STEM backgrounds. While there has been a recognizable effort in the delivery of haptic design knowledge that includes a diverse group of people [57, 72], this approach primarily informs those already aligned

with a Western STEM academic field by the nature of delivery through academic institutions. Peripheral hapticians might not have the same access to the knowledge of haptics as others within academia or industry, which can result in an underestimation of groups who may benefit from these resources such as DIY learners, artists, and interdisciplinary creatives. In this thesis, we see a need for better collaborative haptics knowledge access to facilitate terms like “haptics” and “the haptician” set out to represent.

1.1.3 The Haptic Design Ecosystem

Human-computer interaction (HCI) has long understood the importance of the human context that informs design practices. Haptics has also adapted to align with this sentiment [53]. Yet, HCI is not the only aspect that informs the field of haptics which requires multiple interdisciplinary knowledge forms (*e.g.*, mechanical engineering, psychophysics, education, and so on). The inner workings of these groups is often referred to as an *ecosystem*. The metaphor of an ecosystem is derived from the term in biological science, meaning the complementary relationships between organisms and their environments. A haptics design ecosystem would refer to the integration of haptic designs in their environments through contextual awareness of stakeholders, design reasoning, and evaluation [4].

As a rapidly growing design field, haptics can benefit from an increased diverse and visionary pool of hapticians that continue to extend and create rich, touch-centered environments. How do we include peripheral hapticians in the haptic design ecosystem to allow an empowering, inclusive, and reflexive design community? There has been some traction in open source haptic resources as well as many tools developed to help design and test haptic interfaces that take into account more of the haptic design ecosystem as a whole. In this thesis, we consider stakeholders described in Section 1.1.1 and Section 1.1.2 that are not as prioritized in the current haptic design ecosystem, such as peripheral hapticians.

1.2 Research Questions

1. Is there a way to elevate alternative and specialized haptics knowledge for a larger collaboration and knowledge sharing ecosystem?

2. How are experience levels currently defined in haptics?
3. What qualities of a community resource could provide an empowering, inclusive, and reflexive design ecosystem?
4. What value could come from making haptic design more empowering through a design justice lens (individually and culturally)?

1.3 Approach

Making haptic design accessible and inclusive is the long term goal of the Haptics Commons project, in this thesis we focus on the development of a community centered haptic design resource that reflects interpretations of frameworks inspired by the foundations of design justice and Feminist HCI. Using qualitative, feminist and design justice informed approaches, 1) we submit a set of social principles for haptic design that target inclusion of varied haptics knowledges; we then 2) design a haptic design resource called HapHub; and 3) iterate on the design of HapHub, rename it Haptics Commons, and further illustrate a viable design approach to expand the haptic design ecosystem.

For 1) we ran a semi-structured interview study with peripheral hapticians where we asked them about their experiences with haptics, how they identify themselves in the field, and what haptics needs to be more inclusive and accessible. For 2) we created a low-fidelity prototype of HapHub, an online haptic design resource, and ran a study that evaluated the prototype navigation, structure, and usability. For 3) we iterated on the HapHub prototype by changing its name to Haptics Commons, designed it in medium fidelity, and implemented recommendations from the previous iteration to improve feel, structure, and usability. The overall structure and inter-project dependencies can be seen in Figure 1.4.

For each portion of this project, we took a justice-based pluralist approach to knowledge formation, accepting that all knowledge is situated and partial. We take on this perspective, in line with the principles of design justice [61], in this portion of this project because haptic research and design has been criticized in the past for prescribing to a mostly technological perspective of touch [51, 66]. We interpret this as parallel to the description of scientific knowledge as a “monoculture”

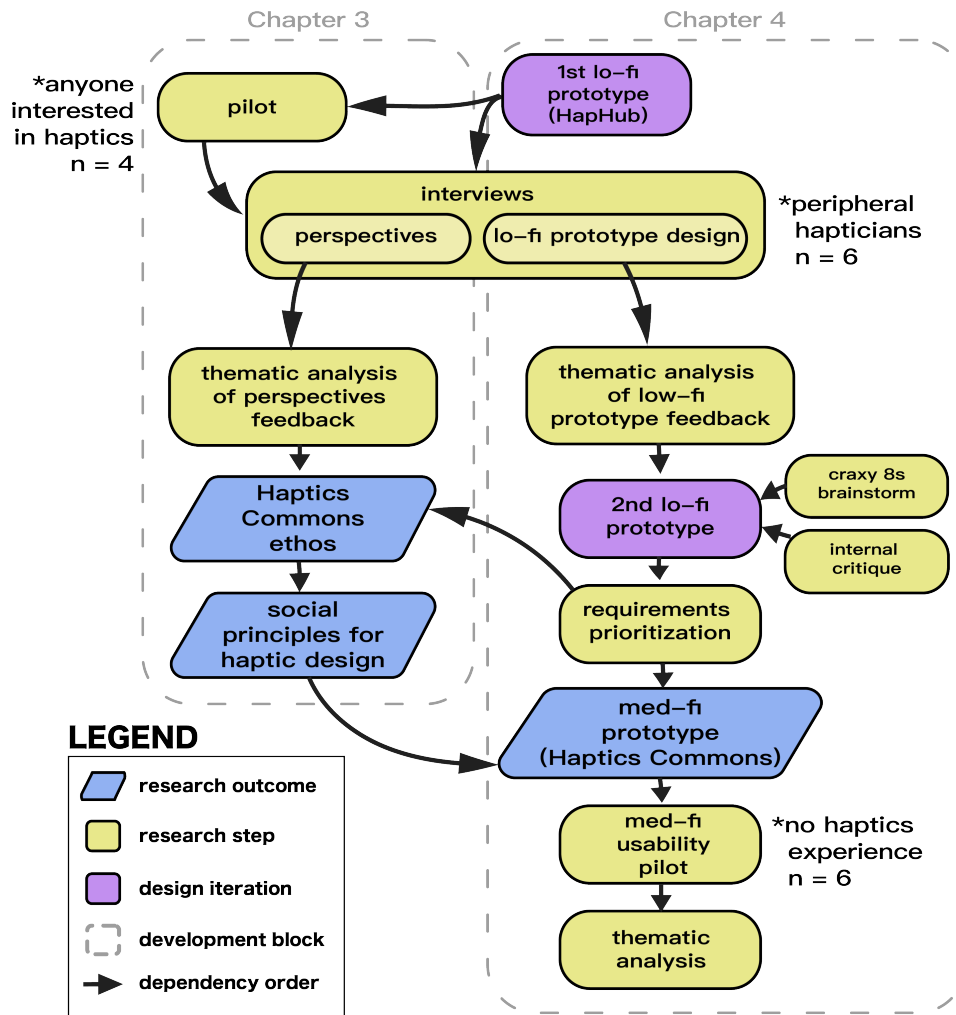


Figure 1.4: Research overview: This research was conducted in two parallel blocks (outlined in grey), one focused on developing social principles for haptic design based on peripheral haptician perspectives and the other one focused on the design of an inclusive, accessible haptic design community resource.

[24]. We agree, this does not mean that haptics is not internally diverse, but has taken on a monolithic quality in its relation to the range of other knowledge and experience regarded as non-scientific, lay, or experiential. We adopt on a feminist, intersectional interpretation of the haptician since “feminist criticism, in turn, has

provided some of the most powerful resources for the criticism of the monoculture of knowledge based on modern science and, in particular, of the way it has historically excluded or marginalized certain subjects, such as women” [24].

My research approach is highly *qualitative* methodologically. Below I provide brief explanations of philosophical research paradigms relating to my approach: pluralism, intersectionality and reflexivity, and design justice perspectives all intertwined in the approach of this project.

1.3.1 Feminist Qualitative Methodology

We take a feminist qualitative methodological approach in this research. Feminism is rooted in gender equality. As a practice, feminism involves recognition of inequality, power, bias, and privilege – more generally, practicing feminism makes space for underrepresented, marginalized voices [54]. Feminism as an approach to interpret values of socio-technical justice in HCI provides “critical perspectives that could help reveal unspoken values within HCI’s dominant research and design paradigms and underpin the development of new approaches, methods and design variations” [4]. In Section 2.1.2, we provide more detail and examples of how a feminist perspective has been adapted for HCI and design practices.

1.3.2 Intersectionality and Reflexivity

Reflexivity in qualitative research informs readers about possible biases or influences that the researcher may have had on the research process [47]. Acknowledging reflexivity in research can address the role of the researcher in the context of their work. As a researcher, the aim is to ask difficult questions that address and contribute to knowledge creation. Intersectionality, a term introduced in 1989 by Kimberlé Crenshaw, refers to an individual’s intersecting and interconnected social categorizations (*e.g.*, race, class, gender, ableism) [18]. Intersectionality has been applied to various fields to highlight how systems of exclusion and oppression can impact people differently based on their intersecting identities. The term has also been applied in HCI and design discourse to highlight how design and technology can repeat oppressive systems [70]. For example, many feminist HCI practices question how to dismantle possible structural inequalities built on harm-

ful foundations [18, 91], such as historical examples of institutional and academic exclusion [10, 48]. Self-reflexivity and researcher reflexivity (often in the form of a researcher positionality statement) is one way HCI researchers have recently aimed to disrupt oppressive, discriminatory systems in the field.

A common practice in qualitative, feminist research methodologies is a statement of researcher reflexivity as stated by the researchers. This process accepts that no research can be purely objective and in doing so, positionality statements acknowledge any potential conflicts of interest or influence in research reporting. I provide a researcher positionality statement in Section 1.4 and report participant demographic information their own words as to avoid obscurification.

1.3.3 Pluralism

Pluralism, also commonly referred to as an “ecology of knowledges”, is the concept that knowledge is not an essentialist, fixed concept [24, 27]. By accepting that knowledge can take on many forms beyond the scientific (*e.g.*, emotional knowledge, experiential knowledge, indigenous ways of knowing), haptic design can center standpoints of varied lived experiences, empower other project participants, and build branching relationships and collaborations across socially different lines that may have not previously been considered.

1.3.4 Design Justice

Design justice is an approach to socio-technical design, led by the marginalized, and resonates with feminist perspectives of pluralism, intersectionality, and reflexivity. Design justice is a position that aims to dismantle systems that reproduce structural inequality through design [61]. The perspective began with the Design Justice Network, “an international community of people and organizations who are committed to rethinking design processes so that they center people who are too often marginalized by design” [16, 61]. The Design Justice Network considers the relationship between design, power, and justice to tackle the matrix of domination (white supremacist heteropatriarchy, ableism, capitalism, and settler colonialism) through a commitment to their ten guiding principles⁶:

⁶Design Justice principles as reported on the Design Justice Network website

1. We use design to **sustain, heal, and empower** our communities, as well as to seek liberation from exploitative and oppressive systems.
2. We **center the voices of those who are directly impacted by the** outcomes of the design process.
3. We **prioritize design's impact on the community** over the intentions of the designer.
4. We view **change as emergent from an accountable, accessible, and collaborative process**, rather than as a point at the end of a process.
5. We see the role of the **designer as a facilitator rather than an expert**.
6. We believe that **everyone is an expert based on their own lived experience**, and that we all have unique and brilliant contributions to bring to a design process.
7. We **share design knowledge and tools** with our communities.
8. We work towards **sustainable, community-led and -controlled** outcomes.
9. We work towards **non-exploitative solutions** that reconnect us to the earth and to each other.
10. Before seeking new design solutions, **we look for what is already working** at the community level. We honor and uplift traditional, indigenous, and local knowledge and practices.

As a field of HCI and design, we aim for this project to resonate with the design justice principles as a guiding structure to the approach and impact of haptic design and technology. Our qualitative approach through a lens of design justice is reflected in revealing and understanding systems of exclusion that may not be immediately apparent in haptics.

1.3.5 Our Focus on Peripheral Hapticians

In our approach, we recruit and only talk to peripheral hapticians and people with no previous haptics experience. Immediately, we acknowledge that this is not all

stakeholders in the investigation for haptic design accessibility. Of course, we would hope to include other stakeholders in our research and design in the future.

By focusing on the voices of peripheral hapticians to form cultural perspectives of haptic design, we give agency to those who might not previously be prioritized in participatory design practices. This is in line with a feminist approach that focuses on dismantling points of inequality and systemic exclusion by centering marginalized voices. It has been observed that in an online community, people typically comfortable with technology have more of a voice in how a technology-centered community is structured [42]. So we do not repeat a structure of inequality in this context, we first center voices of people who feel as though they need more support and communication from the haptics community: peripheral hapticians.

This is but one piece of a larger research and design project. By starting *with* voices of peripheral hapticians, we were both able to appropriately scope our interviews so we could hear from a variety of voices, as well as ensure we were following feminist frameworks in participatory design and design justice guidelines that work against systems of exclusion and oppression. This is a foundational technique used in justice-based approaches of representation so certain, less dominant groups do not get forgotten or provided inconvenient solutions later (*e.g.*, if people are visually misgendered going through airport security, they are required to be physically touched and/or further questioned about their identity, which can present many more problems for the individual). The goal of this thesis is community building. In the future, we hope to bring in voices beyond the ones we focus on in this thesis. Since the design result we are striving for involves and engages diverse hapticians, we acknowledge the importance of also involving all stakeholders in the design of the resource. In this thesis we focus on peripheral hapticians, but in the future we wish to involve others in the process of design and community participation.

Lastly, our focus on peripheral hapticians provide the perspective of pluralist knowledge disrupts the idea that there is a dominant pathway to being a haptician. In fact, we widen the interpretation of how to be a haptician through feminist perspectives of situated knowledge that can strengthen diverse representations of knowledge.

1.4 Researcher's Position

I write for curious minds as they seek out haptic design, but also for researchers and educators of haptics to recognize potential implicit biases and systemic inequalities that might exist in their work. Discussing ethical considerations of research entails providing information about the author's cultural context to help demystify the "we" this thesis mentions and how it might influence the research. Due to the standard academic nomenclature, I used the pronoun "we" in this thesis instead of "I" in some instances. The "we" refers to the research team consisting of me, three undergraduate volunteers, and my supervisor Dr. Karon MacLean. Here, I detail the thesis author's position.

Standpoint theory in feminist praxis recognizes that knowledge is situated in the lived experiences of the researcher [46]. Often, this is done as an ethical requirement in academic journals to acknowledge both the potential influences and conflicts in the reported work. Positionality statements are scarce in HCI publications, but recently have had an uptick in frequency as the field is recognizing the lack of objectivity possible in the scientific process. As a researcher dedicated to activism issues such as epistemic diversity, anti-colonialism, equity, empowerment, social and design justice, I would like to situate my position as a researcher for the reader to lend rigor and transparency to our work.

I personally have a stake in this topic of research as a mixed-race woman of color, international student, and graduate student in the field of computer science and haptics without a formal engineering background. I moved to Vancouver in 2015 to pursue my Bachelor's degree and during the years since I have both benefited and been harmed by racism, sexism, capitalism, and educational inequality. Yet I also recognize that I come from a potentially different position of privilege and marginalization than others, therefore there will be areas of inequality and marginalization I do not and have not experienced. Not only does this mean that I identify with research in this topic, but that I have my own experiences and opinions about marginalization and accessibility of haptic knowledge and resources. I acknowledge that my position in a Master's program in Human Computer Interaction has helped me rethink approaches and epistemologies to designing and evaluating haptic design ecosystems, access to this position is both a privilege and

product of settler colonialism. As a graduate student at UBC, I would like to acknowledge that the land on which I study is the traditional, ancestral, and unceded territory of the x^wmək^wəyəm (Musqueam People). I recall the unjust, racist, and colonial practices that have had a lasting legacy, and continue to create prejudiced obstacles for Indigenous peoples across Canada.

I aim to utilize design methodology in HCI to disrupt and complicate contexts that repeat or threaten to repeat the matrix of domination [16]. I then consider design and design ecosystems that might productively agitate underlying biases or assumptions. In turn, my hopes with this approach are to design with others that are active in the field of haptics, but equally share a personal interest in expanding thoughtful haptics knowledge, sharing, and accessibility. My approach is informed by the principles of design justice and a feminist, anti-colonial perspective – I work to not “fix” people in disadvantaged positions, but bring them to the forefront of discussion by critically examining existing haptic design spaces and providing the tools for empowerment in them.

1.5 Contributions

1. **Characterization and social principles for haptic design:** Reframed a *broadened understanding of the haptician*, going beyond current representations in our interpretation. We characterized attributes that contribute to dimensions of expertise in haptics that *promotes recognized inclusivity* in the field and developed principles for the future of haptic design accessibility.
2. **Problem identification:** Examined haptic design/resource accessibility needs for hapticians from *various backgrounds* to facilitate the rising interest in haptic technology.
3. **Design instantiation:** Prototyped an exemplar resource that takes into consideration *informed design recommendations for sharing haptic knowledge* and empowering hapticians of diverse backgrounds and experiences.

1.6 Thesis Organization

The rest of this thesis is organized as follows:

In Chapter 2, we provide some background on the theoretical framework we adopt and how it relates to Human-Computer Interaction research practices and scientific knowledge production as a whole. We present some issues present in current haptic design accessibility as well as give an overview of how hapticians have been studied as well as trailblazing approaches in haptic design that inherently reflect inclusivity efforts.

In all, we conduct two interviews and present two prototypes. In the first interview, we split the results into two chunks: perspectives (Chapter 3) and prototype (HapHub, Chapter 4). In the second interview, prototype and results are presented in Chapter 4.

Chapter 3 presents the results of our first round of interviews with peripheral hapticians, where we conducted participatory interviews with a sample of 6 hapticians. In this study, we only report on the “perspectives” portion of this interview block and introduce a set of eight social principles for haptic design.

Chapter 4 presents the two prototype iterations (HapHub and Haptics Commons). We discuss results from evaluations of both prototypes, potential design implications, and overall opinions from 6 participants unfamiliar with haptics.

Chapter 5 discusses details of our research questions, revisited. Chapter 6 revisits our contributions, impact of our approach, and future directions for research.

Chapter 2

Related Work

In this project, we consider concepts of epistemological justice and design in the field of haptic interface design. We bridge qualitative methodology and feminist HCI perspectives to assess notions of accessibility, equity, empowerment, and inclusion. In this chapter, we discuss selected previous works that we build upon and are relevant to our objectives.

2.1 Justice & Equity in HCI

Topics relating to social justice issues have been long studied in HCI, but recently have had an uptick in interest. As technology has advanced and humans continue to interact with it, we have seen how impact can permeate on multiple dimensions. In the scope of our work, we introduce social justice HCI investigations and frameworks that guide our approach in haptic design ecosystems.

2.1.1 HCI and Design Call to Action

Scholars of human-computer interaction (HCI) and computer-supported cooperative work (CSCW) have recently drawn on the work of grassroots, anti-racist, feminist scholars of Critical Race Theory (CRT) action research, and narrative episode interviews to reveal the prevalence of racism within interaction design educational systems [3, 64, 87]. Researchers have also examined grassroots values in technology to reveal inequitable sociotechnical realities within these movements [43]. For

example, Ghoshal et al. found that when people within a Southern Movement Assembly employed information and communication technologies, the people with technical skills gained more power and control in the organizational process which resulted in inequitable participation within the group. Additionally, people more comfortable with approaching technology typically have more of a voice in how a technology-centered community is structured, even if they believe they do not belong in that role [42]. Research that has examined similar points of inequity and systemic exclusion typically call for the centering of marginalized voices as technical skills are most commonly associated with racial, gender, and socioeconomic privileges.

More generally, past research has identified a mismatch between social values (human activity is highly flexible, nuanced, and contextualized) and technical feasibility wherein the technical capabilities of a system does not match the social requirements from technology [2]. It is well known by scholars of human factors in computer science that the application of scientific knowledge that involves people must consider both technical requirements – what we can support technically, *and* human requirements – what we can support socially [65]. Haptic research and design is not excluded from a similar critique. Researchers have questioned whether haptics origins have influenced the way the field has focused on technological perspectives [51, 66]. Others have asked whether people could bridge this gap by designing haptic systems from experience perspectives [22].

Our work responds to HCI and CSCW calls to action of technological justice through a focus on knowledge accessibility and empowerment with haptic technology to engage people in discussions of haptics on multiple levels. There exists research on design frameworks that aim to educate and introduce students to the field of haptics [57, 78]. Seifi and colleagues [78] aimed to identify “true accessibility requirements” for novice designers, though this work homogenizes the definition of “the novice” through selecting participants from predominantly engineering, academic backgrounds. Haptics is a powerful sense that is able to portray the importance of storytelling and emotion through immersive technologies that don’t always consider engineering end-goals [20, 26, 30, 82]. It is well known that hapticians need sufficient support in their design practice [57, 73, 74], and through perspectives of technocultural theory, we center marginalized perspectives in the

evaluation of haptic design ecosystems to similarly address the systemic inequity the culture of technology.

2.1.2 Feminist HCI

In addressing this call to action, we must examine the frameworks that others have used to approach interpret values of socio-technical justice. In being attentive to difference, a feminist perspective often questions structures that reproduce social power and scientific oppression. Feminists have offered the example of womens' experiences to argue against the idea of one dominant experience. In doing so, feminist scholars have recognized a plurality of lived experience rather than a single essential one [48]. Yet it is also important to remember feminism has far more to offer than pointing out instances of heteropatriarchy [5]. We first examine Feminist HCI, a term coined by Bardzell in 2010 [4]. Many of the core feminist values center commitments such as agency, inclusivity, diversity, and empowerment. Through exploring feminist approaches in industrial design, game design, and architecture, Bardzell provides an extension of values already expressed in HCI that illustrate a generative way to assess participation, agency, embodiment, and ecology in interaction design [4, 6]. Similarly, past HCI research has examined constructions of universal, objective truths often generalized and discussed in technology and design. The field of HCI is widely recognized for its ability to cater to people through systems and interaction design, yet has been criticized in the past for narrowing the human experience to purely interactions with a system rather than context-informed interaction design [16]. Feminism in HCI brings in a critical step in examining awareness and accountability for potential social and cultural impacts technology has on society [6].

In 1988, Dona Haraway introduced the idea that all knowledge is situated in the position of the individual [46]. One of the resounding intellectual achievements of feminist theory is Harding's critical strategy for recognizing and understanding different epistemologies. Known as standpoint theory, this major contribution to feminist theory reimagines the production of knowledge to be situated in the individual's social and political lived experiences [47]. Methodologically, scholars of feminist HCI have also recognized the importance of empathetic, participant

dialogic or narrative analysis in qualitative “experiential” research for challenging reductive assumptions and western knowledge conceptions [14].

Fiesler et al. have expressed that “rarely are computing systems developed by the communities they serve,” yet by starting a process of inquiry from the position of lived experience in that community, people who have typically been excluded from knowledge production are given a voice [37]. In the case of Blake et al., researchers worked with elders of a community in Namibia to co-design a media creation tool. By doing so, researchers used empowered design as a way to address power relationships between co-designers in the local community, enabling the community with the training and skills to address needs within their own community[8]. In Vacca’s research, they set out to find design techniques that could inform complex cultural and ecological conflicts faced by Latina teenagers. Their technique used a multiracial feminist framework and intersectional elaboration (narratives of lived experiences) to co-design a support system for Latina teens’ emotional health [89].

Echoing the work of Bardzell, the overlap between feminist HCI and co-design is in fact giving voice to the marginal – an underlining of situated knowledges within a community that bring instrumental insights into the design process that would typically not be recognized by designers on their own [5, 89]. Recently, there has been a rising interest in centering voices of the marginal, what is called the third-wave HCI, from which we can learn in both approach and theory [10, 12, 19, 70]. From these examples, we see that appropriations of social, cultural, and gender HCI practices center the voices typically not heard in the design process. Acknowledging situated knowledges and voices of the marginal can provide valuable insights to a design, use, and adaption of technology.

2.1.3 Design Justice and Intersectionality

Computer science and design history has been criticized in the past for being predominantly male, white, and heteronormative [17, 54]. More specifically, the term “user” in HCI has also been criticized for a similar reductionist point of view stemming from conceptions of the modern man, an illustrative example in Figure 2.1.

Black feminist thought reconceptualizes race, class, and gender as a unified system rather than mutually exclusive aspects of identity. This framework is known

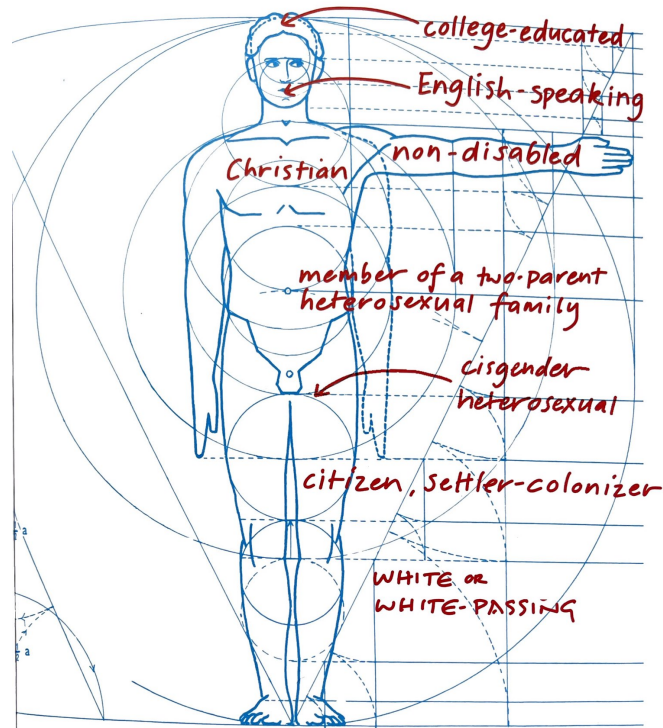


Figure 2.1: A diagram of the “modern man and his bubbles” by Ernst Neufert and annotated by Jennifer Tobias. The annotations in this diagram are a commentary on Neufert’s masculine measurements that sealed the notion of universality in white, heteronormative, western traditions [54].

as intersectionality [18]. It has a long standing history in African American abolitionism and women’s rights activism introduced by Kimberlé Crenshaw (see Figure 2.2). Crenshaw uses the metaphor of an intersection to illustrate this idea:

“If an accident happens at an intersection, it can be caused by cars traveling from any number of directions and, sometimes, from all of them. Similarly, if a Black woman is harmed because she is in the intersection, her injury could result from sex discrimination or race discrimination.” [18]

SOURCE Kimberlé Crenshaw, "Demarginalizing the Intersection of Race and Sex: A Black Feminist Critique of Antidiscrimination Doctrine, Feminist Theory and Antiracist Politics," *University of Chicago Legal Forum*, special issue: "Feminism in the Law: Theory, Practice and Criticism," 1989: 139–68.

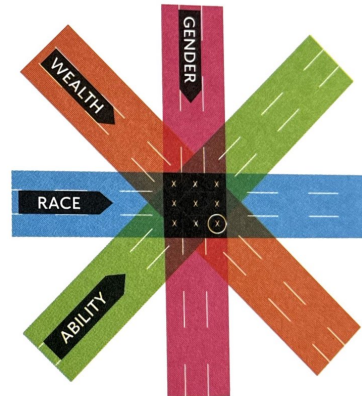


Figure 2.2: An illustration of Kimberlé Crenshaw’s intersectional experience as a black, cisgender woman law student at Harvard [18, 54].

Intersectional analysis instigated a slow paradigm shift that has begun to make its way into HCI and design system discourse. The focus of intersectionality has been reflected in shifting design against single-axis analysis: “in which race, class, or gender is considered as an independent construct,” to a design construct that considers lived experiences as intersectional when creating well-meaning objects, systems, or environments [16]. This idea is echoed in the work of Ogbonnaya-Ogburu et al. in that each person represents a collection of overlapping, potentially conflicting, identities that require an anti-essentialist approach in design [64].

One specific area that has grown in HCI discussions has stemmed from the work of Patricia Hill Collins, a black feminist scholar who coined the term: the matrix of domination [15]. As outlined in *Design Justice*, design has the ability to reproduce, be reproduced by, or “challenge the matrix of domination (white supremacy, heteropatriarchy, capitalism, and settler colonialism)” [16]. As noted by Asad, many forms of justice have commonalities with design through a focus on process [3]. As discussed in Section 2.1.1, scholars have announced a call to action and opened dialogue for better recognition and representation in design practices, decisions, and labor. Researchers specifically have paid attention to whose labor is valued historically and actively in design [3, 16, 64, 87].

This is the framework that we will be using to understand people and forms

of knowledge in haptics. For example, a haptician may have an engineering background, but they might also be a cisgender woman and a dancer. Imagine this person is working on an embodied haptic vest. Their engineering background may inform their approach to some aspects of haptic design, but so do their experiences being a woman and being a dancer. When it comes to theories of embodiment, one that is commonly discussed in haptics, lived experiences inform how and what we decide to design. To parallel this theory to haptics is to think about how the haptician has previously been represented and how knowledge has been recognized in the field.

2.1.4 On Pluralism and Reflexivity in the Sciences

In thinking about the ways identity can be intersectional, it is also important to critically reflect on the points of intersection that could be constructing your own perspectives and identity. In the example given in the previous section, the haptician who is an engineer, cisgender woman, and a dancer has multiple reflection points in her lived experience that inform how she knows about embodiment in haptics. Similarly, in this thesis I provide a statement of my positionality to contextualize and situate our reporting.

A major tenet of feminist HCI is the acceptance of pluralism and critical reflexivity, also referred to as ecology of knowledge and positionality, respectively. de Sousa Santos et al. argue that to further diversify knowledge systems, science must be recognized as a partial knowledge system, thus refusing the “monoculture of scientific knowledge,” and prioritizing local, experiential, and indigenous ways of knowing as well [24]. de Sousa Santos et al.’s call for knowledge diversity aims to disrupt the priority of empirical knowledge and remove hierarchy in ways of knowing all together. Western epistemology has constructed science as a form of universal, objective, and neutral knowledge that views other forms as particular, local, or situational – justifying a positivist global colonial order [67]. The concept of pluralism aims to address the issue of epistemic hegemony present in current dominant systems, like Western knowledge. By adopting feminist critiques of positivism¹, methods such as participatory design, co-design, and design justice

¹Positivism is traditionally an empirical theory of objective truth – an a posteriori fact that is

perspectives can aim to provide emancipatory discourse² and practice to pluralist knowledge recognition [46].

In interaction design and HCI, researchers have referred to pluralism as a crucial consideration in design processes to reflexively consider “their broadest contexts and awareness of the widest range of stakeholders throughout design reasoning, decision-making, and evaluation” [71]. Pluralism has also been an adopted principle in other organizations of socio-technical justice such as design justice [61], data feminism [27], and graphic design discourse [54]. Design by and for marginalized communities also has had a foothold in HCI research. For example, collaboration in museum design and experience has been done [13] as well as technological integrations of indigenous knowledge, empowering those with the power to design in VR [68].

Considerations committed to pluralist ideas of touch are also important to include in haptic design. For example, historically there has been damaging rhetoric produced around “higher” and “lower” senses that targets specific cultural knowledge systems around touch. Specifically, German philosopher Friedrich Schiller has said in 1794 that “as long as man is still as savage,” (savage is a term that has historically been in reference to non-Western, Black, brown and Indigenous peoples as a tactic to dehumanize and oppress) the sense of touch, taste, and smell are purely for aesthetics rather than the “higher” senses of sight and hearing [69]. Our pluralist and critically reflexive lens for haptic design would be to recognize that there is not one single, dominant, or technical way to look at haptic design, but that the past approaches have created a partial understanding – a multiplicity that is continually expandable.

2.2 Haptic Design Communities

There are many different design spaces online and locally that contribute to haptic design knowledge and practice. We can take inspiration from the challenges faced

confirmed by logical reasoning. Feminist critiques of positivism fall in three camps: 1) rejection of the notion that science is value-free 2) human experience cannot be separated from our understanding of the world and 3) gender representation should remain a relevant axis of investigation in science [6].

²“using language, along with other aspects of social practice, in a way which works towards greater freedom and respect for all people” (Janks & Ivanić, 1992: 305)

and successes in the examples from others.

2.2.1 How Hapticians Have Been Represented

Haptics remains a challenging task for many designers. Hapticians have been researched for insights to their haptic design practices to understand some of these challenges. MacLean has identified four major gaps of inspiration, theory, process, and value when designing haptic media [56]. To break down some of these challenges into more digestible chunks, hapticians are typically studied based on how much experience they have in haptic design or application area.

Most of the time, research on hapticians is motivated by the need for redistribution of generalized support or design needs within the field. For example, Seifi et al. studied how novice hapticians design to identify where people needed support in learning haptic design. Here, researchers compared design practices to expert hapticians to identify three needs for haptic design resources and processes: 1) theory and guidelines for haptic design 2) design examples and content galleries for inspiration and tools and 3) an ecosystem of haptic design authoring tools to support different design stages, activities, and user groups. Seifi et al.'s research on novice hapticians and their needs has been instrumental in understanding the design and delivery of haptic design practices to undergraduate engineers [78]. We build on this approach by exploring the design of a haptics resource that address the three main gaps in haptician support.

Although their sample was limited to undergraduate engineers, Seifi et al.'s findings can be generalized to other contexts of haptic design support and other specific applications. For instance, Degraen et al. studied the needs of novice hapticians designing haptic systems in VR using their voice. In this project, the novice haptician participants were reported to have backgrounds in computer science, media, microbiology, and linguistics with some varied experience in VR. In two studies, investigated novice hapticians and expert hapticians evaluation methods of haptic user experience to try to understand and characterize dimensions haptic experience [53]. Similarly, haptic experts have also been researched for their evaluation methods on haptic devices [36, 79], design practices [72], representation [63], and application areas [40].

More specifically, haptics practitioners have also called for a shift in the way haptics is thought about in a technological sense. Jewitt et al. calls for a shift away from digital touch to a social and sensory priority of touch experiences in a 10 point manifesto and call to action [51]. In congruent with this call, in Parisi's work on documenting the history of haptics and touch, they identify that current mainstreams of haptics have "colonized" touch through haptic technology. Parisi notes that haptic technology is not the problem itself, but it is the priority of technology in touch experiences that "involved the production of a calculable instrumentalized mass haptic subject that became the foundation for a genealogy of subsequent types of interfaces." Through their work, Parisi disrupts the technical focus of haptics, questioning and confronting power relations between touch and technical media [66]. Furthermore, Offenwanger et al.'s findings revealed that representations of "the haptician" can produce gender bias in haptician participants due to the field's foundations in engineering [63]. Parisi, Jewitt et al., and Offenwanger et al. provide a thought provoking insight to the way we conceptualize haptics, technology, and the haptician. We shift our focus away from the skill level and field specified "haptician" to further identify types of support other people interested in haptics might need.

2.2.2 Open-Source and Haptic Design Communities

One approach to haptic design has been increasing the accessibility of information, tools, and design strategies for future innovation and community. A common way others have strived for accessibility is to do this through open-source projects and makerspaces [35, 43, 85]. Open-source, community-centered projects have been described as "scratching an itch" as a problem the community has been trying to resolve [37]. There are a myriad of benefits to open-source and makerspaces that have granted access [52], learning [35], opportunity [90], creative outlets [41, 94], and community for many [84]. Some have observed that open source projects have mostly been formed by software developers [85], but these groups have set an example for a community-led, open-source projects that are made for and by the community it is intended for.

There has been a growing effort in haptic design to create accessible formats

of haptic design and knowledge. There has been some community centered itch scratching in open-source haptic projects that prioritize engineering and software projects such as haptic software made for and by developers [62], haptic VR gloves and online community for gamers [23], online courses [80], podcasts [49], and DIY haptic kits to take home [39, 59, 60, 92]. DIY haptic kits such as Hapkit, Haply, HapticLabs and WoodenHaptics all provide take-home versions of haptic devices that can be experimented with to learn haptic design, but these DIY solutions do not provide a widely recognized community and are highly individual explorations without guided support.

What seems to be missing from these specific haptic open-source projects is value sensitive design (VSD) approach where more community members can participate easily with one another. Fiesler et al. provided a unique example of VSD that was built by the community it was intended for [37]. Their example does not center technology related topics, but a common interest that keeps the community active is the shared commitment to fan fiction writing. Another example is craft communities such as Ravelry³ for fiber artists; a community was created due to the founder being “frustrated by the lack of organization of online knitting resources” [85].

Schneider et al.’s recent workshop (2022) asked about how open collaboration and sharing can be improved in haptic design communities, yet this work is still in its early stages [73]. Similarly, Shor also conducted a recent workshop (2022) that held a panel and discussion on how to increase interdisciplinary diversity in haptic research, product design, and artistic installations, though this work is also still in its early stages. We take inspiration from the value of open-source, community-led practices to address the sprawl of haptic design knowledge, support, and community dialogues.

2.2.3 Trailblazing Approaches in Haptic Design

We can look at a small collection of examples in haptic design to inform our approach. There has been notable work in multiple sub-fields of haptics, in order to provide a meeting space for them we consider and appreciate their variety.

³<https://www.ravelry.com/>

Finding a meeting ground where people can share an interest is an important part of community building. An example of an active DIY haptics community is LucasVR [23]. This community has built at-home haptic gloves for VR gaming and in their approach, they provide tutorial videos and a Discord discussion server with more than 10,000 community members. Approaching community building in an entirely different way, The Haptics Club podcast that started in 2021 has opened the conversation to haptics in industry and academia, exemplifying a great variety of perspectives in haptic design, knowledge, and application [49]. One interesting aspect of both LucasVR and The Haptics Club podcast is the offshoots of reading groups, tutorial videos and online discussions about haptics. Something like Schneider et al. and Shor’s workshops open discussions on how haptics can be shifted in perspective towards more creative, experiential forms of communication in haptics either through packaging haptic demos [73] or shifting technological focus [22, 26, 81].

Examples like these are important to consider because they informs us of what kind of needs are currently being addressed in the growing haptic design ecosystem. We aim not to replace any of these communities or dialogues, but to leverage them by bringing people together in a shared space, hopefully branching across fields, interests, and knowledge.

Chapter 3

Uncovering Hapticians’ Perspectives

With diverse representation comes with a wealth of experiences and perspectives that elevate the design industry and the work we put out into the world— Kaleena Sales

In Chapter 2 we have discussed some of the issues present in current haptic design accessibility and inclusivity efforts as well as a narrowed interpretation of “the haptician” that stems from assumptions of specific experience and skills. This chapter aims to more concretely identify perspectives of peripheral hapticians that previously have not been heard from in an attempt to establish whether there exists a need to expand beyond current haptic design experiences and interdependent relationships.

To do so, we describe the feminist, design justice research approach that focused on finding out whether the haptic design ecosystem would benefit from further knowledge democratization, and subsequently if there exists an alternative approach that centers community values and concerns. We describe a small pilot interview and consequent refining of recruitment techniques and our study design. We close with a proposal of eight social principles for haptic design for a reflexive approach to haptic design knowledge sharing.

3.1 Objectives

The field of haptics is rapidly growing. We aim to use lessons from other human-computer interaction design fields to help grow haptics in a direction that remains reflexive and aware of both designers’ and users’ accessibility and equity. Application areas of haptics are also rapidly expanding, and we have argued in the previous chapter that it will be important to include a wider spectrum of voices in this application, from the stand points both of giving more individuals access to the technology, and of increasing the diversity of ideas and experiences that influence design.

To echo the words of design educator Kaleena Sales: “What’s important is that as we meet young designers along their journey, we don’t impose antiquated ideas about what it means to make good design, or quiet their instincts to fit our expectations” [54]. This chapter aims to investigate our research question by asking peripheral hapticians to recall their experiences navigating into haptics and how they identify themselves in the current haptic design space through challenges, accomplishments, and networks.

3.2 Approach

Similar to the classic “empathize” stage in IDEO’s design thinking framework [50], this stage of the research project aimed to address two of our research questions: *RQ2: How are experience levels currently defined in haptics?* and *RQ3: What qualities of a community resource could provide an empowering, inclusive, and reflexive design ecosystem?* In-depth interviews, discourse analysis, and observation are at the core of feminist methods [88] and have been also workhorses in the field of feminist HCI through approachable mediums, building inclusive products, enriching creativity, and personal representation [12]. Adopting feminist methodology through a design justice perspective echoes our focus in the design justice principles [17] and feminist qualitative research approach in knowledge formation and value sensitive design [4].

Qualitative methods such as in-depth interviews and thematic analysis have been criticized as unreliable to objectivity, since the data collected is highly subjective [31]. While this may seem like a risk to subjectivity and bias within the

study design, it is also necessary for the study participants to feel comfortable discussing potential issues or challenges with someone who understands “the space between” – in research, specifically interviews, this can be vital in removing a tensioned space between researcher and participants [31]. We take this approach to help advocate for the participatory model that aims to accomplish a non-manipulative relationship when interviewing and working together in design [6, 88].

Through in-depth, semi-structured interviews and thematic analysis, we feature the participant’s feelings, perspectives, and lived experiences with little researcher control or manipulation. In turn, we reflect feminist standpoint theory perspectives by acknowledging and not influencing the participants’ retelling of their experience and feelings.

We follow the study design structure shown in Figure 3.1. Our interviews originally had two parts (labeled “interviews” in Figure 3.1): 1) perspectives on the haptic design ecosystem and 2) a prototype design evaluation. In our interviews in this chapter we will only discuss the perspectives portion of the interview (Chapter 3) the other prototype design portion of the interview is discussed in Chapter 4.

3.3 Interviews: Hapticians That Self-identify To Be on a Periphery

We first conducted a pilot study with people that identified as haptics-curious. With study design adjustments from the pilot, we took more targeted approach to recruitment of peripheral hapticians to illuminate and contextualize some of their experiences in the field. With a similar, slightly altered study design, we qualitatively investigated information seeking and community practices in haptics through an exploratory study pilot and interview. We aimed to determine patterns in the underlying haptic design ecosystem that could be relevant to accessibility, empowerment, and knowledge sharing in the field. Based on our findings, we propose eight inclusivity codes to bring a larger haptic design community together.

3.3.1 Pilot: New Hapticians and Haptics Curious Folx

We conducted a pilot study (N=4) and aimed to talk with anyone who identified as being interested in haptics. The intent was to get a better idea of the landscape

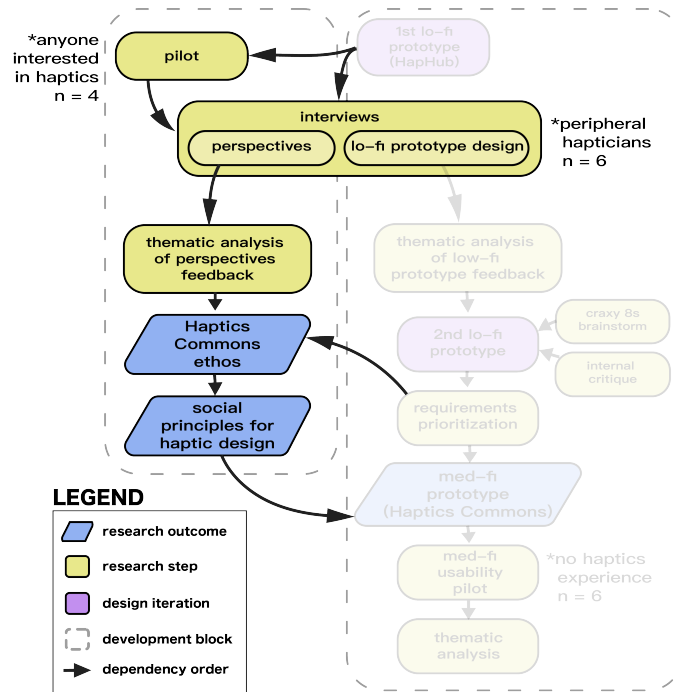


Figure 3.1: Highlighted portion of the protocol focused on the perspectives development block of the research (Chapter 3) to generate an ethos and social code for the haptic design resource.

people are facing on their own when trying to learn and/or design haptic experiences as well as inquire about our second and third research questions (*RQ2: How are experience levels currently defined in haptics?* and *RQ3: What qualities of a community resource could provide an empowering, inclusive, and reflexive design ecosystem?*). In a 1 hour long interview, we asked participants about their specific experience with haptics, any challenges they faced in projects, and their personal motivation that brought them to the field. Then we had participants reflect through a brainstorm task and asked them for potential solutions to a haptic design resource. Protocol details can be found in Section A.3.

Recruitment and Participants

Participants were recruited through public postings, e.g. Reddit community forum r/haptics, or through individual emails in personal networks and referrals. The

pilot was conducted with four haptics curious participants (N=4) whom were made aware of the study from the r/haptics Reddit forum. Our inclusion criteria was that the participant needed to be interested in haptics and have at least one experience with haptic sensations that they can identify. Participants all stated to be from Canada with three located in Nairobi, Kenya and one in Montreal, Canada. The recruitment message is detailed in Section A.1.

Takeaways

On reflection, the four participants we interviewed were in fact haptics interested and were inspired by the work done in haptics fields but did not have any personal experience on haptics projects.

All participants identified to be beginner-intermediate level hapticians, and when asked to define this experience in context participants referred to materials like books and Youtube videos.

However, this recruitment style was not ideal for the types of discussions we wanted to have. Researchers were able to identify that the participants were not familiar with haptics beyond a general understanding. For example, in a question asking about imagining a haptics application that they wish existed, P1 discussed an idea of dentistry stating “*dentistry might be a good area to put haptics,*” yet when the researcher probed for more detail in this idea the participant was unable to expand what they meant beyond the proposal of combining haptics and dentistry. Similar difficulties were identified with P2, P3, and P4, often times resulting in inability to describe their interests and getting stuck on one idea over multiple questions. Some questions asked about personal experiences and definitions in their experience with haptics, often times resulting in a pause in the conversation and audible typing heard. When comparing the responses with basic Google searches (e.g. “define haptic design”), both P1 and P4 responded with an online definition, verbatim. Furthermore, P3 and P4 both asked the researcher if they could “*provide more information for more compensation*” and if there was anything they could do to “*convince [the researcher] to pay more,*” indicating monetary incentives.

From the pilot, we realized the need for targeted recruiting in order to discuss perspectives on the field, which is not just haptics-curious people, but people who

P#	Haptics experience level (self-stated)	Haptics Contexts	Background	Pronouns	Location	What brought them to haptics
P1	I don't know, not expert	artist	fine arts	she/her/hers	Netherlands	<i>"I'm so tired of all this art that is just distant and there is nothing really physical"</i>
P2	close to expert but defined by the field	entrepreneur	physics	he/him/his	Italy	<i>"I got interested into algorithms at the end [of my degree]. And I am a musician so I love signal processing."</i>
P3	four years of experience as an experience designer	engineer	industrial engineering	he/him/his	Germany	<i>"I suppose I've been always very tactile person... I use artistic exploration as a way of allowing my scientific interests to be developed"</i>
P4	relatively new, not an expert	design graduate student	fashion design	she/her/hers	U.K.	<i>"I've become really interested recently in how we communicate research, complex ideas to the everyday person... like a big theme in my work is like hardness of technologies that comfort-less-ness."</i>
P5	intermediate level	design graduate student	fine arts	she/her/hers	U.S.A.	<i>"I'm interested in disability like justice, and also gender and sex... in this intersection point of pleasure and pain. I knew my interest was in interactive, like three dimensional stuff."</i>
P6	somewhere in the middle ground	entrepreneur	industrial design	he/him/his	Netherlands	<i>"I've always been like a very hands on guy... I've also done a lot of music in my past or I'm still doing some music. And so I think that also because haptics are so similar to sound and auditive feedback."</i>

Table 3.1: Six participants disclosed their preferred pronouns, their experience level, the context they use haptics knowledge, their background, location, and what brought them to haptics.

had hands-on experience. The pilot made us realize that we wanted people who were well along the way of their haptic design journey so they could reflect on what they have experienced during that journey.

3.3.2 Recruitment and Participants

We used purposive sampling to recruit a diverse sample of participants (N=6). Participants were recruited by leveraging personal networks and crowdsourcing in online spaces (like Reddit¹ and Discord² servers). These were identified by the researchers through knowledge of specific works or online searching of terms like “DIY haptics” and “digital touch”. We were able to compile a list of 26 varied haptics contexts, of which were a mix of individuals, groups, and online discussion channels. Recruitment messages similar to the one in Section A.1 were personalized to the contact and emailed directly. Some groups were on online discussion platforms, like Discord [28], wherein a recruitment message was posted. We emailed or posted to the 26 contacts and received 12 responses, of which 7 agreed to participate. Of the participants, one was unable to participate in the interview and has been removed from the rest of our reporting. We also aimed to get a diverse sample of hapticians across varying backgrounds and context of their work: pronouns (3 she/her/hers, 3 he/him/his), haptics contexts (1 artists, 2 entrepreneurs, 2 design graduate students, 1 engineer), knowledge backgrounds (1 fashion designer, 2 fine arts, 1 physics, 1 engineering, 1 industrial design), location (1 U.S.A., 1 U.K., 2 Netherlands, 1 Germany, 1 Italy) and motivations shown in Table 3.1.

3.3.3 Methods and Analysis

We prepared an adjusted interview protocol from the pilot (see Section A.4). Similar to the pilot, we explored and aimed to understand the perspectives of hapticians as well as gain some insight to what features of an online resource resonated with their experience.

Interview Questions

The interviews were semi-structured. The author of this thesis was the sole interviewer for all six interviews. We have listed a detailed protocol with interview questions in Section A.4. We aimed to keep the interviews under one hour, although one went over by twenty minutes. In all interviews we asked participants to

¹<https://www.reddit.com/>

²<https://discord.com/>

Phase	Description of the process
1. Familiarizing yourself with your data:	Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas.
2. Generating initial codes:	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
3. Searching for themes:	Collating codes into potential themes, gathering all data relevant to each potential theme.
4. Reviewing themes:	Checking if the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic ‘map’ of the analysis.
5. Defining and naming themes:	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme.
6. Producing the report:	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis.

Table 3.2: Braun and Clarke’s six phases of thematic analysis.

introduce themselves, their pronouns, and how they would define their experience level in haptics. We then asked them to describe why they chose to define themselves with that amount of experience in context with any experience or projects they have done. Additionally, we asked participants to describe both the challenges and successes they had during this description. For more context on their broader scope of interests and skills, we asked them about their background, hobbies, and creative projects. We asked what design looked like to them, if they were a designer, what haptics meant to them, and how they define different hapticians skills. This led into questions about haptic design, specifically how they define it and what experience they had with haptic design – what brought them to haptic design, any specific notable interests, and how they found resources to learn. We asked them to reflect on how easy they thought it was to enter into the field of haptics at the moment and how they imagine people would succeed or struggle in this entry process. Finally, we asked participants to propose up a solution to learning haptic design concepts. The second portion of the interview focused on the HapHub prototype which can be found in Chapter 4.

Data Analysis

To analyze the interview data, we used a theoretical thematic analysis approach with the six steps (Table 3.2) to processing qualitative interview data [9].

We transcribed and cleaned interview transcripts under the Braun and Clarke recommendations of thematic analysis [9]. We took a counterbalanced approach

(see Figure 3.2) to coding with 4 coders: one was the thesis author who was trained with both haptics and qualitative methods (such as thematic analysis) and 3 researchers with little to no familiarity with haptics and thematic analysis. In our analysis (Table 3.2), we noted the perspectives in the interviews could potentially influence our individual and collaborative inductive coding process. To account for this possibility, we split the interview data into two sections (perspectives and prototype) and took a counterbalanced approach within our team. Two coders took a chronological approach in their analysis (perspectives then prototype) and the other two coders coded the second section first (prototype then perspectives) in their analysis. To develop recommendations for our iterative design process as well as generate social principles for haptic design, we wanted to ensure we prioritized prototype recommendations for the resource platform and perspectives and lived-experiences for the social principles for haptic design. Our process of prioritization and recommendations for the prototype is detailed in Chapter 4.

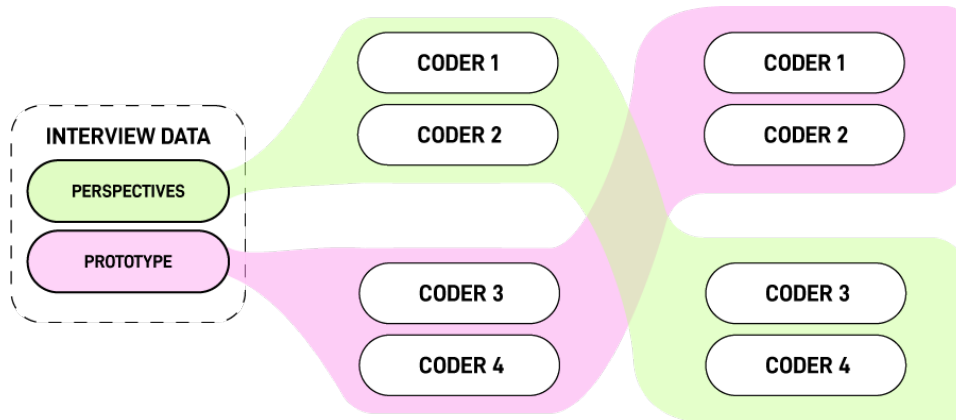


Figure 3.2: Thematic analysis structure with 4 coders. Data was split into two sections depending on the task in the interview: perspectives and prototype. When asked to discuss their experience and perspectives on haptics we called this the perspectives portion. When asked to interact with the prototype we called this the prototype portion.

Familiarizing yourself with the data. To prepare for iterative inductive coding, researchers reviewed interview recordings and cleaned transcripts of any identifying information, word-fillers, and transcription mistakes – researchers ensured

the transcripts retained their 'true' original nature [32]. This phase was used as an *active* review of the data. Researchers made notes on preliminary, first-pass ideas stand out quotes. Researchers regularly met to discuss notes in order to align coding approaches and labeling, however no initial codes were created yet. An example of what some of the in-person organization discussions looked like is shown in Figure 3.3.

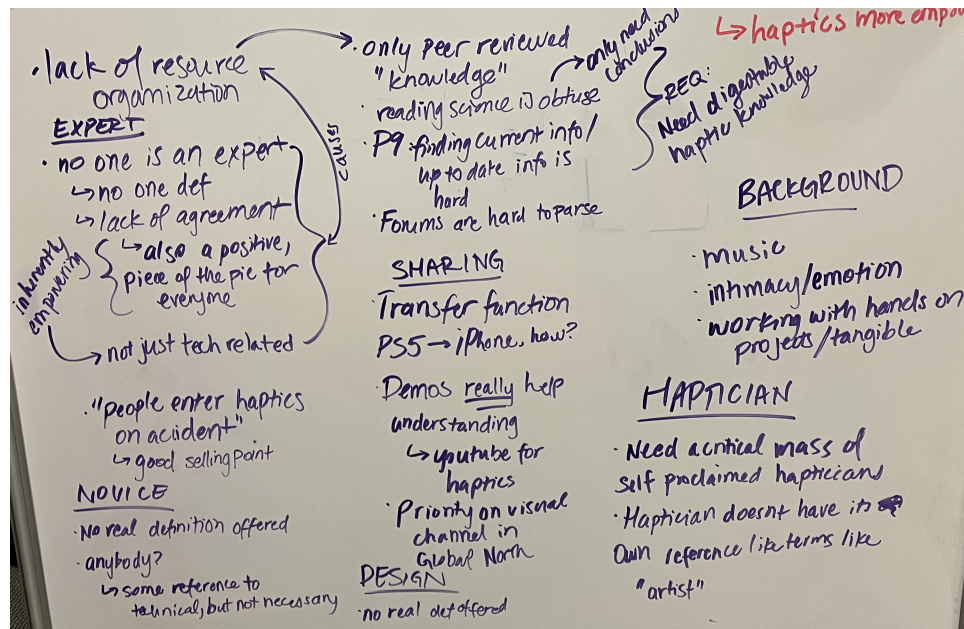


Figure 3.3: An example of organizing and familiarizing researchers with the data. In person, open discussions of general arising ideas were discussed and often collaboratively generated.

Generating initial codes. This phase began as soon as researchers completed their first-pass, active review of the transcription data. When all researchers felt familiarized with the data and coding approach, we individually took an open coding approach to inductively uncover the codes using NVivo. The individual coding process was supported with weekly group meetings with all four researchers to discuss the generation process and varying features arising in the data. As we organized our data into meaningful groups, we obtained multiple lists of codes with varying hierarchical (e.g. thematic subgroups) structure. To align some of this

organization and generation process, we used Figma [38], an online collaborative tool, to include all of our coded data in a collaborative, interactive setting.

If the structure of our codes were different, we began to resolve these differences with several meetings over the course of multiple weeks transferring initial codes into a collaborative Figma file to adjust for any inconsistencies in code structure.

Searching for themes. The process from generating initial codes collaboratively naturally flowed into the next phase that entailed moving the coded data around into groups that became more defined themes. We started with personal reflection and discussion with a white board activity that combined our main takeaways from the data. Letting the data speak for itself was an important yet lengthy process as it helped us sort the different codes into themes as we played around with the organization of theme piles. Similar to the mind-map exemplified by Braun and Clarke, we played around in Figma to create theme-piles as we thought about the relationship between codes, themes, and hierarchies (potential sub-themes) as seen in Figure 3.3. We finalized this phase with a collection of candidate themes and sub-themes that consisted of direct quotes from the transcription data.

Reviewing themes. This phase of thematic analysis was conducted to refine our theme searching process. With our loose list of themes and hierarchical sub-themes, we duplicated the Figma diagram to continue moving around themes for review and clarification. All four researchers collaboratively worked on the same Figma file as we reviewed whether the data within each emerging theme cohered together meaningfully. A snapshot of this process is detailed in Figure 3.4.

We first reviewed our themes by reading through the data and confirmed whether the theme's extracts showed an apparent pattern that supports the theme cohesively. If the theme felt supported by the pattern, we would relate the theme to the entire data set. In our case, this meant relating it to the white boarding process outlined in Figure 3.3. When felt the theme provided an accurate representation of the data in its subset, we generated a bullet point description of the theme that described the accuracy and relation to the data set as a whole. Sometimes, some themes felt unsupported by a cohesive pattern, thus we refigured the theme and questioned whether the theme itself was problematic. By doing so, we were able to question the earlier coding stages and if something had been over-seen during the process.

paraphrased descriptor of the theme’s contents and stated what is interesting about them and why, especially in consideration to our research questions. The following phase details the results derived from the emergent themes.

Producing the report. Results reflect most of the “perspectives” portion of the semi-structured interview described in Section 3.4 (see Figure 3.5 for the overall structures of themes). Results and recommendations of the “prototype” portion of the interview are detailed in Chapter 4.



Figure 3.5: Hierarchy of themes from the perspectives portion of interviews.

3.4 Results: Themes Describing Social Perspectives from Peripheral Haptic Designers

We identified four overarching themes from our in our thematic results. The results from the thematic analysis of our qualitative interviews reflect the importance of haptic knowledge accessibility for continued exploration in the field yet, how rigid implicit assumptions, divided communities, and barriers to entry are still overt obstacles. Results from the interviews also included hapticians perspectives on a potential haptics community resource prototype we presented to them called

HapHub (see Section 4.3). We use some of the inspiration from the results of the semi-structured interview as well as direct recommendations from the lo-fi prototype evaluation to create Haptics Commons detailed in Chapter 4.

3.4.1 Theme 1: The Peripheral Haptician is Curious, Playful, and Has Fuzzy Experience

Results from our thematic analysis also indicated there are multiple possible avenues to haptics that fork the majority path. We observed that people enter the field of haptics through a combination of a post secondary degree, institutional settings, and personal interest in touch topics. This is not the only factor that brings someone to haptics, it is also necessary that they have intersecting interests that centers around a theme of touch. All participants interviewed were from post secondary backgrounds, although were from different disciplines (Section 3.3.2) and motivations (Table 3.1).

Participants found their interests from a wide variety influence. For instance, P3 and P6 described their continuing interests in haptics as a part of who they were. *“I suppose I’ve been always very tactile person,”* P3 says; *“I’ve always been like a very hands on guy,”* stated P6. Some found their interest in haptics was sparked by an interest in music and design. P2 got into haptics by being *“good at signal processing,”* but also having a love for music. P4 loved the discussions around *“how we communicate research, complex ideas, to the everyday person”* such as the *“hardness of technologies”*. Others felt as though their interest in haptics was sparked by a frustration with the status quo. As P1 described her art practice she said, *“I’m so tired of all this art that is just distant and there is nothing really physical,”* and gave examples of gallery exhibitions in *“frames, clean, you know,”* she wanted the antithesis of sanitized display: *“something that can enrich our experience sometimes some artwork that is sensual, that is intimate”*. P5 was also able to describe her interests as *“interactive, like three dimensional stuff.”* P5 also rejects the concept of sanitizing creative experiences *“like a sculpture on the pedestal or like a painting,”* stating *“I want stuff that people can interact with in real life.”* Whether they were *“always very tactile”* (P3), into music, or driven to make interactive art, our findings indicate haptics is a great passion for participants; a catalyst of inspiration that can be passed along when shared and discussed with

others.

P3 said they couldn't quite define what an expert haptician means, but they have their own criteria for what *"good hapticians have, which is sort of a curiosity and playfulness."* This is not far off from the curiosity metaphor P2 noted: *"For expert[s] its like, open the box, open up the block, check what's inside, and let's talk about what that looks like."*

Terminology like *"expert"* is potentially disparaging rhetoric to those who are non-experts. It creates a in-group and out-group dynamic that in turn underestimates the labor of the non-experts as less than, or not of the same quality. For example, P1 has many haptic, artistic projects that they see as exploratory and creative in their practice. When asked about how they would define their knowledge of haptics they said *"I don't have the knowledge [an expert] has. I just have the crazy ideas."* P1 sees their artistic work as fundamentally different than an expert haptician, of different quality, and knowledge, yet the years of experience, practice, and creative thought that goes into the multitude of projects would say otherwise. While there are recognizable differences between someone new to the field and with many years of experience *"the difference between an expert and [a] novice is probably just the amount of time and effort put into this"* (P5). In other words, expertise can be attained by anyone, and the realization of this expertise is ever changing and not context-dependent.

Participants noted that anyone with a sensory haptic system has knowledge of haptics. Haptics taps into inherently creative, exploratory, curious, and playful qualities. Several participants noted that trial and error is a part of the designing haptics process, but tapping into their own interests helped keep them motivated. P4 said *"I think so many of us get into [haptics] accidentally."* As an interdisciplinary field, people looking to learn more about haptics must understand that it might take *"a lot of courage and exploration"* (P1) until a person finds what they resonate with. Sometimes *"it's complex for people to get into the field"* and there is *"so much trial and error because you also have so little inspiration available"* (P6) – a substantial obstacle in haptic design is that there is not much shared work online, *"like it takes a long time to even just get your head around what [haptics] involves"* (P4).

While participants recognized a barrier to entry in haptics, P5 reassures that

“anyone who kind of has certain awareness, or ability to reflect on [their experiences], and hence make connection[s] between different sensory simulations can be considered a haptician.” Other things like “basic design skills, like all the speaking, storytelling, or engineering skills, those are like skills that can be learned” (P5). Like learning any new skill or information seeking practice, there will be times of uncertainty in learning haptic design practices, but it does not mean learning haptics is a futile endeavor.

3.4.2 Theme 2: Haptics Can Mean Many Things to Different People

When haptics can be explained as both “*the tactile agency of the device*” (P2) in a technical sense and “*everything that has to do with artificial touch kind of things*” (P1) more broadly, there exists immense variation in contexts haptics can be made valuable beyond the technical capabilities.

While it was evident participants had a personal connection to haptics, there were many different definitions for what haptics *means*. For example, while some may say haptic includes practices like design, P3 thought “[*haptics is*] *really the study of nuance. It’s like a million subtle things. Haptics is not design*” all on its own. Indeed, “*there’s literally everything in your life that has to do with touch,*” (P5) yet when “*technologies that in some way digitally mediate or translate touch or aspects of touch,*” (P4) someone has to be there to consider the “*digitally mediated*” or “*translated*” touch sensation. P3 felt as though haptics is “*too technically focused*” and that design is “*young, white and privileged,*” therefore in haptic design, it would mean “[*designers*] *slap a bunch of actuators onto something and go wow, look how realistic this can be. Haptics!*” P3 found themselves frustrated with the focus on technical aspects in haptics and implores that haptic designers should “*navigate that balance [of] understanding what the user needs to feel in order to get that experience across and then helping navigate the technical requirements.*” P4 echoed this sentiment and shared that their haptics group used altered terminology instead of *haptic* to describe translated touch experiences: “[*haptics as a term*] *was too much associated with the hands... you know handheld devices*” and the word *haptics* felt too “*bogged down or weighed down by these connotations.*” In some instances, participants found that they discuss haptics within the

context of whoever they are talking to. P6 stated *“It’s different now to say [what haptics means] because I keep explaining it to different people in a different way.”* P2 found that they had to *“talk the language of the people that are in front of you, in their own terms, and relate haptics concepts”* that way.

P3 and P5 shed light on the fact that there has been some barriers to what is “appropriate” in haptics on multiple representational levels. For instance, P3 reflected on touch practices in different parts of the world: *“Dutch people are not very touchy, They’re not a very touch culture. the three kisses on the cheek thing—that’s the limit.”* Matching criticism on Western values of touch, P5 said *“I think people are coming to the realization that Western civilization as a whole, like the Western culture, very much prioritizes on vision.”*

There is a *“very intimate nature of touch that can reach this boundary of what people consider public and too personal or private to discuss in an academic setting or professional setting”* (P5). In P5’s experience, they were creating a haptic wearable that explored intersections of (dis)comfort and pleasure, and in some cases could be considered sexual or intimate. When asking for help *“all my professors, like male professors who I had great relationships with as like teacher, mentor, and student, didn’t feel comfortable talking about this project with me.”* P5 felt stranded in their interest and ability to create the wearable. P3 agrees, *“there’s a real tangible problem that can be solved through better sexual health,”* yet both P3 and P5 have been met with a *“kind of reluctance about this whole sex tech situation”* (P5). For example, P5 held a sex-tech hackathon at their university. They were excited about exploring this space:

“At the time, we were just kind of tired about how the art industry functions [by] itself and how like the tech industry has its own problems. So we wanted to do a version of hackathon that is like less about winning prizes and more about people coming together to explore these found, and stigmatized subjects that they might not be able to do in their day to day professional setting.”

P5 aimed to recruit from a diverse pool of people to act as mentors and mentees:

“So it was a three day hackathon and we have four/five mentors of different fields, so we have sex workers who work with disabled people,

sex scholars and gender studies. We have like a performance artist, and they do this drug performance specifically related to having alien genitalia. And you know just a diverse pool of mentors and we have like very different participants too, so they're like HCI (human computer interaction) students from different institutions throughout the US like artists, designers, and also people who have experiences with sex work."

With a wide range of mentors and mentees, P5 designed the hackathon to not require specific technical skills in haptics:

"I mean we definitely want people with technical skills that can do some basic like hacking into the device with different motors and sensors and stuff, but it wasn't necessary because a lot of projects like very, I would say, low tech. Like there's this one group who was kind of exploring venture down, kind of like the female contraceptive. So that project basically didn't have much technical elements in it."

While the hackathon received a lot of interest from attendees, due to the nature of the event, P5 found things like funding from the university to be difficult to source. P5 made the hackathon sound more like an "art festival" so it can be "less scandalous" for the university to fund. For example, P5 had no problem getting companies to donate devices to the hackathon,

"but when it comes to funding for getting food and drinks, like having extra money, it's a bit challenging, just because because of the nature of the event. I think we were able to get some support from the Gender Studies Department at the institution, like here and there are different organizations. But it was interesting like you know, even though it's ours, you know, basically, sponsored by the CS (computer science) department, like they were kind of reluctant about this whole sex tech situation."

While sex tech is not the only sub field of haptics that could use more welcome, participants' experiences with exclusion in their haptic interest areas ar-

ticated how diverse touch interests vary for different people and may present context-specific differences depending on how they follow their interests.

3.4.3 Theme 3: Information and Communication Seeking in Haptic Design Presents Obstacles

Participants mentioned that linguistic features of touch are difficult to capture for many reasons (e.g. devices, perceptual differences, tactile to verbal translation) and therefore tackling the problem of creating haptic sensations with others creates other practical obstacles. For example, *“if you’re explaining to someone ‘its vibrating,’ nobody has any idea what’s happening”* if they do not have the haptic device with them (P6). When the *“ergonomics are different from device to device”* it can be *“hard to bridge”* haptic sensations from one to another (P2). P6 identified that right now *“experts are facing the challenge of explaining what they’re doing or when they’re approaching a client or coworker”* with their haptic designs. This challenge has created a *“classic rabbit hole”* for tactile languages and communication in haptics (P3).

We can learn from and anticipate communication complications based on other hapticians experiences. For instance, P1 described designing haptics for an art installation with a hired haptics engineer: *“at some point [the engineer] said ‘Yeah, but can you tell me how this is going to look like, can you tell me, I don’t know anymore,’ and I said yeah, I don’t know either.”* Conceptually, P1 and the engineer were in agreements for what the art installation should *feel* like, but were facing challenges in realizing the installation together from both an artistic and technical understanding. What helped them resolve their differences was not getting so stuck in the practicality of the device, but focusing on the aligning their conceptual understandings. As an exploratory practice, P1 said *“We just had to continue,”* and *“at some point I said okay guys. Now we have to make something. Now we have to start prototyping something and it has to be precise and we have to work towards the exhibition.”* Taking on the visionary role of the exhibition, P1 was able to work towards her art exhibition without focusing too much on the haptic language details. Feeling inarticulate in haptic design was common between several participants, yet also an important step in creating together.

Many have felt lost in their navigation for haptics information and knowledge.

Similar to feeling inarticulate with communicating haptic sensations, haptics can also be difficult to share with others. Take the example from P1, before their team had a tangible haptic prototype, they felt it was difficult to communicate their intended haptic effects. When prototyping *“even the technical engineering is very experimental. I mean we were here in my studio and we were putting you know actuators into ceramic pieces.”* Sometimes it can be *“really hard to test straightaway what the output of your designs,”* for example, *“if you are [using] an iPhone, and you want to test your multi-sensory experience in haptics, you need to build a unity project and it takes you 10 minutes”* (P2). P2 speculates that *“the loop of design in haptics is too long”* from start to finish on a haptics project. Even if recommended haptic devices existed, *“the tools are not there to allow [designers] to yet to build a sustainable and self growing ecosystem where designers share to designers what works and what doesn’t”* (P2).

3.4.4 Theme 4: Haptic Design Knowledge Sharing Requires a Community Effort

Feeling a sense of a haptic design community can be difficult, especially when the community online and locally is relatively scattered. One starting point could be having a motivating reason to be seeking out haptics. As P4 said, *“I think so many of us get into [haptics] accidentally,”* because of their personal ties with the topic that ignited their passion to stick with it. Identifying what about haptics is motivating is important, *“starting with like looking for inspiration, looking into papers, products that are already out there”* (P6). *“Once you have a better understanding of the media and the technology, like, you know the strategies of practice, you need to connect it to a social theme. You know, something that gives meaning to the touch”* for the designer individually (P5). In P2’s experience, they found most people understood the potential of haptics through demos: *“I think the best thing that spoke to everyone is demos.”* Things like open discussion and sense of community help connect any potential fridge haptics groups together, thus *“collaboration is the core to haptics”* (P3). P2 asks, *“How can you be proud in a community in sharing besides having it tested by someone else?”* indicating the importance of both virtual and local connections. P3 stipulates, *“[haptics] is a very social field, everybody kind of likes to talk to one another. We all want to see*

different approaches,” indicating factors like sense of community, acceptance, and curiosity are all values a haptics resources and communities should practice.

3.5 Discussion

Characterizing where peripheral hapticians find inspiration, face challenges, have hope, and foresee haptic design futures gives us guidance for how to move forward. We will first discuss three categories of our discussion retrospectively, looking at our data and potential next steps in our investigation. We end this section with eight social principles for haptic design adapted from hapticians perspectives and generated for the betterment of the growing haptic design community.

The Haptician is Intersectional

In the same way the term *user* in HCI has been criticized for dehumanizing people [29], representations of the designer should also be examined closely. We noted all hapticians we interviewed had post secondary education. There was high prevalence of post secondary education due to our sample, but it is not an uncommon way haptics has been taught to designers [78]. In a larger investigation about gender representation, Offenwanger et al. identified a critical point in haptics, calling for better gender representation in many kinds of technical research, including haptics [63]. Furthermore, while approaches to design problems in haptics have been identified [78, 79] and some provided a solution [57, 76], it is still unclear who these hapticians and designers are. Although literature has represented hapticians of various levels as engineers or computer scientists [25, 53, 78, 79], our results indicated hapticians go beyond this representational subset – that is, their profiles diverge significantly from those that have been previously studied or assumed.

Experience and skill level has been an aspect of researching the haptician in the past [53, 76]. The book *Internet For The People* [83] describes expertise as commonly defined in technical terms, asking to blur “technology’s creators and its users”. To distance expertise from exclusively technical skill would help dismantle structures of power that are associated with technological skill [42] – “some people are experts in programming, others in design, still others in their daily lives” [83]. Similar to Principles 5 and 6 of the Design Justice Principles [61], hapticians have

the potential to be practitioner of haptics knowledge through expertise in their personal lived experience or their past haptic design work. We propose that expert hapticians can occupy a duality of a practitioner (people with specialized skill) and explorer (people looking to learn). On one hand, they are also not only seen as experts in their years of experience or accomplishments, but also in lived experience. On the other hand, there is always something new to learn about haptics from other hapticians. There is no clear list of qualifications a haptician must have (see Figure 1.3 as an example). In the past, when haptics expertise has been used as a descriptor for a haptician [79], there appeared to be an implicit assumption of experience. In the same sense, we rethink the expert haptician as someone who is able to approach a problem in haptics with curiosity, playfulness, and confidence, and based on their experience, lived or otherwise, they have valuable contributions in designing haptics experiences.

Haptic Design Should Welcome Diverse Contributions

Haptics is a rapidly growing field. The desire for more tangible interactions has started to pull haptics into the mainstream, and while the value is understood by many, it has been difficult to capture the variety of haptic design contributions. Haptic design as a practice and technical field is not exempt from criticism on the different cultural and social values of touch. Representation in haptics should be taken into consideration and widely recognized. Haptics as a human sense does not carry the same value in all parts of the world, nor domains. These different cultural values of haptics trickles down to impact haptics as a design discipline. Differences in value has resulted in rhetoric surrounding “appropriate” haptics. From our thematic results, we question whether other intersectional forms of haptic design values need more support. Additionally, cultural considerations are vital to haptic design processes as the value of touch may vary in social and cultural contexts; it has implications on the way hapticians place priority in their designs and how their designs are experienced.

In our interpretation of haptic design projects, we rethink framing haptic design as technical contributions to other contributions that are non-technical as well. To make haptic design accessible for the people contributing to the field, we hope

to remove the idea of “appropriate” haptic designs and accept diverse forms of contributions made directly by participating hapticians in the haptics community.

Haptic Design Obstacles and Their Proposed Solutions

Participants identified two major obstacles currently standing in the way of haptic design accessibility. One obstacle, of communicating haptic design work to others people, is in part because the language to do so is highly abstracted (e.g. communicating the exact sensation over distance can be difficult without the same devices). There is substantial literature on haptic language and iconography that help others understand the potential of haptic design [11, 21, 34, 55]. Haptic language and iconography enables some of the nuance and subtlety of haptics to get lost in translation at times, potentially leading to miscommunication.

A second obstacle is that the current design loop for haptics is long due to the lack of rapid prototyping tools, online resources, and shared techniques that can dissuade people from iterating or sharing their work. Further, with no efficient or centralized system to store haptic content, sharing haptics comes down to having exact replicas of haptic environments.

In Chapter 4 we propose a mitigation to this both problems in the form of an online haptic design website (HapHub and in its later version, Haptics Commons). We explore both obstacles of communication and design in the current haptic design ecosystem (Chapter 4) in the form of a haptic design resource that would allow hapticians to approach one another through open sharing and community relationships.

We posit that the obstacles of information seeking and communication in haptic design can be mitigated through publicizing personal strategies in haptics. Though the entry to haptics can be complex, hapticians who have developed strategies to problem solve in a developing design space can help others learn by sharing their techniques. Providing an carefully structured haptic design community environment can direct other exploring hapticians to resources, techniques, and each other. In Chapter 4, we develop a constructive haptic design sharing approach that centers communication, personal interests, and specialized knowledges to help other hapticians start to coalesce in a haptic design community. We guide our potential

solution to navigation, communication, and representation in haptic design through open participation in collective knowledge formation settings.

3.6 Social Principles for Haptic Design

We propose eight core social principles for haptic design based on our findings that aim to uplift intersectional domains in haptics through elevating individual skills and ways of knowing. These eight social principles emerged as we sought to codify what we heard in the themes into a set of more actionable assertions that had the potential to guide behavior in a supportive, inclusive social context. In line with the method of converting themes from qualitative research into guiding principles from IDEO [50], we converted each of our sub-themes from our thematic analysis into descriptive social principles. Doing so ensured we had coverage of the most important elements brought up in our interviews appearing our social principles. However, we recognize the principles are defined on the social, cultural context of haptic design, therefore they can be interpreted and applied in other technological contexts – our principles seek to give the haptic design ecosystem integrity and shape.

We presented these social principles for haptic design to participants in our prototyping phases (Chapter 4). In the prototypes we called them *haptic design principles* because we first aimed to designate design principles in a social context, similar to the format of Design Justice Principles and IDEO’s “ideate” phase of design thinking [50, 61]. We felt the principles were still a working title, thus kept the option open to specify our principles to their social context. On reflection, and in this thesis, we will refer to the set of social principles as: *social principles for haptic design*.

These principles emerge from individual and collective design justice thought and are not a rigid document draft. We intend that the design of a community sharing resource should reinforce this code. In the future, we hope that others contribute, edit, and add to the list of inclusivity codes co-written by hapticians to continue to evolve them.

1. **We Let Intention Guide Our Direction:** What about haptics is interesting to us? The desire for more tangible interactions has started to pull haptics

into the mainstream, and while the value is understood by many, access to that value isn't necessarily a clear path. We keep in mind our personal reason for learning about haptics and let that guide our exploration and inquiry.

2. **There's No Dumb Questions:** The current design loop for haptics is long from start to finish. We realize it can be difficult to share our work with others if we don't have the same hardware, knowledge, or experience as others. Navigating this kind of confusion can make us feel lost in our approach. We uplift community discussion to help us through challenging tasks.
3. **We Bring A Lot to the Table:** The interdisciplinary nature of haptics is something to leverage along with our own specialized skills. Ignorance is the breeding ground for growth and knowledge expansion. We all have different backgrounds that empower us with specialized knowledge.
4. **Expertise Transcends "the Expert":** No one is an expert in all of haptics. While expertise can commonly be measured by the amount of years of experience, most will not call themselves an expert because they do not know all of the subfields in haptics. Additionally, there is no clear description of what an expert in haptics does, how long they have worked in the field, or knows exactly. We acknowledge that all levels of expertise are open to exploration, curiosity, and playfulness.
5. **We're Not a Novice, We're an Explorer:** Anyone with a sensory haptic system can design haptics if they want. While it can be difficult to conceptualize everything initially, we continue trying. Trial and error is a part of this process. We all know something about touch from human experience. We tap into our creative, exploratory, curious, and playful self to learn.
6. **It's OK to Feel Inarticulate:** It is difficult to describe haptic designs and sensations to others because there is no haptic language. In a digitally mediated world, nuance gets lost in the haptic experiences when explaining it to others. We understand it can be hard to relate concepts to one another.
7. **Sharing is Caring:** We want to share and empower each other so we can learn from others' techniques so long as they are openly shared. We remain

open about what works for us and what we have seen work for others.

8. **We All Have Biases:** Our differences are our strengths. We all come from different experiential and cultural backgrounds, we recognize our biases and accept that there are multiple ways of knowing.

Chapter 4

Designing a Haptics Commons

We're making tools for other people to make things.— Kristy Tillman

We discussed the experiences that have shaped some hapticians' perspectives in Chapter 3 (Section 3.4). Moreover, the previous chapter proposed eight social principles for haptic design (Section 3.6) that aim to reflect an inclusive, empowering haptic design community approach.

In this chapter we propose the design of a haptic design resource (with the initial working title *HapHub*) that considered peripheral hapticians' needs. Here, we asked the same six participants, through a design justice and feminist research approach, to reflect on their practice and optional organizational structures needed in a haptic design resource. We considered past perspectives of our suggested social principles for haptic design to iterate twice on our prototype of the haptic design resource, which we ultimately named *Haptics Commons*. Last, we ran a study with six people unfamiliar with haptics wherein we presented our social principles for haptic design and evaluated the prototype through guided tasks when interacting with Haptics Commons.

4.1 Objectives of Design Stage

This chapter addresses two research questions: *RQ1: Is there a way to elevate alternative and specialized haptics knowledge for a larger collaboration and knowledge sharing ecosystem?* and *RQ4: What value could come from making*

haptics more empowering through a design justice lens (individually and culturally)? While talking to peripheral hapticians about their perspectives on the field, we aimed to understand their perspectives on solutions they feel would resolve some of the obstacles in haptics they have experienced or seen. We showed a low-fidelity prototype (HapHub) aimed at bridging some of the complications with haptics accessibility, agency, and empowerment. We did this in the same interview phase as the previous chapter, as the second portion of our data analysis focused on design recommendations for the next iteration of our prototype (Haptics Commons).

Specifically, we concentrated on the design of how a community-centered resource might be organized and some of the structural qualities it may need. We focused on how to make design decisions that were informed by existing values and norms from peripheral hapticians such as accessibility, inclusivity, and empowerment. In the previous chapter (Chapter 3) we learned about qualities that would be helpful in a haptic design resource as well as potential points of accessibility and inclusion in the ecosystem. We designed a next iteration of the resource (Haptics Commons) with the hapticians situated knowledge through the lived-experience informed design process. Throughout, we echoed Costanza-Chock’s design approach of resisting a single, universal point of view [4] in design and knowledge formation.

4.2 Design and Evaluation Approach

Within this design phase, we followed the iterative design structure shown in Figure 4.1.

Our design justice and feminist HCI approach aimed at increasing participation in the design process with the community it was intended for. Rather than only engaging participants as consumers of the research project, we focused on empowering participants to engage in the design process as stakeholders through critique and usability evaluations. One challenge with a feminist and design justice approach is realizing that democratizing information accessibility through design is already difficult, and when it comes to specific decisions like interfaces, functions, and features, there exist debates on whether this approach can adequately address

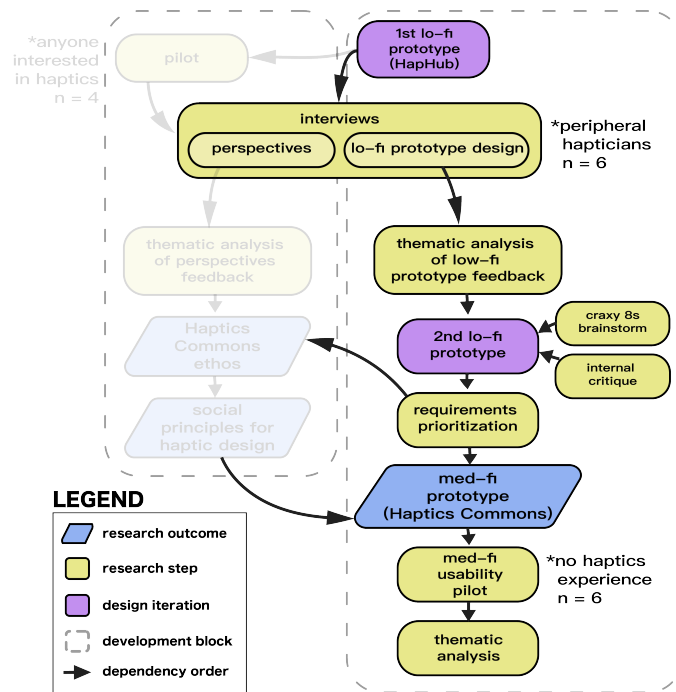


Figure 4.1: This portion of the research focused on the design and evaluation of haptic design resource prototypes (highlighted portion of the protocol).

issues for the entire community. While some of this speculation may be due to research constraints (e.g. length of study, recruitment, etc.), we aimed to also capture participants' preferences when interacting with a haptic design resource. For this reason, we do not include all possible stakeholders and aim our focus on those that identified with being along a periphery of the haptic design ecosystem. In future iterations, we would hope to further include more stakeholders of the haptic design ecosystem.

In this iteration, we aimed to give voice to the marginal, echoing the work of Donna Haraway [46]. We informed the design of our haptic design resource with the lived-experiences of the stakeholders' situated knowledge. This approach reflects a process that is instrumental in implementing insights and perspectives that typically would not be heard in the haptics community.

Centering peripheral hapticians voices also means that we cannot claim there

is a universal way to approach the design of a haptic community resource, nor are there universal claims that can be made. We recognize that some of the results of our iterative prototyping practice give us assurance in recommending certain design decisions, but is not an exhaustive report. Design decisions were made based on an overall brainstormed structure of the haptic design resource (Figure 4.2), multiple paper prototyping iterations, internal and external critique, and rapid prototyping iterations digitally using Figma [38].

4.3 Low-Fidelity Prototype: Design and Evaluation

This section details the first iteration of an inclusive, accessible haptic design resource. This prototype was built prior to our interviews (Figure 1.4). We took into consideration past examples of project and community established resources to implement the resource we gave the working name *HapHub*.

4.3.1 Approach

We designed HapHub by consulting past resources, imagining interactions, and reflected on a range of experiences in our lab. Particularly, we aimed to explore the framing of inclusivity and accessibility in haptic design, aiming to promote an empowered approach.

Objectives and Inspirations

To design HapHub, we took inspiration existing online resources.

Purpose. We aimed to provide an inclusive, community-centered online space where haptics-curious people could connect and share ideas about haptics. We gave the resource a working title of a “hub” to emphasize creation of a central meeting-ground for them rather than reproducing other resources. Based on our purpose, we provided a place for a tagline, a clear mission, and guiding principles.

Use. We took inspiration from other, similar resources that utilize features we hoped to support. For example, forums like Dev.to¹ and Arduino Forum² inspired the structure of sub-interest discussions we hoped to facilitate. Project shar-

¹<https://dev.to/>

²<https://forum.arduino.cc/>

ing sites like Thingiverse³ and Hack-A-Day⁴ shared projects in discussion-based, community engaged ways that fostered people engaging and expanding on ideas presented. Though there are a multitude of communities online that target empowering others in communities, there was a disparity of haptics knowledge shared online. It can be hard to synthesize information across multiple platforms, thus we take inspiration from working platforms, as we have listed above, to inspire the development and structure of HapHub.

Prototype Description

Aspects that differentiate HapHub from other resource and community websites with similar objectives is the ability to connect community discussion directly with static portions of the website. Additionally, and more unusually, hapticians on the website would be the creators of the content – handing over responsibility of content creation and moderation to an open-source structure. Other portions of the site like overall page headings and discussion support (via Discord) are relatively standard with a community resource. See Figure 4.2 for reference to how we imagined this to be structured.

Figure 4.2's conceptual map shows the structure of HapHub. Parts of HapHub have a typical website structure that explain its purpose (About), have access to a community or comment section (Community), and relevant haptic design resources (Resources). More unusually, we wanted different parts of the site to inform other ongoing discussions. To ensure the ongoing discussions were remaining updated, vibrant, and current, we envisioned live-linked questions and discussion topics to areas of the site like reading and research. We imagined local and virtual nodes to also be a vital part of the community, allowing people to meet in person or form sub-groups online if they found other people with similar haptic design interests. Our resources pages is organized atypically because we wanted the community to actually create the resources they wanted to see on the site – this means that HapHub would allow for submissions of resources, proposals of projects, and the ability to see past projects for inspiration.

We designed a low-fidelity prototype named HapHub using Figma. Prior to

³<https://www.thingiverse.com/>

⁴<https://hackaday.com/>

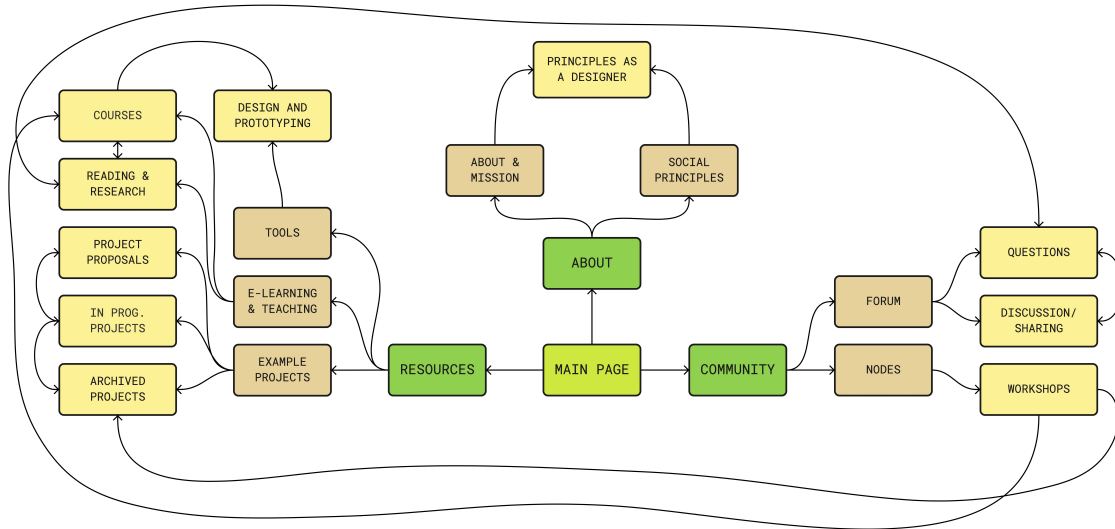


Figure 4.2: Concept map of a haptic design resource that focused on community building and sharing.

semi-structured interview sessions, we implemented an initial prototype of HapHub (described in Section 4.3.1) that centers community discussion and knowledge sharing for haptics. In this design, we prioritized overall site structure that presented the concept of the online community.

Figure 4.2 details the site map and overall structure of HapHub. We aimed to support a variety of stakeholders in the ideation of HapHub and intended different portions of the site inform one another. For the purpose of the low-fidelity prototype, we included headings, but all content used filler text. We split the site into four main sections:

Main Page (Figure 4.3) is the first page people see when they enter HapHub (Figure 4.3). We wanted to introduce the idea of an open sharing platform for haptic design, and highlighted what people may find on the site as well as a clear mission.

About (Figure 4.4) contextualized the purpose and use of HapHub. While some of this information will be evident from the main page, we introduced the mission and guiding principles HapHub maintains.

Resources (Figure 4.6) supported knowledge seeking and contributing of haptic

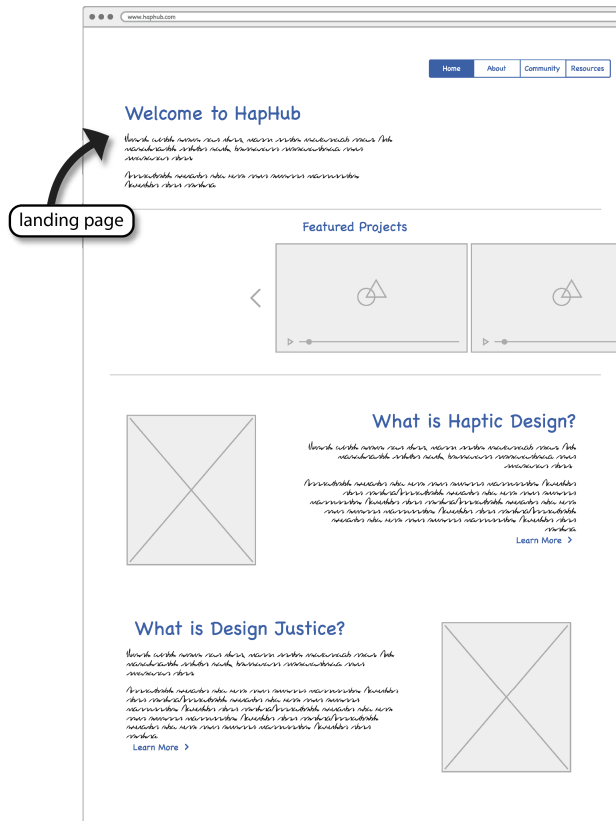


Figure 4.3: HapHub landing page that provides an overview of the resource and related concepts.

knowledge a person may want to explore. We split the resources into three main buckets: *tools*, *learning & teaching*, and *example projects*. These three buckets each had different types of haptic design sharing purposes. *Tools* catalogued potential design and engineering aids hapticians have made and used in their work. For example, something like [76] would be listed in tools. *Learning & teaching* listed possible learning material people can use to expand their haptics knowledge such as reading material like [60] or courses like [80] and [57]. *Example projects* captured ongoing haptics projects, past archived projects, and proposed projects looking for collaboration or help. Projects like the TACTimat [75] and Lucas VRTech [23] provide examples for others to see what kind of work people are doing in haptics.

Overall the resources inform one another to some extent. For example, the

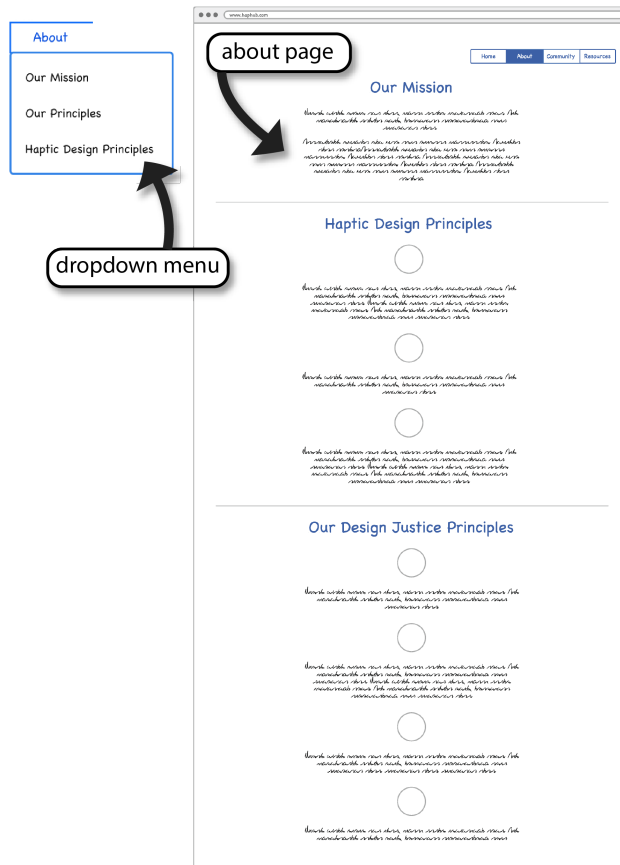


Figure 4.4: HapHub about page that describes the goal of the resource and related concepts like design principles.

Lucas VRTech DIY haptic glove project has a tutorial that would be included as a learning item as well [23]. In a case like this, interlinking between project and learning would help the person navigate between an example project and trying to learn how to make it. If they would like to discuss the project, they can also post comments and questions to the community page.

Community (Figure 4.5) had two main features: *forum* and *nodes*. The HapHub *forum* supported a conversation-style discussion forum format (see Figure 4.5) as well as potential linkages with other people interested in haptics in the local community. Both virtual and local community frameworks took an open, self-forming approach where the community should define its need of sub groups virtually and

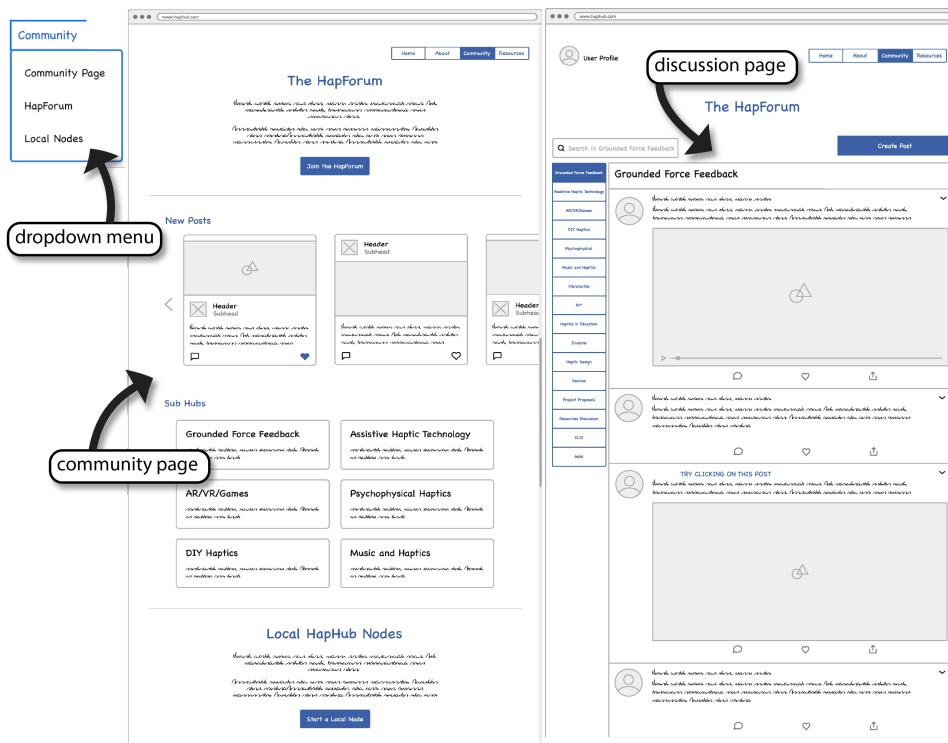


Figure 4.5: HapHub community page. This page contains discussion of haptics concepts and projects.

locally and is shared with others. For example, in a chat discussion board, if multiple people are discussing the grounded force feedback device Haply and are locally in Vancouver, BC they can create a Haply sub group and a local node in Vancouver. The HapHub community centered knowledge sharing, open source, and multitude of experience so everyone can find their footing in haptics.

4.3.2 Evaluation

This subsection of the research followed the iterative design structure shown in Figure 4.7. We used the prototype described in Section 4.3.

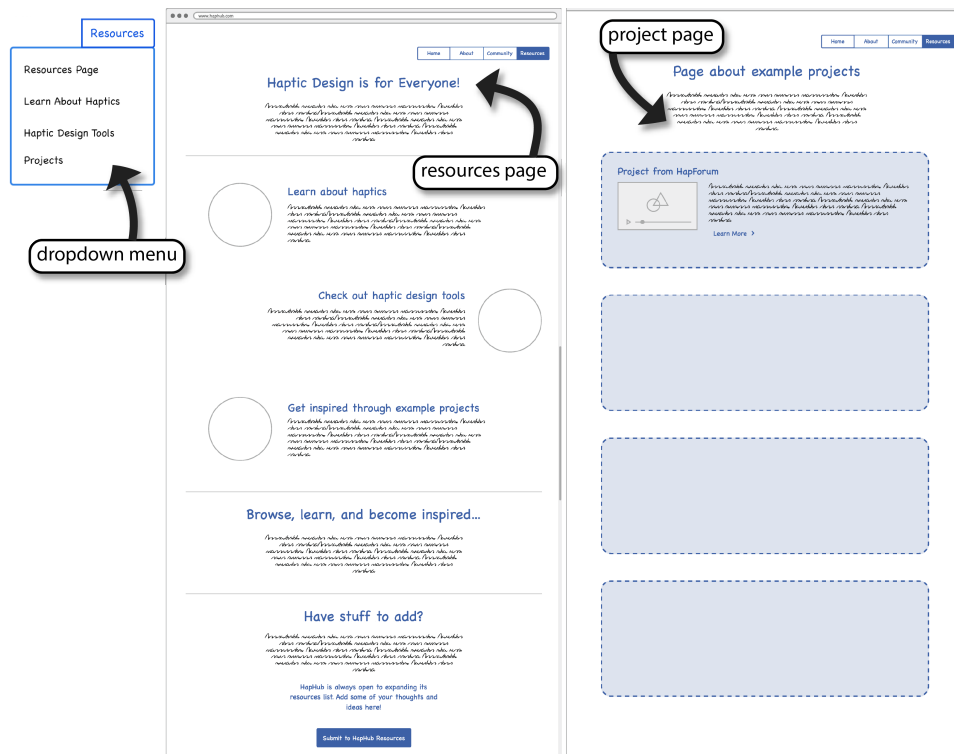


Figure 4.6: HapHub resources page. This page shows one example of what the projects portion of the page would have to offer. Each resource (tools, learning, and projects) would contain design tools, teaching material, and examples from others.

Protocol

Participants only interacted with prototyped web pages listed in Section 4.3.1. This portion of the design evaluation is shown in Figure 4.7. The most novel part of the prototype was the linking between community discussion and haptic design resources. By doing so, hapticians could visit and interact with various categories of resources and engage with relevant discussions on them in either the comments or forum. For example, if someone visited a project and another person came up with a work-around solution for a problem they faced, that could be shared widely on the HapHub site.

Participants were the same six participants described in Section 3.3.2, all were

peripheral hapticians with experience working on various haptics projects.

When interacting with the prototype we sought to propose the idea of a haptic design resource for haptics-curious people and wondered what the first takes of a structured resource like this would be for our participants. In this study, they had just finished recalling their experiences in the field of haptics and had no previous knowledge of the premise of HapHub. Participants were asked to think-aloud and were prompted with the following four questions (detailed protocol in Section A.4):

1. Take a look at this low-fidelity mock-up, what are your general takeaways of a platform like this?
2. Do you think this would cultivate an easy approach to haptics for those entering in the field?
3. Would you use it?
4. What can be improved? Is there anything here you wish was there, but isn't?

Participants

Participants (N=6) were the same six participants described in Section 3.3.2. All were self proclaimed people with experience in designing touch experiences and identified as doing work that could relate to the field of haptics.

Analysis

The results from our qualitative interviews in Chapter 3 revealed the importance of clarifying the prototype's purpose while supporting concerns of inclusivity, sustaining community discussion, and sharing with varied haptic experience. To clarify some of the identified problem areas in the haptic design ecosystem, we also performed a prioritized requirements technique to clarify changes needed for HapHub. In this section, we list the five main themes and sub-themes that resulted from the interviews prior to prototype requirement prioritization.

The analyses in this chapter are based on the Braun and Clarke methodology we discussed in Section 3.3.3. Additionally, in the next phase of prototyping we

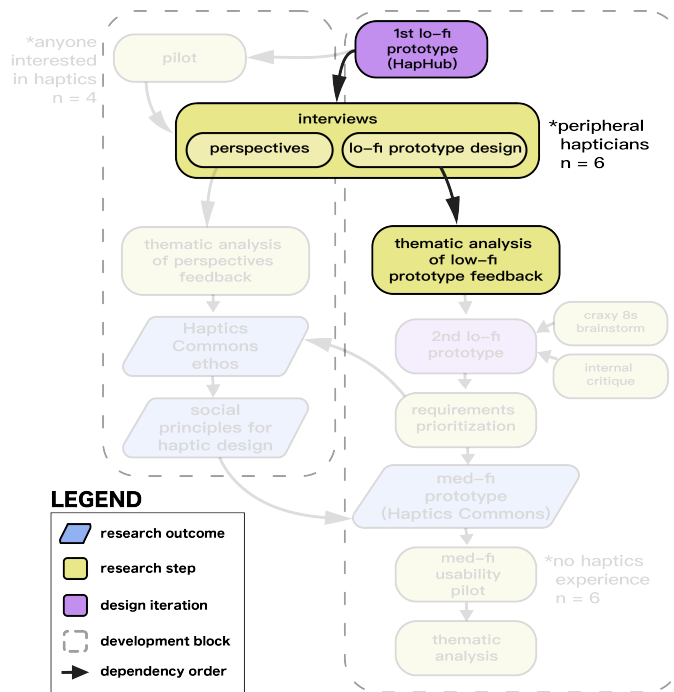


Figure 4.7: This part of the research focused on understanding results from our low-fidelity prototype (HapHub).

used prioritization techniques to translate some of the themes into prototype requirements (see Section 4.4.1).

sharing	structured resources	badge/color system for submissions	community	discussion	Discord/Slack
	resource submission support	featured projects		events and opportunities	volunteering/jobs
	examples (code, projects)	recent activity and news		networking	marketing
approachability	authorship	open source approach	purpose	getting started	what is haptics (mission)
	feel	fun		usage	what to do here
		casual			affiliation link
	collaborative			proposals	
logistics	maintenance	moderation			
	roles	responsibility sign-up system			

Figure 4.8: Hierarchy of HapHub themes

Results

Results are themes from our thematic analysis, which reflect general reactions to the low-fidelity prototype of HapHub based on the questions asked (detailed in Section 4.2).

Theme 1: Clarify Purpose at the Onset. Participants found they needed more clarity on the purpose and use of HapHub from looking at the home page. P6 explained: *“why about this. Like the About menu item, because when I’m entering the website, I would expect I need information. Like first I need the basic stuff.”* To present a clear purpose, the participants referred to things like adding a mission statement, guiding principles, and a tagline: *“Welcome to Hap Hub would have like a tagline”* (P3). P1 also suggested new organization of the home page that would cater to a diverse audience by showing examples of resources and projects on the landing page. She explains, *“first page should really be a very nice curated overview, like you’ve go on this haptics and you see, artists, doing installations and then you see engineering building robotics and then you see people in therapy, developing really great massage tools you know and then one page, you know, you see that haptics is actually spread over all this disciplines.”* Additionally, P4 thought that the division of the About dropdown menu did not need separation: *“I mean I don’t know what you would write under our mission, but I would just put the About and Our Mission together, just on the About page.”*

As participants navigated away from the home page and through the rest of the resource, most found they understood the purpose and use of HapHub as a community resource. *“I would have expected that I’m learning about haptics on HapHub so to say, but maybe it’s also more like a, what you call it, like an orientation of websites to different resources that’s already available. And that case, it would make sense ... It makes it clear for me, like you go here to learn about haptics, here to check out haptic design tools, and here to be inspired”* (P6). Participants recognized the value of designing HapHub with this particular structure planned to support haptics learning materials, community knowledge sharing, and design tools.

Theme 2: Curation and Transparency as a Mechanism of Sharing Knowledge.

Participants valued a categorized and curated way of sharing knowledge, while maintaining an open, welcoming, and transparent way to communicate with one another.

In order to share knowledge, participants found a need for curation and organization of the resources. For example, to share example projects, P3 proposed increased utility with existing online repositories like GitHub: *“I think you may also want a GitHub repo, or maybe a resources of the code people need examples, things like that.”* With all the different categories of resources, P1 reflected, *“that categorizing and curating it will be very helpful, and maybe also what will be really great to have [in resources]”* (P1). On the curation side, P6 suggested a summary page or featured resources would help digest the wealth of information. *“So something like [a featured page] I like for me, that’s always super interesting because through this, I don’t have to catch up with everything that’s going on.”* Similarly, P1 suggested sorting resources by how active they are within the community could be helpful. She said *“having a nice way of archiving information and ways how to find knowledge would be very useful for people. Like for example on the forum, if there are questions, or maybe even have somebody that’s administrating this like you know like outdated information that doesn’t”* go away.

Participants also pointed out the importance of curation as a mode to accomplish effective knowledge sharing, specifically with challenges in haptics. For example, P2 said, *“it’s really hard for people to share things about haptics,”* due to the nature of what he called the “transfer function” between haptics and virtual communication. P6 shared a similar concern of haptics knowledge sharing: *“Some people might say, well, why should I upload my project in here? It doesn’t really fit to the topic, or I would have loved to showcase this and this... And so really having something that’s so straightforward that’s available for everyone. I think that’s a big challenge.”*

While sharing haptics and motivating others to contribute is a potential challenge with HapHub, participants offered up potential solutions that HapHub could tackle this problem through transparent and open-source techniques. P1 talked through an example of finding a specific actuator and the benefits of open-source tools because they would be able to find where and how others have used them.

P2 offered the solution to “*be transparent onto how [haptics] is. And what are the opportunities and challenges*” people have faced. He stated, “*by being shared transparently and in a way that the user can relate with,*” people will be able to relate with the challenges of sharing work in the haptics domain.

Theme 3: Towards Friendliness and Uplifting Similar Values. Participants expressed the importance of showing the value of haptics through a resource like HapHub. Multiple participants emphasized that the prominence of accessibility and ease of use would help communicate this message – “*like making it friendly*” (P4). In order to do so, “*[HapHub] really has to be something that’s so easy to use and so easy like so much fun. In a way, or so exciting that people are sticking to it*” (P6). One participant suggested adding “*a little video or little podcast*” (P4) that people can use to remember HapHub.

Moreover, reflecting on different experience levels, participants considered what would be interesting for someone entering the site for the first time such as, “*they arrive on this website and they think, oh man I don’t have to be in front of my computer coding you know I can, I can you know do all kinds of other things*” (P1). While others considered what other hapticians with more exposure might navigate to on the platform, P6 thought “*the community and the sharing approach would be the most interesting parts. Not so much like the getting started because I’m past that point*”.

P6 reflected on trying to find past haptics work as difficult and frustrating when trying to learn more about haptics, but found “*there’s so much out there, and often it’s the same things over and over again in a different, slightly different way*”. He suggested “*maybe also making the scientific community or research more accessible,*” as a way to help navigate what one participant called a “cluster f**k” of haptics knowledge.

One of the overarching takeaways participants shared was the understanding that everyone coming to HapHub would share a similar interest in engaging with haptics and others in the community. P1 aptly said:

“If we are both in this haptics community. That means that we are both reliable people with the same fascination with the same interest

with a body of work that you know fits the community so then when I'm going to ask somebody from there hey do you want to help me. It will not be so weird as me now trying to write emails to strangers."

Theme 4: Self-forming Communities. To sustain a growing and active online community resource like HapHub, participants expressed the significance for interest groups so it is easier to find sub-fields of haptics. P6 shared the idea of categorizing self-forming sub-communities by haptic interests. Similarly, P1 requested communities formed based on application topics such as *"categories on the field like for example haptics in healthcare or haptics in therapy or haptics in art, would help them navigate through the community as "a reader as a part of the community."*

Participants also warned against designating special haptics interest groups before there is enough interest expressed from within the community. For example, one participant said *"it's very challenging if you're forcing like an environment on people rather than it's like organically grown,"* (P6) while another said they *"want it to be a community generated cluster of resources that doesn't need [to be] active[ly] worked through, so the community can grow"* (P2).

By *"keeping the content flowing in a way and encouraging people also to share it in a very little effort,"* through self-forming communities and interest areas, P6 believes it would guarantee the survival of HapHub at the community engagement level. Keeping this in mind, P5 said, *"I feel like the main challenge is just to maintain a certain level of activity."* P2 shared a similar concern of activity from their own experience, *"We have a Discord with more than 400 people, built in some way for haptics. It's really hard to get [people] engaged because it's really hard for people to share things about haptics"* He states problems with engagement in a haptics online community are there because *"they are harder to engage with because they have a hard time to explain besides technical problems."* He hypothesizes that *"it's really hard for [people] to be proud of a haptics identity."* This posed a fundamental concern for the sustainability of launching a resource like this.

Some participants expressed that there are past haptics discussion groups that have had this similar format and were successful in participation, yet fell to a different pitfall. In a past existing Slack channel P3 states: *"Yeah, I mean it [the*

*haptics group] really was really well done. And then they started charging you know \$1,000 for membership. You had to be a member and, yeah, a lot of people dropped off, a lot of the smaller ones. You know, we've f**ked off, which is a shame because it was really good."* And he speculates this kind of "invitation only mentality" and cost-driven way to form the community is why many people in haptics have moved away from an openly shared community format. In P3's experience, he felt as though there was a period in time where haptics could have had an open-door policy to the community, but practices, like monetary barriers, have jaded his experience in the past.

Theme 5: Logistics Lastly, a couple participants speculated the practicality of HapHub by considering maintenance, funding, and sustainability. P3 said, "*If everyone's trying to build the one website, you really got to make sure...I think before you launch it, you have to get a good critical mass of people on there.*" P3's concern for sustainability stem from the logistics of maintaining HapHub's momentum. P5 vocalized a similar concern, but offered a solution to underwrite the labor that goes into creating HapHub by providing a "*streamline financial compensation to make it work.*" P5's concerns are ones that are important to consider when deploying community-centered resources, but she agreed that the design itself was promising:

"it just requires more humans and labour behind it. And if that's something that you can manage to do I think it's great. And, you know, everything is like now constantly updated and if you have your own events, online talks, lectures, workshops, I think that will be great"

4.3.3 Discussion

Our results around clarifying the purpose and curation tactics show the complexity, yet important need, for designing an inclusive, expansive haptic design resource. While the all-encompassing nature of HapHub had several advantages that were identified by participants, it also had the potential to cause confusion and doubt in the sustainability of the resource. Our study suggests that active participation and curation were primary concerns expressed by participants. The problem of

community building has not been explicitly examined at the design and research problem space for the discipline of haptics. Thus we can learn from other, similar online resources to inspire our design. Here we will reflect on some of the evaluation results and provide suggestions to move forward in the design of HapHub.

Supporting varied haptics interests through design

Specifically for haptics, a largely interdisciplinary field, capturing all possible interests through conceived designation proves a difficult task. Rather, allowing these spaces carve out their own groups based on conversation and shared interest, the community “sense” will follow. There are multiple examples of online resources and communities that do this, for example, online makerspaces like Thingiverse⁵ or fiber artist communities like Ravelry⁶. Each of these examples cover a vast amount of information – joining on one common interest. In Thingiverse for example, users have an interest in 3D modeling and share digital 3D designs, yet the application of the 3D model may vary greatly from engineering parts to modeling realistic instruments and more. These groups did not form on their own; they were formed by the needs of the community to have a space to discuss more specific 3D modeling applications. HapHub, similarly, could account for the variety of needs hapticians may have – theoretical, perceptual, application domain, creative practice, assistive, and so on. An implication from our results is maintaining the sense of open-source, community valued input when generating content on HapHub.

Current examples like Thingiverse and Ravelry also require people to sign up in order to share or create material that helps others browse community content. HapHub targeted support for varied projects, tools, and courses, but there will always be a pitfall of sharing haptic design as described in P2’s experience with a haptic design Discord channel. As the online community grows, people will engage in different methods of sharing haptic content. Ideally, this would result in a community-formed standard for sharing. For now, sharing format takes the form of static images and text with potential to move comments and questions to the discussion board.

⁵<https://www.thingiverse.com/>

⁶<https://www.ravelry.com/>

Cultivating Community Contributions

To address the challenge of active open sharing of projects and ideas, shared feelings of empowerment and support in haptics can motivate others to contribute. For example, if a person sees other people getting support and encouragement on their haptics project, it can inspire others to also share their progress. To do so, we will clearly state what HapHub stands for through social principles for haptic design (see Section 3.5) and its mission. Additionally, as P3 said, a clear tagline would help others take something away with them, so they can remember what HapHub stands for. The idea that a clear ethos through principles, a mission statement, and tagline will help empower others in haptics is speculative, but not entirely new. Guiding principles have long been used to help sustain a platform's community culture and are seen in many groups to uphold a welcoming space [27, 61, 83]. By using inspiration for what works in other online communities, we can hopefully follow suit in empowering others in haptic design.

Tagline – *Harmonizing with others in the haptics community.*

This tagline centers the idea of *harmony* – for the haptics community this would mean coalescing the multi-disciplinary and intersectional identities of hapticians to encompass a unified front in exploring provoking, yet varied haptic design ideas.

From our decision on the tagline, we also generated a cohesive mission statement that aimed to reflect the eight social principles of haptic design.

Mission – *Haptics Commons aims to **reframe the role of a haptician** by empowering and inspiring diverse communities to create haptics together. **Haptics is for anyone**, and by redefining the means to create and design haptics, we are challenging the barriers of expertise through reflexivity, growth, connection, and difference. We uplift intersectional domains in haptics through **elevating individual skills and ways of knowing**.*

Renaming HapHub

As we reflected on the results, tagline, principles, and mission, we came to the conclusion that the “hub” of HapHub’s name did not reflect the provisions of the

community resource. After extensive group brainstorm between researchers and within our research group, we found that the word “commons” reflected the collective, community centered intention of the haptics resource. The word commons stems from 14th century BC, an originated in meaning “the people collectively.” Thus, we renamed the resource: **Haptics Commons**.

Reflection on Design Approach

We decided to design a low-fidelity prototype before hearing from the stakeholders. We made this decision because we felt basing discussions on a prototype would help ground our conversations in the concept of inclusivity. While part of the interview was directed at the peripheral hapticians personal experience and perspectives, we also aimed to obtain guidance on what might be needed for an online haptic design community through prototype evaluation. In doing so, we will also implement some of the results from our perspectives and prototype evaluation to develop another, higher fidelity prototype called Haptics Commons.

4.4 Medium-Fidelity Prototype: Design

This section details the next iteration of the HapHub prototype taking into consideration its new name – Haptics Commons – and synthesized recommendations and revisions. We implemented Haptics Commons in medium fidelity using Figma. The following details our approach (see Figure 4.9 prototype development block).

4.4.1 Design Approach

We designed Haptics Commons with prioritized requirements and brainstormed specific design decisions with design sprints. After we designed the medium-fidelity prototype, we conducted a semi-structured think-aloud usability study to evaluate the implementation of Haptics Commons in medium fidelity.

MoSCoW Prioritization

To support the next phase in our iterative prototyping, we used MoSCoW prioritization to reorganize the prototype themes from Section 4.3.2 into design recom-

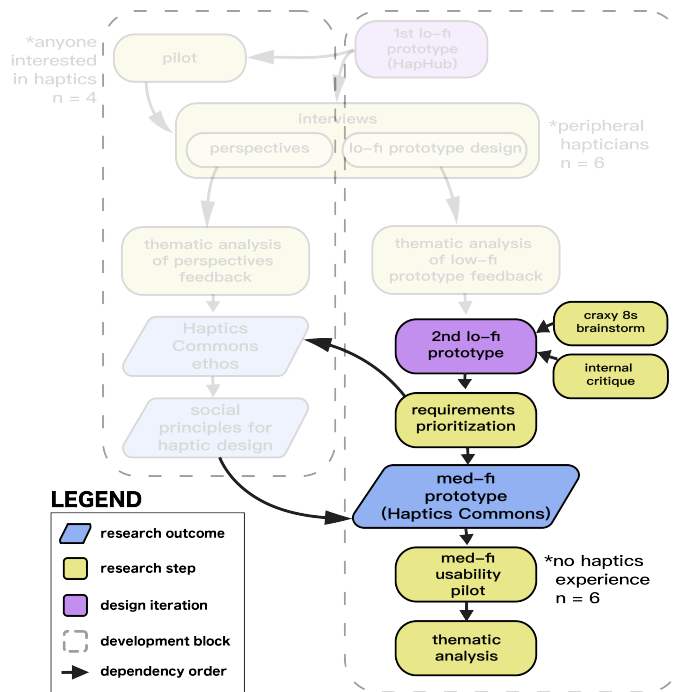


Figure 4.9: This part of the research focused on prioritizing requirements and results from low-fidelity prototype evaluation and iterating on our prototype (Haptics Commons). We end this portion of the research with a pilot study.

mendations.

MoSCoW is a technique that is commonly used in software design to assign prioritized requirements in a collaborative manner (see Table 4.1) [86]. The four raters (described in Section 3.3.3) grouped the qualitative thematic data in *Must have*, *Should have*, *Could have*, and *Won't have* categories based on responses from participants. A description of these priorities is detailed in Table 4.1.

Table 4.2 details our collaborative MoSCoW prioritization analysis. We aimed to group themes and sub-themes into design requirements. Each priority ranking serves as a bucket with no hierarchy within groups. In weekly group meetings, researchers translated suggestions from interviews into design requirements and collaboratively sorted the requirements on Figma.

Priority	Description of Priority
Mo - Must have	Required things that the project cannot live without
S - Should have	Higher priority portions of the project but are not essential to it functioning. Non-critical, yet highly valued and important.
Co - Could have	Nice things to have in the project, would add to the project but are not necessary.
W - Won't have	Probably not going to implement these things in the project. Could potentially be included, but low priority.

Table 4.1: MoSCoW prioritization technique

Priority	Design Requirements
Must have -	<ul style="list-style-type: none"> - What is Haptics (mission) - What to do here/purpose - Community discussion board - Structured resources - Examples (code, projs, etc) - Open source approach to authorship - Resource submission support - Feel: casual, fun, collaborative
Should have -	<ul style="list-style-type: none"> - Getting started: DIY demos - Maintenance (mods) - Roles (responsibility sign up) - Feature projects - Directory to open source code/data - Recent activity in haptics (+ archiving past news) - Proposal projs/collaboration - Badge/color system to distinguish submissions
Could have -	<ul style="list-style-type: none"> - Oauth login with Discord/Slack - Events - List communities in haptics - Volunteering/job opportunities
Won't have -	<ul style="list-style-type: none"> - Affiliation link - Marketing - Mentorship programs - Networking

Table 4.2: MoSCoW prioritization technique to convert themes and sub-themes into design requirements. There is no internal hierarchy within each grouping. Even-numbered items in design requirements were not intentional.

Design Sprints

Design sprints are an established technique commonly used in user experience (UX) design. The design sprint approach emphasizes original thinking about problems through rapid idea forming and iteration. We utilized a technique called “Crazy 8’s” in Google’s Design Sprint Kit [44]. We used this fast sketching exercise to challenge to sketch eight distinct ideas in eight minutes. The goal was to push beyond our first idea of HapHub and combine results from our interviews to generate a wide variety of solutions. The process of our design sprints can be seen in Figure 4.10.

Overall the main portions of the site were supported in the previous HapHub iteration. That is, the page headings, type of interactions, and community structure

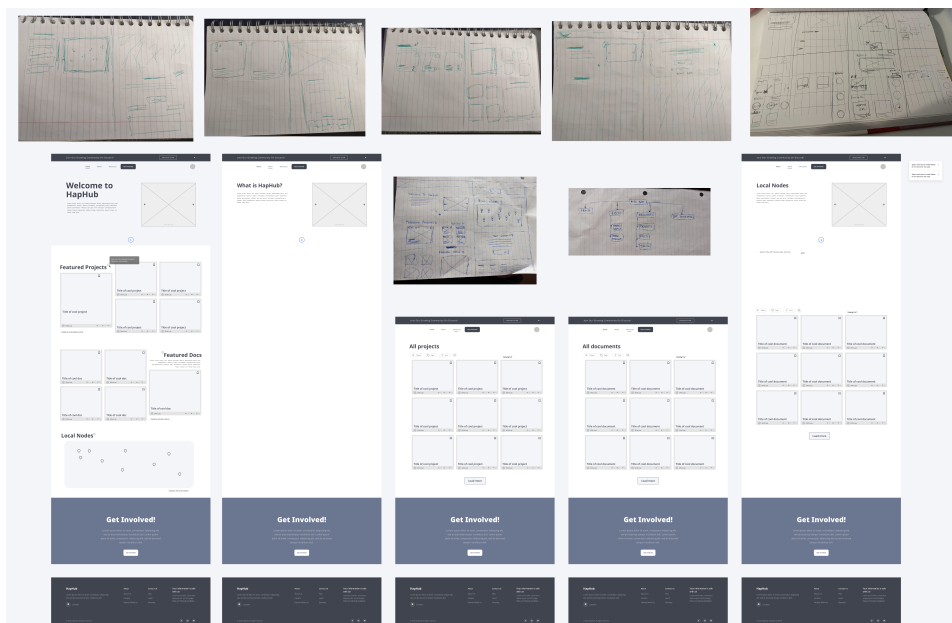


Figure 4.10: Design sprints of Haptics Commons. Images towards the top of the figure are paper prototypes from the Crazy 8's sprint. 5 frames seen at the bottom are low fidelity prototypes actualizing some of the ideas from the sprints.

were consistent with our implementation of HapHub. With design recommendations from the analysis of our interviews, prioritization, and design sprints, we made adjustments to the site map of HapHub. Figure 4.11 illustrates the implemented pages and features of Haptics Commons.

A shift in the design was to add a floating chat widget to Discord [28]. By doing so, we intended on aligning different static portions of the website with conversations that were happening in the community. Using the idea of a floating widget like the one from WidgetBot [93], we designed Haptics Commons to correlate between discussion topics on the site, chat channels on Discord, and discussion threads on Discord.

4.4.2 Prototype Description

The medium-fidelity prototype followed the sitemap developed in the design sprints Figure 4.10. There are many similarities to HapHub (see Section 4.2) in the overall structure; in this next iteration of the resource prototype we added more features that are highlighted in blue on Figure 4.11.

In fact, we changed Haptics Commons to first and foremost show featured resources, opportunities, and the community (in the format of a Discord server) on the landing page. Based on our evaluation of HapHub, participants wanted more of a visual landing page that directly linked to other portions of the site. We changed the forum format of our Haptics Commons community brainstorm to reflect more modern, in-use recommendations like Discord. Doing so also allows the opportunity for people to connect in real time via text, voice, video, and file sharing. We would also encourage sub-groups to form on the Discord channel so people can self-organize based on interest areas in haptic design.

More unusually, we thought it might be difficult to go back and forth between static website on Haptics Commons and the Discord application. We prototyped a floating Discord widget on multiple pages of the site, linked to relevant threads of conversations.

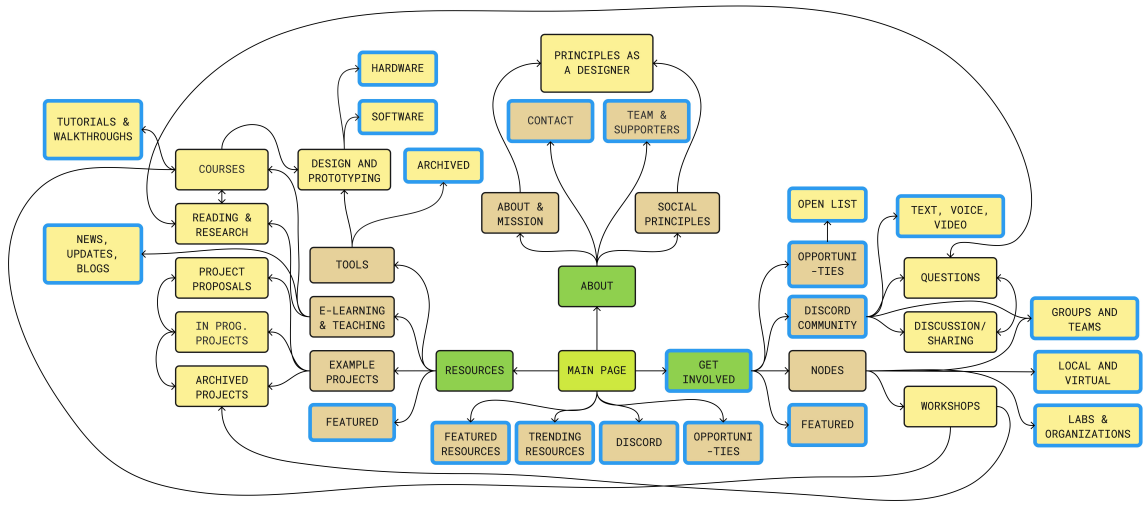


Figure 4.11: Sitemap of Haptics Commons. As a higher fidelity prototype, Haptics Commons had additional detail and structure but did not change the original structure of HapHub. New additions are marked in blue outlines. Green nodes are page names, brown nodes are type of page feature, and yellow is the content of the features.

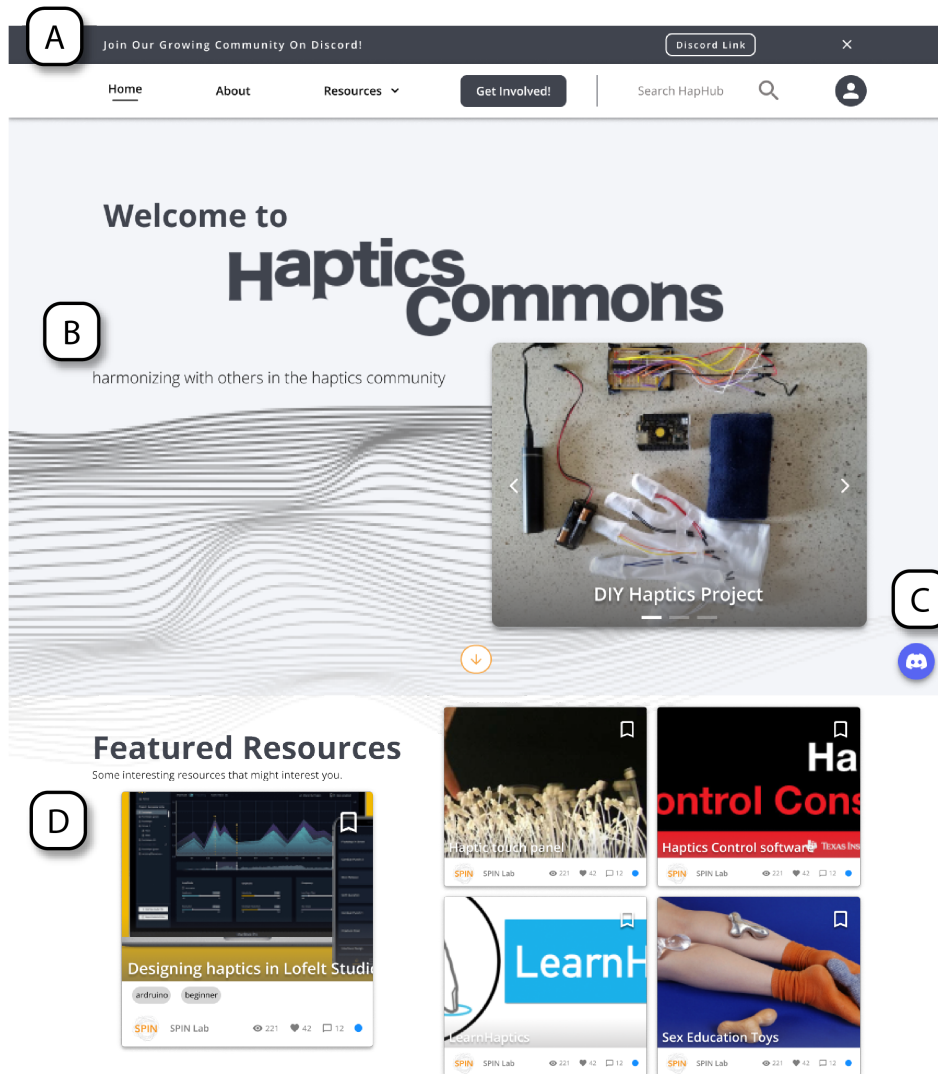
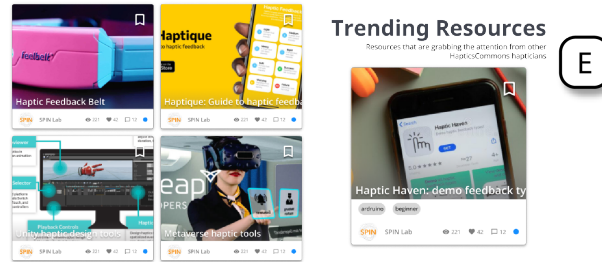


Figure 4.12: Haptics Commons landing page. A) Pop-up message that invites people to join the Discord server B) Tagline of the site that reads “harmonizing with others in the haptics community” C) Discord widget that floats on every page of the site. Clicking it will open a small, floating discord server that corresponds to the page people are on D) Featured resources are shown on the front page to help visually display the different types of projects, learning, and tools there are.



Local Nodes

The community can be taken offline with local nodes! Find people to connect with in real life.

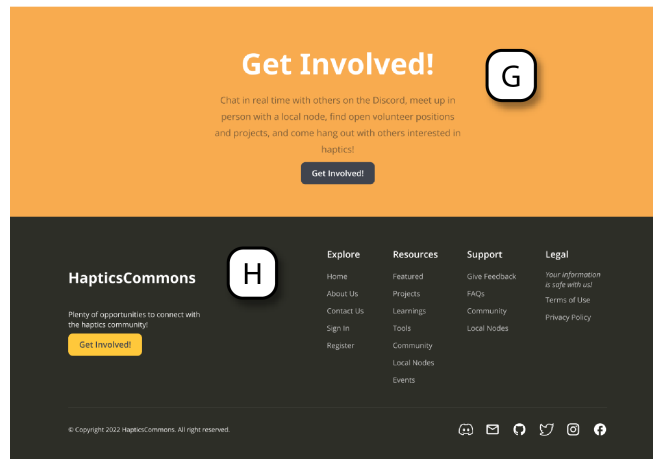
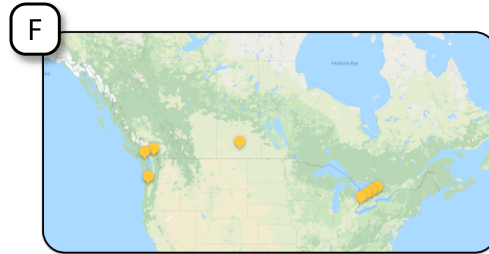


Figure 4.13: Haptics commons landing page continued. **E)** Trending resources are ones that people interact with the most on the site. **F)** Local nodes are shown visually to indicate where people are forming Haptics Commons groups locally. **G)** Get involved is indicated again at the bottom of the page after a person has browsed the examples above. **H)** A footer is included to list pertinent information relating to the site like menu items.

Main Page (Figure 4.12 and Figure 4.13) is the first page people see when they interact Haptics Commons. This page details overview elements of what people might find on Haptics Commons. Figure 4.12 details the first portion of the website. All but one menu item stayed the same to HapHub. We chose to change the Community menu item to Get Involved to reflect a broader definition of community involvement. Rather than including drop-down menus for each item in the menu bar, Haptics Commons only included a menu drop-down for the resources option to address an issue of clarity in HapHub’s menu.

To reflect the results of our previous iteration (*Theme 1: Clarify Purpose at the Onset*), we decided to also include a clear tagline that communicates the overall purpose of Haptics Commons. Additionally, to communicate the use of the site, we included direct links to featured resources, trending resources, community, and opportunities on the main page. In doing so, we also wanted to address our social design principles (see Section 3.6), specifically through finding what might pique the interest of different hapticians through examples on the main page. This way we can resonate with the social principles of *Principle 1: We Let Intention Guide Our Direction* and *Principle 3: We Bring A Lot to the Table* by allowing hapticians to see an example of what others are doing in the field and what they can contribute.

The image shows a screenshot of the 'About' page for Haptics Commons. On the left, there is an orange box titled 'Our Mission' with a circled 'A' next to it. The mission statement reads: 'Haptics Commons aims to reframe the role of a hapticist by empowering and inspiring diverse communities to create haptics together. Haptics is for anyone, and by redefining the means to create and design haptics, we are challenging the barriers of expertise through reflexivity, growth, connection, and difference. We uplift intersectional domains in haptics through elevating individual skills and ways of knowing.' On the right, there is a section titled 'Haptic Design Principles' with a circled 'B' next to it. This section contains eight numbered principles, each with a brief description: 1. Letting Intention Guide Your Direction, 2. There's No Dumb Questions, 3. You Bring A Lot to the Table, 4. Expertise Transcends 'The Expert', 5. You're Not a Novice, You're an Explorer, 6. It's OK to Feel Inarticulate, 7. Sharing is Caring, and 8. Touch is Touchy.

Figure 4.14: Haptics Commons “About” page details. A) Haptics Commons’ mission and B) social principles for haptic design.

About (Figure 4.14) is a similar structure to HapHub. From the results of our previous evaluation (*Theme 3: Towards Friendliness and Uplifting Similar Values*), the design justice principles were not immediately evident in their application to

haptic design. Because we use a lens of design justice to structure the social principles for haptic design and mission, we decided to keep the mission and design principles of Haptics Commons central to the about page without depicting design justice directly. We also detailed the team of Haptics Commons to provide context to the platform's creation. In the design of the About page, we wanted allow participants to reflect and potentially return to the social principles and mission of Haptics Commons. Doing so would help remind hapticians that this site is a commons (resonating with *Principle 8: We All Have Biases*), one in which all the resources, knowledge, and community sharing are for and by the whole of a haptics community.

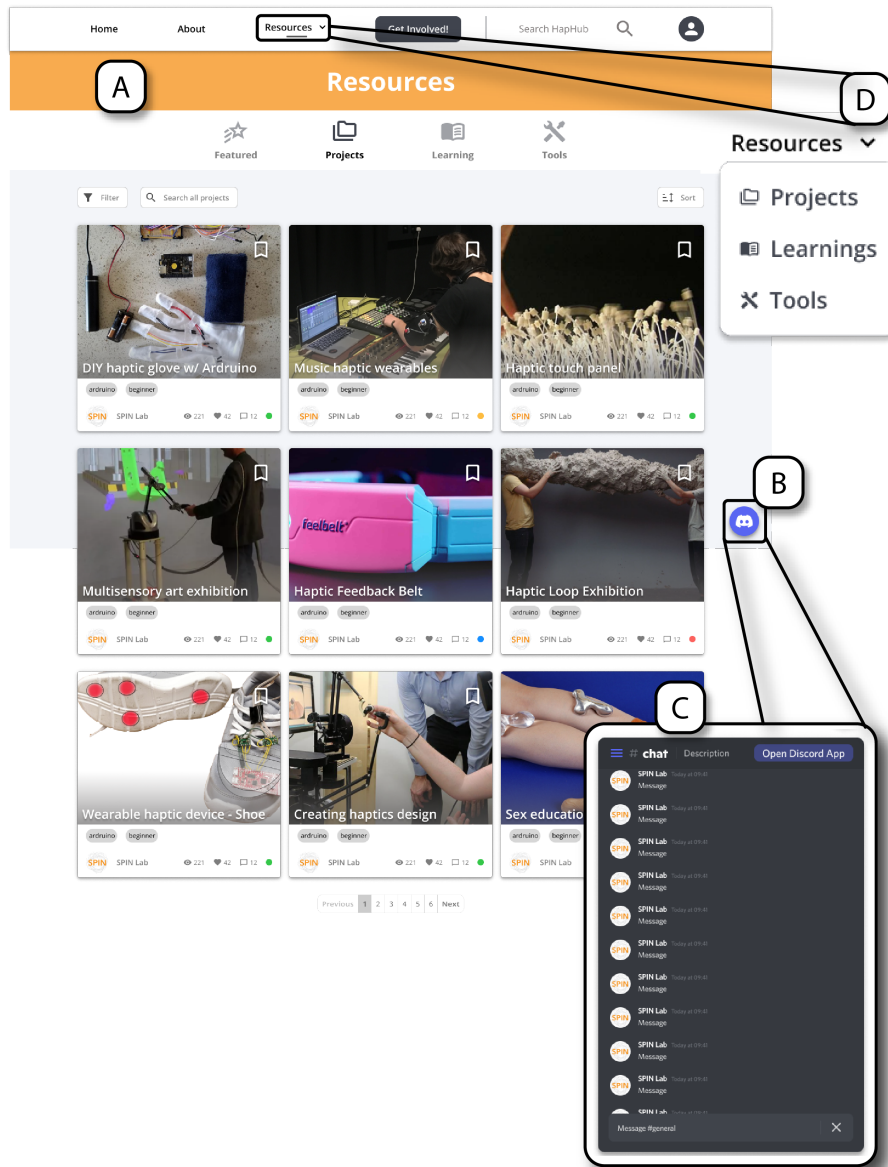


Figure 4.15: Haptics Commons Resources page. Clicking on the Resources menu brings the person to view a featured overview. **A)** Resources are split by featured resources, projects, learning, and tools. **B)** Drop-down menu of resources. **C)** Discord widget is always available in every page. **D)** When the Discord widget is clicked, a small, floating Discord server will appear on the page.

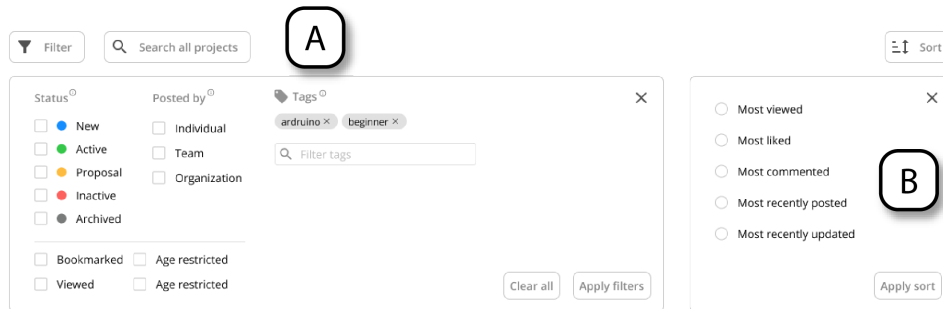


Figure 4.16: Haptics Commons Resources filters. Filters are accessed on every resources page by clicking on the button labeled “Filter”. Filters help sort the resources by **A)** activity, type of participation, tags, and personalized logging. Additionally, filters can be sorted by **B)** amount of interaction.

Resources (Figure 4.6 and Figure 4.16) landing page of resources has featured and trending resources that can be categorized by multiple filters. This portion of the site stayed very similar to HapHub, supporting the request for viewing both trending and archived resources. Additionally, each resource type (projects, learning, and tools) can be filtered as well.

Upon reflection from HapHub (*Theme 2: Curation and Transparency as a Mechanism of Sharing Knowledge* and *Theme 4: Self-forming Communities*), we wanted the resources to reflect the intentional decision to sort the organization of the resources as well as be able to intuitively filter them to each persons’ interests. Moreover, the decision to have both filters, trending, and featured resources has also been informed by the social principles of rethinking expertise (*Principle 4: Expertise Transcends “the Expert”* and *Principle 5: We’re Not a Novice, We’re an Explorer*). By designing the resources with sub-group tags, activity, and authorship, hapticians with multiple backgrounds can find some guidance in feeling inarticulate (inspired by *Principle 7: Sharing is Caring*) and examples of how others have displayed their haptics projects online. If they need to, the Discord widget was also designed to be available on every page and link to the current page that the person is on (influenced by a need to address *Principle 2: There’s No Dumb Questions*). If they have an outstanding question about a specific resource, the design of the widget helps bring forward others questions and relevant and live discussion.

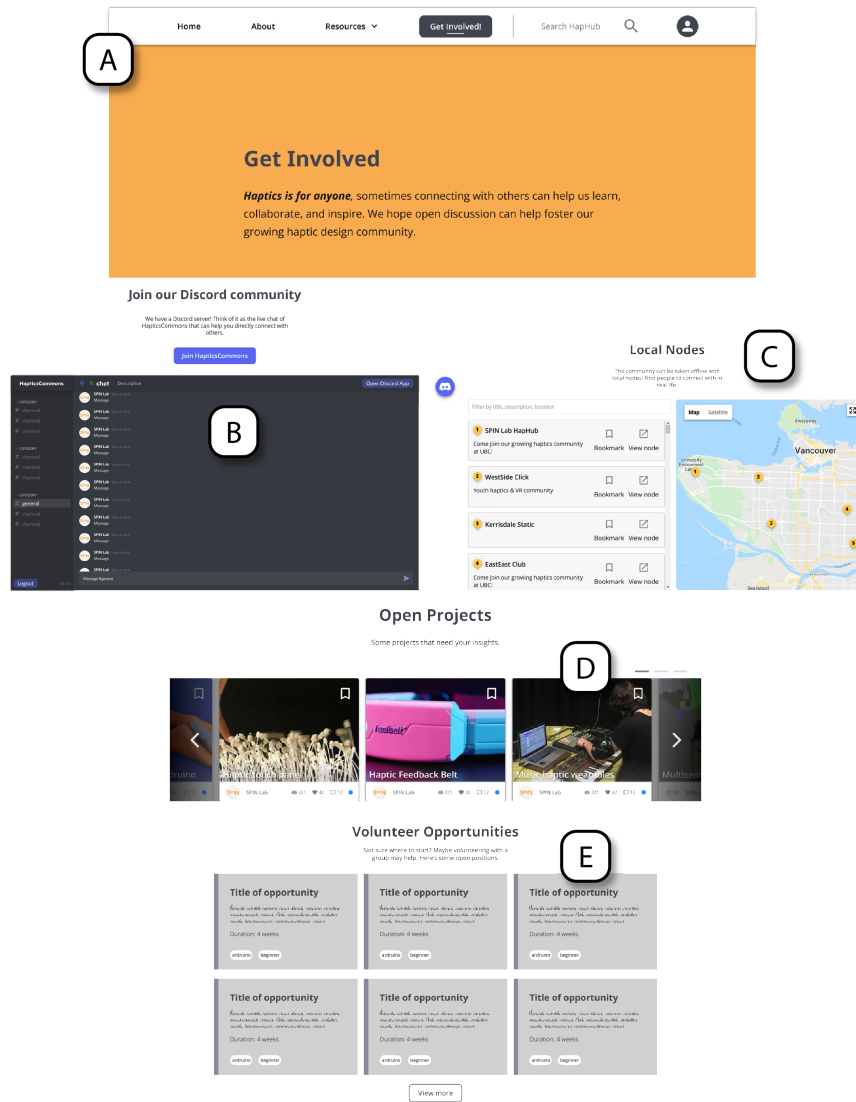


Figure 4.17: Haptics Commons Get Involved page. Page is shown in segments. Participants saw each portion of the site in alphabetical order by scrolling. **A)** reiterates the mission of the community. **B)** The Discord community is also embedded into the get involved page so people can browse what the server looks like in a different format from the widget **C)** shows local nodes on a map **D)** lists open projects and **E)** lists open opportunities.

Get Involved (Figure 4.17) allows people to see the various ways they can be a part of the Haptics Commons Community. From our recommendations to make Haptics Commons friendly and mutually supportive (*Theme 3: Towards Friendliness and Uplifting Similar Values*), we decided to include a way to get involved in the community on every page, whether it be through Discord, linking to opportunities, or displaying open opportunities. Get involved supports options to chat via Discord, any open projects that people have requested collaboration with, volunteer opportunities, and local nodes to meet up locally with other hapticians. Engagement on Haptics Commons is linked to Discord authentication. People can engage through an account that is connected to both their Discord account on the Haptics Commons Discord server as well as comment through that same login on the Haptics Commons website. As seen in all Haptics Commons examples (see Figure 4.12, Figure 4.14, Figure 4.15, and Figure 4.17), the Haptics Commons Discord channel is displayed in a minimized, floating widget to allow people to engage with the community discussion on every page. Each page of Haptics Commons, including individual resources, are aligned with a corresponding Discord channel and/or thread.

Much of the design of the Get Involved page was to address the social principle, *Principle 6: It's OK to Feel Inarticulate*. We learned from our interviews with peripheral hapticians that without demos, examples, talking with others, and collaboration haptics is incredibly difficult to communicate with others (much like *Principle 7: Sharing is Caring*). While there is no solution to this communication problem yet, our attempt at easing some of the challenges of communicating haptic design and concepts is through allowing potential relationships to be built and sharing of what works and does not work in other hapticians' experiences.

4.5 Medium-Fidelity Prototype: Evaluation

This section of the research evaluates the design described in the previous section Section 4.4. We evaluated the prototype with six haptics-curious participants as a pilot study. Following, we conducted thematic analysis on the pilot results for suggestions for future iterations and stakeholders.

4.5.1 Evaluation Protocol

We created a persona in advance to the evaluation and asked participants to imagine themselves as the persona when they participated in the pilot semi-structured interview study. Interview questions were similar to the described ones in Section 4.2 with task adjustments to the walkthrough to assess usability. In each page of the Haptics Commons website, we asked participants to click into the interactive portions of the website while thinking aloud. We asked them to join the Haptics Commons Discord community, reflect on the tone and feel of the site, assess social principles for haptic design and mission, and evaluate the structure of resources on the website (see Section A.5 for detailed protocol and interview questions). Interviewers (four in total) were the same raters from the earlier iteration of the prototype analysis in Section 4.3.2.

Persona, representation, and study design

To focus our evaluation, we decided to assign a persona of an exploring haptician, someone with little to no exposure to haptics and is aiming to discover the Haptics Commons resource. The reason for this decision was to evaluate a point of entry to Haptics Commons. At a later time, we hope evaluate other lived experience, identities, and interest areas in haptics, but for the purpose of this study and prototype, we narrowed our scope with the following scenario:

We'd like you to navigate the interface as someone who recently became interested in haptics and is looking to explore more about it. You have a general understanding of what haptics is, but don't know how to further this interest of yours.

This subsection of the research followed the iterative design structure shown in Figure 4.9.

4.5.2 Participants

We used purposive sampling supplemented by convenience sampling to increase recruitment. We advertised the study through word-of-mouth and online discussion board postings. Eight participants responded to our word-of-mouth recruit-

ment message. Of the eight, we were able to schedule interviews with six participants (2 UX designers, 1 software developer, 1 gardener, 1 business management, 1 marketing student).

4.5.3 Analysis

Two researchers (the interviewer and coder from the previous iteration of the study and one coder from the previous iteration) coded the six interviews, taking notes to provide descriptive data points in Figma. Referencing the interviewers' coding sheets, researchers collaboratively transcribed stand-out points from coding sheets and interviews.

Analysis was done in Figma by placing data description points (quotes and notable behaviors from coding sheets) into separate, virtual sticky notes for collaborative affinity diagramming. We chose to affinity diagram, a parallel approach to stacking themes as suggested by Braun and Clarke, to be able to make sense of the large amount of varied and rich discussion that came from the Haptics Commons evaluation (see Figure 4.18).

Researchers took a similar approach to earlier iterations of thematic analysis and allowed the codes to arise through collaborative, virtual affinity diagramming while on a Zoom call to discuss and organize. The virtual sticky notes were colored based on the participant number and we virtually moved around the data to based on its content. Through lively discussion and collaboration, both coders were able to discuss together and make decisions on what types of themes were arising from the affinity diagramming.

4.5.4 Results

In general, participants thought Haptics Commons was clean, modern, educational, and beginner friendly. However, there were some striking differences in how they imagined using Haptics Commons as the persona they were provided – (Figure 4.18 provides an overview of participants' individual reactions). For example, all participants found Haptics Commons valuable as the persona they were provided, yet some disagreed on whether they would use it if they were not imagining themselves as this persona. P2, P4, and P5 all mentioned they enjoyed

browsing the site, but probably would not engage further because they couldn't imagine themselves doing so, personally. P1, P3 and P6 all found Haptics Commons interesting to them individually, emphasizing the welcome and educational nature of the resource structure. One participant mentioned they could also see themselves using the platform as a form of news both on the static site and Discord discussions.

There was a positive response to Haptics Commons, as reported by participants. Other than minor bugs in the fidelity of the prototype, participants mostly listed benefits to the people in the community like supporting and connecting with others and accessibility to educational materials.

Reporting in this section is based on preliminary qualitative data. The purpose of this evaluation was to investigate the study design and prototype at medium fidelity.

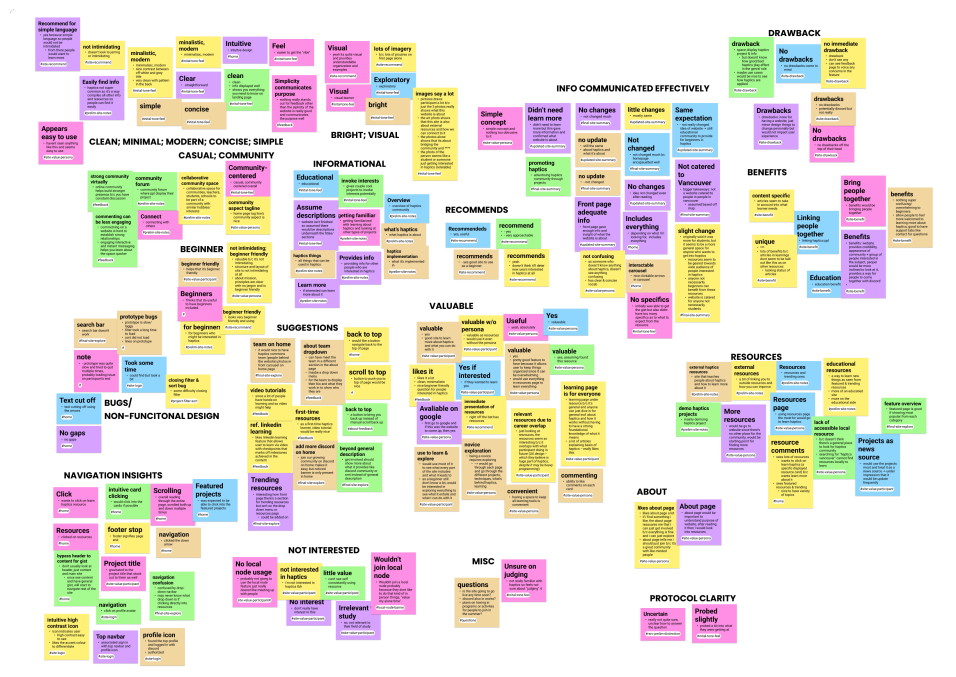


Figure 4.18: An overview of participants' varied reactions to different components of Haptics Commons. Here participant number is indicated by color and are organized by participant response category. For a detailed overview of responses sorted by themes.

A Strong Haptics Commons Ethos

P1 and P2 repeatedly returned to the about page, noting that they found the mission and social principles for haptic design helpful for the overall “feel” of the platform. All participants found the about page to underline the sense of community, describing it as encouraging and friendly. Participants resonated strongest with two social principles for haptic design most: “We’re Not a Novice, We’re an Explorer” and “There’s No Dumb Questions”. Although the about page helped communicate a sense of welcome, participants also noted the length can be taxing to read through. Some recommended to adjust the layout to summarize each point for ease of reading.

A Curated Approach to Resources

Sub-categories and organization of Haptics Commons was quickly identified by participants. The organization of the site was mentioned by P2 and P4, noting the featured resources page as helpful to contextualize what they would find. P6 stated they were surprised by the different areas of haptics, since they previously did not realize haptics could be so diverse topically.

Overall, participants understood each resource type (projects, learning, tools) and were able to describe their use accurately. For example, when asked to describe what they would expect to find in the tools resources page P6 described tools as “*what you can do in conjunction with haptics*” and P5 described it as “*things that can help you develop haptics related projects*”; both congruous with the intended use of the haptic tool.

Three participants particularly liked the ability to filter and sort the resources, citing that they liked that they could personalize their search to reflect their individual interests.

A Community That’s Always There

By clicking on the Get Involved page, participants were able to identify the value of a static site supported by a Discord discussion channel. On a particular project page, P1 expressed some confusion to whether the discord widget supported specific project discussions. 4 participants identified the Discord channel as com-

plementary to a comment section, allowing a wider range for learning, sharing, and discussion. They identified a low-barrier to entry at the community level, and appreciated the overall structure between the web and Discord platforms.

4.6 Final Takeaways

Based on our preliminary results, Haptics Commons' curation and accessibility message was well received by haptics-curious people with no previous haptics experience. We would hope to conduct further evaluation of the Haptics Commons prototype which would help us understand the impact of our design in the community, including prominent stakeholders in our later evaluations.

This design iteration and interview sample targeted haptics-curious people who had no prior exposure or experience with haptic design. Based on our results, it seems likely that the site is, for this group, beginner-friendly and empowering; addressing recommendations from the previous iteration of HapHub. For people who are haptics-curious and don't have experience with haptics, lowering the barrier to entry of Haptics Commons is important to evaluate whether the initial organization and complexity of the site can be understood at a basic level. For those with experience in haptics, adjusting to a new haptics community platform like Haptics Commons, we would expect understanding the site to be similar to that of a haptics-curious person as well. Further investigation is needed in the type of interactions people will want to engage with at a longitudinal and community scope, although this may require an already existing and active participation from the community on the platform.

Furthermore, we gained insights to whether the overall ethos of Haptics Commons helped guide participants' feelings about community knowledge sharing and accessibility. We were able to realize that providing a detailed mission, tagline, and guiding principles helped lower the barrier to entry on the platform and made others feel welcome to share ideas.

We gained an impactful promise from our preliminary usability study. We have gotten an idea of the usability of the prototype from an exploring haptician. The results from our study give us motive to continue to iterate on Haptics Commons and investigate the impact with other stakeholders in the haptics community.

4.7 Reflection and Discussion

We have discussed the design and implementation of two prototypes that aim to propose a solution to haptic design knowledge sharing and accessibility. We return to our questions we asked at the beginning of this chapter: *RQ1: Is there a way to uplift specialized haptics knowledge for a larger collaboration and knowledge sharing ecosystem?* and *RQ3: What qualities of a community resource provide an empowering, inclusive, and reflexive design ecosystem?* We have discussed some of the ways in which we aimed to address these questions through study design and methodology. Using inspiration from past examples of both resources and justice-based communities, we reported on both 1) a low-fidelity prototype (HapHub) of a haptic design resource evaluated by peripheral hapticians and 2) preliminary results from a medium-fidelity prototype (Haptics Commons) of the same resource, evaluated by people with little to no experience with haptics.

By probing different design dimensions and structuring a perspective of haptic design through a clear mission and guiding principles, we opened the possibility for resources like this to widen a perspective of who can be a haptician. Through uplifting specialized knowledges of the user through our mission and social principles for haptic design, people were able to reflect on their feelings of inclusivity in a space they might have previously not feel as heard in. To provide an empowering space, we aimed to provide a critical step in addressing reflexivity and inclusivity in haptic design.

Again, we would hope to continue to evaluate the most recent iteration of Haptics Commons with different hapticians of varied backgrounds. Hapticians from the more mainstream avenues have been researched in the past to gain insights on their specialized knowledge and lived experiences [36, 76, 77]. Our approach took a “designing from the margins” approach, a methodological approach to equitable design from critical race theorist and activist Kimberley Crenshaw [18]. We began by first “addressing the needs and problems of those who are most disadvantaged and with restructuring and remaking the world where necessary;” in our case, peripheral hapticians. After another design iteration, we also included “others who are singularly disadvantaged would also benefit;” in our case, perspective hapticians. Reflecting Crenshaw’s approach to equitable design, by placing people

who are currently in a disadvantaged position at the center of the design process, we resist compartmentalising peoples' experiences to generate collective action against a narrow delivery of haptic design knowledge.

Future iterations of this research could consider what would motivate other stakeholders, such as currently active people in haptics academia and industry, which are not included in the sampling of this research. Doing so would inform a wider reach of the interactions between people of varied skill levels and technological backgrounds specific in haptics. Additionally, we could also get a better picture of what would motivate stakeholders to continue to use the Haptics Commons resource such as:

- peripheral hapticians (current scope)
- explorers in haptics (scope included in preliminary evaluation)
- experts/skilled people in some dimension of haptics (future directions)

Importantly, our hope in the future would include a pluralist perspective, critically considering intersectional identities and perspectives of “the haptician” that continues to welcome and empower others in the field.

Chapter 5

Discussion

At the start of this research, we set out to investigate the following questions. In this chapter, we will revisit our original research questions, listed below, and evaluate our progress towards them.

1. **Elevated Specialized Haptics Knowledge:** is there a way to elevate alternative and specialized haptics knowledge for a larger collaboration and knowledge sharing ecosystem?
2. **Experience Levels in Haptics:** how are experience levels currently defined in haptics?
3. **Haptics Community Resource Qualities:** what qualities of a community resource could provide an empowering, inclusive, and reflexive design ecosystem?
4. **Building Relationships as a Form of Empowerment:** what value could come from making haptics more empowering through a design justice lens (individually and culturally)?

5.1 Haptic Design Ecosystem Empowerment

We questioned whether there was a way to elevate specialized knowledge in haptic design communities and whether experience levels are currently defined in haptics.

We hypothesized that tapping into peripheral hapticians' specialized knowledge through theories of pluralism would help break down level-defined structures in haptic design ecosystems.

5.1.1 RQ1: Elevated Specialized Haptics Knowledge

In this thesis we explored a way to look at haptics knowledge that expands haptics resource availability, accessibility, and the role of the haptician. Centering the work of the marginal, and in our case the peripheral, can ensure hapticians are being supported in their interest. In Chapter 1, we identify peripheral hapticians and haptics-curious people and mostly focus on this group in Chapter 3 when asking about their perspectives in the field (technical, engineering perspectives). We do so in order to ensure we are giving voice to the marginal before that of the dominant voice that is mostly heard in the field of haptics. However, this approach did not address needs of the core, more traditional approach to haptics.

Chapter 1 also introduces the idea of peripheral hapticians, of which we have defined for the purpose of representing hapticians that feel as though they could use more representation or support in the field of haptics. We realize by defining peripheral hapticians we may be potentially repeating an in-group, out-group way of referring hapticians. In this case, we hope that the term “peripheral” in haptics dissipates as ideas of specialized knowledge, empowerment, and pluralism is accepted more widely. We do so in this thesis as a mode to challenge current representations of the haptician, and in no way wish to repeat exclusionary or oppressive practices.

In interviewing peripheral hapticians, we wanted to focus on the non-technical or non-engineering perspectives of haptic design. Haptics has come a long way from its mechanical engineering origins, and we sought to represent others that did not feel as though they fit within the traditional pathway of the haptician. In doing so, we were able to ask about 1) peripheral hapticians' perspectives on their inspiration, challenges, and potential hope for the future of haptics and 2) propose a relationship standard in the form of an eight social principles for haptic design. We codified what we found in the themes into the set of an eight social principles for haptic design that will help develop actionable assertions that could guide a supportive, inclusive social context.

Our approach to our semi-structured interviews was limited because we only included peripheral hapticians in our research. We do note that this approach does not come from people at the “core” of the field of haptics, but took this approach in line with a feminist and design justice framework. We hope that future iterations of our work would also explicitly ask other stakeholders in the “core” of the haptic design ecosystem to evaluate this same design. We imagine an alternative approach if we had first represented the “core” haptician such that the focus might be more on the ability to translate haptic projects into shareable chunks like the approach of Schneider et al. [73]. Inherently, this approach is a tangible question about sharing haptics demonstrations and knowledge, but mostly focuses on the technological approach to doing so. What we could see in a future iteration is combining examples like Schneider et al.’s approach with ours to encapsulate the depth and breadth of haptic design.

5.1.2 RQ2: Experience Levels in Haptics

We found that peripheral hapticians did not identify as experts in their field, even though they had extensive experience (Chapter 3). In fact, this was a surprise. When referring to other experts, our participants usually would mention people who were around from the technological boom of haptics (late 1990s). While those 30+ years in the field would seem expert-status, this did put into question whether haptics expertise levels were in fact representational of the skills people have built since then. Research primarily has focused on novice or expert hapticians, yet where do the peripheral hapticians fall? Our participants called themselves neither expert nor novice, therefore is that them? In realizing these fuzzy definitions of novice and expert we also note these terms are not so explicit in skill, experience, and background. In this thesis, we chose to rethink referring to hapticians this way.

We made the careful decision in our principles to refer to novice hapticians as explorers. We also refer to expert hapticians as practitioners of knowledge, since we also accept that people can be experts in their lived-experience. In turn, this makes everyone knowledgeable of haptics in one way or another, whether it be an explorer point of view or practitioner that can bridge gaps an explorer previously would not have noticed. This also means previously referred to novice and expert

hapticians can be either practitioners and/or explorers.

As a specific, personal example, my supervisor, Dr. Karon MacLean, has 30+ years of experience in the field of haptics, starting from a mechanical engineering background, achieving many impressive academic and directorial accomplishments, and now supervising this thesis. In one of our past conversations she has told me about her work on a haptic knob and the work of her colleagues on button presses. While I learned of these past works in our conversation, I also was able to inform her of the world of mechanical keyboard switches, often shown in ASMR Youtube videos or used by gamers. We went down a rabbit-hole discussing back and forth some of these interesting similarities and interactions. Karon and myself both took on the role of a practitioner *and* explorer in our discussion – a duality that might not have been obvious in the first place, but provided an engaging brainstorm. What we hoped to accomplish with our social principles was a repetition of this same discussion, facilitating engaging relationships, conversations, and collaborations with peripheral and perspective hapticians.

5.2 To Be Inclusive, and Beyond

We hypothesized that a community-focused, online resource for haptic design could help establish new collaborations and inspirations. Through the design of Haptics Commons, we asked what qualities could provide this environment as well as what value it would bring to the haptic design ecosystem. From our exploration, we have found that enabling collaboration and inspiration also has the potential to open up possibilities of new relationships. Through our design of Haptics Commons, we conjecture that by itself collaboration and inspiration can enable and empower a potential to build and maintain relationships with other hapticians – a pathway to sustaining a symbiotic haptic design ecosystem.

5.2.1 RQ3: Haptics Community Resource Qualities

Providing an space for discussion and knowledge sharing helps build relationship across boundaries that previously might not have seemed possible and provides an opening for empowerment.

One apparent criticism of this work is asking whether the obstacles faced by

peripheral hapticians and proposed solutions are specific to the field of haptics. In fact, they may not be. Similarly to our results in Chapter 3, we (the research team) are all personally invested in the field of haptics for a myriad of reasons. In my personal experience, I do not come from a “core” haptician background. Introduced to the field of haptics through research has been both rewarding and challenging, motivating my interest in creating a resource for hapticians that feel as though they are not receiving the facilitation they need in the field. Similar to many of the participants of this research, I found that the welcoming group of hapticians and labs I had access to helped grow my skills and interest, for which I am endlessly grateful. Yet our solution and framework we present does not mean that our findings are entirely generalizable to all hapticians nor designers. We realize that our position in the field of haptics allows us to be self-reflective on whether hapticians are being supported, yet in this growing design ecosystem, there are other contexts in which the Haptics Commons approach could apply. For example, in the past, access to rapid prototyping tools like 3D printing has been reserved for more technical settings. It also previously required technical skills in 3D modeling and fabrication materials. As rapid prototyping technology became more accessible, communities to share how to design with rapid prototyping tools started appearing online and locally like makerspaces and virtual community websites. In this sense, our approach to designing Haptics Commons is similar to other examples of forming design communities, thus generalizable in approach overall.

We recognize that in focusing on peripheral hapticians first, we have narrowed our scope to people we could find through our recruitment strategies. The scope to peripheral hapticians was limited as a feminist representational technique for equity, but does not mean our work here is done. We expect that many of the lessons learned here should apply to other hapticians, technological landscapes, and design ecosystems. In some of our related work, we discussed other approaches to accessibility, open-source, and community empowerment; we could see the structure of our haptic design resource applying in different, community focused directions. Additionally in our approach (Section 1.3), we describe the interaction between a feminist, design justice perspective and how it has allowed us to follow a justice-based approach to designing a resource. Although the first step in our recruitment was just a subset of stakeholders that we imagine benefiting from

Haptics Commons, we would hope to explore future direction with a wider range of stakeholders. While we brainstorm the various branches that this research can go, we acknowledge that some of the social principles for haptic design and resource design prototypes are not only haptics-bound. We would hope that our justice-based approach to representation for designers in technological fields would also be useful in other growing design fields.

5.2.2 RQ4: Building Relationships as a Form of Empowerment

In the experience of our research team, we found value and support gets mostly unlocked through different kinds of expertise and working together. As a research team, we have all had the experience of a confusing conversation with mismatched skill sets in group projects. Upon reflection, what we notice has come out of the other end of these experiences is a strong, mutual relationship among two or more people. Similarly, recent research has shown meaningful engagement in a community stems from diversity across disciplines, interests, *and* whether relationships can be formed [58]. This is exactly what we aimed to elevate through acknowledging specialized haptics knowledge in our evaluation of a haptic resource prototype (Chapter 4): affordances in budding relationships.

That is not to say there does not exist the potential for these relationships currently, but that specialized knowledge in the more traditional-haptician role can be expanded through relationships with peripheral specialized knowledge. While there are identified obstacles in haptics sharing and accessibility still (e.g. problems of sharing haptic projects, embodiment discussions, device specificity), empowering those that currently feel like they do not have a voice in the matter will help bring their ideas for solutions to these problems to the table. Stemming from personal interest, most peripheral hapticians we talked to emphasized they came to be interested in haptics on accident (Chapter 3). In our experience, allowing free creative reign for those that are interested in haptic design can allow hapticians to feel as though they are a part of a community that is full of potential future connections (Chapter 4).

Our experience with talking with peripheral hapticians helped us see the value in relationships that can help inform the ways in which hapticians learn, share,

and practice haptic design (Chapter 4). We found the haptician representationally deviated from those that have been previously studied or assumed through our recruitment strategies as well as in-depth semi-structured interviews on their personal experience. What we did not cover was the “core” of the representational haptician, purposefully. In addition, we were only able to recruit six participants from a Western, academic setting. While this may have been due to the recruitment methods, we also wish to consider other values of touch on a cultural level as well – in accordance with feminist theories of pluralism, doing so would help represent and understand other forms of haptic knowledge. In one instance, we found that one haptician prefers the term “digital touch”. We note that we did not recruit with this knowledge of synonyms or similar fields, thus some of our representational data may also reflect a subset of people who identify with the word haptics or haptician. For this thesis, we narrowed our scope and recruitment to appropriately get our project the stage of designing an inclusive, justice-approach haptic design resource prototype. In a future iteration, we would hope widen the scope of this thesis approach and longitudinally examine the impact of the social principles for haptic design.

Chapter 6

Conclusion

In this thesis, we sought to democratize haptic design knowledge by using a feminist, design justice framework to develop a resource and social principles. To this end, we conducted two parallel threads of investigation (Figure 1.4). On one hand, we examined the perspectives of peripheral hapticians. In parallel, we conducted a two-iteration design process informed at each step by the feedback of potential audience drawn from peripheral current or potential hapticians.

We have presented the results from our semi-structured interviews and a early prototype (HapHub) that examined the perspectives of peripheral hapticians and what they value from an online haptic design resource. Moreover, we presented the results from our iterative design of Haptics Commons based upon the previous recommendations and discussed responses from new hapticians. Starting from an initial spectrum of perspectives on haptic design experience and accessibility (Chapter 3), we have identified obstacles faced in haptics from peripheral hapticians (Section 3.3) that we translate into eight social principles for haptic design codes for inclusivity in the field (Section 3.5). Finally, we center community discussion and collaboration through design exploration (Chapter 4) in a low-fidelity prototype called HapHub (Section 4.3) followed by a medium-fidelity prototype called Haptics Commons (Section 4.4).

In this closing chapter, we will first summarize our contributions in more detail and then discuss implications for future work.

6.1 Thesis Contributions

At the start of this thesis, we outlined four main contributions (Section 1.5). In this section, we will revisit these contributions and evaluate the impact of them.

1. **Characterization and social principles for haptic design:** Reframed a *broadened understanding of the haptician*, going beyond current representations in our interpretation. We characterized attributes that contribute to dimensions of expertise in haptics that *promotes recognized inclusivity* in the field and developed principles for the future of haptic design accessibility.
2. **Problem identification:** Examined haptic design/resource accessibility needs for hapticians from *various backgrounds* to facilitate the rising interest in haptic technology.
3. **Design instantiation:** Prototyped an exemplar resource that takes into consideration *informed design recommendations for sharing haptic knowledge* and empowering hapticians of diverse backgrounds and experiences.

Characterization and Social Principles for Haptic Design

Our first key contribution is a *broadened understanding of the haptician* through understanding current representations (Chapter 3). We assessed the ways hapticians have been represented (Chapter 2) and responded to calls of expanding beyond the technically-tied definition through defining the peripheral haptician and asking them what support they need from a haptic design ecosystem (Chapter 4). We characterized attributes that contributed to dimensions of expertise in haptics and expanded on recognized inclusivity in the field through eight guiding social principles for haptic design. This type of characterization ties to a level of consciousness: knowing and acknowledging the lived experiences of hapticians that feel under supported. Future work could investigate this the duality of practitioner and explorer further. Including other stakeholders in the conversation would help represent the current haptic design ecosystem and the overall rethinking of the role of the haptician.

Additionally, we developed recommendations for the future of haptics accessibility (Chapter 3) through social principles for haptic design. Using our guiding

principles, we propose interpretations to the themes brought up by peripheral hapticians. We implemented these principles as our guiding approach of an inclusive, welcoming haptic design resource on a cultural and individual level. From our preliminary results on the impact of our social principles for haptic design (Chapter 4), participants found they helped frame the structure of an inclusive haptic design resource, however their description might be too lengthy to remember quickly. The strong caveat is that, although they are descriptive social principles for haptic design, we aim for them to be iterative and constructed by the community. Future work should take a participatory approach to iterating on these social principles for haptic design in order for them to reflect the diversity of hapticians and support they feel like they need. In our case, we only evaluated the principles with prospective hapticians, therefore, we would want to also iterate collaboratively on the principles with other stakeholders the principles aimed to represent (peripheral hapticians, STEM-aligned hapticians, more perspective hapticians).

Identifying problems

In Chapter 3, we identified social haptic design accessibility needs for hapticians from *multiple peripheral backgrounds* through semi-structured, narrative interviews. Results from the interviews with peripheral hapticians suggested there needs to be a way to handle the different sub-fields and interest areas of haptic knowledge to provide support in circumstances where people feel underrepresented. Additionally, empowerment and sense of community are lacking in the current haptic design ecosystem due to limited support and relationship opportunities. Identifying these individual and cultural issues in the haptic design ecosystem helped target the focus of our research. Representing hapticians has not been previously examined in the social, community level contexts. In this contribution, we offer a new interpretation of hapticians' identities that includes intersections of facilitating knowledge (from skill or experience) and exploring new topics (of what they do not know yet).

In the future, haptic design accessibility and inclusion obstacles could be studied with diverse sampling and further investigation into the sub-fields of haptics to more clearly identify why these obstacles may be in place for specific groups.

Through the same feminist, qualitative participatory approach, future work could provide insights to other obstacles hapticians will face at the community, relationship building level as well.

Prototype design

To address some of these issues identified in Chapter 2 and from our requirements gathering interviews (Chapter 3), we instantiated the design of a resource in two iterations, HapHub and Haptics Commons (Chapter 4). We took into consideration *informed design recommendations for sharing haptic knowledge* and presented potential solutions to in haptic community sharing through an introduction of social principles for haptic design, and centering hapticians of diverse backgrounds and experiences. In this prototype we represented hapticians as having a multiplicity of roles that would lead to a more inclusive environment regardless of haptics knowledge and skill. Although hapticians have been studied in the past, how they are represented has not been questioned. We aimed to provide a welcoming environment for most experience levels and backgrounds, however we only evaluated the design of this prototype in a pilot study with participants that identified as perspective hapticians.

Though the prototype was evaluated with a pilot, preliminary results indicated the platform approach was generally welcoming and inclusive to this participant pool, however there was still mixed results on whether this design would be successful in fostering relationships across disciplines, experiences, and interests. Further work still needs to be done to investigate the potential for these relationships both in the design of the prototype and the impact it can have on facilitating meaningful relationships between hapticians. Preliminary results do allow us to have hope in the approach of this design and can serve as a blueprint for the design of a future iteration of Haptics Commons.

6.2 Community Impact and Considerations

In this section, we reflect on our methodological frameworks of Feminist HCI and Design Justice in this thesis.

6.2.1 Where Feminist HCI Applies

Feminist HCI researchers call for the consideration of influence of our research contributions and the people it could impact: “Research conducted within a feminist framework is attentive to issues of difference, the questioning of social power, resistance to scientific oppression, and a commitment to political activism and social justice.” [48]. Some HCI researchers have critiqued the broader field of computing design, citing that rarely computing systems are developed by the communities they’re intended for [14].

To consider the potential impact of our design work, we work with the community it is intended for: hapticians. Through guiding principles, we gave reframed the context of who “qualifies” as a haptician and what is considered an “appropriate” haptics concept. Underlining specialized knowledge in haptics takes a pluralist standpoint, including specialized knowledges at the forefront of our reframing. “The haptician” is no longer contextualized by academic accomplishments, years of contribution, or expertise in haptics, but as self defined and an ever changing state. While some will have metrics to be measured by, like accomplishments, contribution, and expertise, these can be supplemented by other qualitative measures like interest and passion.

We purposed the design of HapHub, and subsequently Haptics Commons, to reflect perspectives from the community. Haptics Commons serves as an open, friendly community-centered resource for haptic design where people can collaborate and be inspired by on another.

The reported discussions of friendliness, empowerment, and community in our Haptics Commons prototype are from a perspective that does not consider all stakeholders. In doing so, we hope to continue to grow and consider the expansion of haptic design communities that include all along the periphery of the field *as well as* the currently participating members in STEM-aligned haptics.

6.2.2 Where Design Justice Applies

We return, now, to the theoretical grounding of our approach. A design justice perspective reflects praxis from scholars of four main activist movements confronting instances of white supremacist heteropatriarchy, ableism, capitalism, and settler co-

lonialism. Our perspective similarly targeted challenges of structural inequalities that appeared in haptic design spaces, rather than reproduce them. By maintaining a reflexive, intersectional perspective on who “the haptician” could be, we explored a growing divide that arose from research that only identified technical abilities for “experts” and “novices” in haptics. The lens of design justice has helped us develop the framework for understanding what equity and information accessibility would look like in haptic design resources. In this instance, design justice has allowed us to critically examine why it might be that hapticians on a peripheral do not feel supported in the field and what it would take to adjust the ecosystem’s scope. That is to say, technical fields in computer science and engineering have not actively excluded others, especially given the diversity goals of “the haptician” [72], but that previous efforts might have narrowed the representation, only partially representing hapticians backgrounds and skills. Design justice has helped us realize that this partial representation was not an intentional exclusion of hapticians, but a foundation to realize there are more hapticians to include. We are inspired by innovative efforts in haptics, and still recognize that the work is not yet over to promote a mutually beneficial, collaborative space for haptics sharing.

6.3 STEM Was Not and Is Not Our Enemy

We would not be able to make these considerations and critique of the haptic design ecosystem without the technological advancements that brought us here. We recognize and uplift the decades of foundational work influencers in academia and industry have had on haptics and design. While we do critique the Western perspective of scientific knowledge, it does not make an enemy out of the knowledge itself, but the priority it takes in knowledge forming practices.

Reflexivity is a concept that has long been discussed in the social sciences, specifically appearing in research relating to sociology and ethnographic practices. As the word “human” shifts to include cultural and experiential meanings, researcher influence and subjectivity cannot be so easily divided from the work.

Reflexivity is often presented as a stance of positionality to help contextualize the reflexive nature of the work. As a common practice in qualitative research, I have included my positionality as a researcher in Section 1.4. On self reflection

for haptics as a field, I have proposed this discussion topic as just the beginning of the conversation. As a rapidly growing technological and conceptual field, haptics could be realized by many more imaginative minds extending off of the foundational work from STEM.

6.4 Closing Remarks

We end this thesis with my personal anecdote about avocados.

There are two ways to remove a pit of an avocado. I have always done it the way where you cut an avocado in half; starting at the stem going, around the 'cado longitudinally, and thwacking the knife into the avocado pit to take it out – often times risking a near miss to cutting my fingers. This way has always worked, they do it in professional, high functioning kitchens. I have never questioned whether I liked this method of removing an avocado pit.

Recently, I went over to a friends house and they were making a salad. They started as I always have, cutting the avocado in half, starting longitudinally. They then did something I have never considered: pushed the pit out from the back of the avocado and through the skin.

This was monumental. My mind was blown, I was shook. Yet, it still made complete sense. I no longer had to risk my fingers. I had no idea why I had never thought of this way before. It just... made sense. The only risk I faced with this technique was an avocado-y finger at the end of it. When I want to feel chef-style I can use the thwack method, when I am faced with a particularly soft avocado, I'll use the push method.

This experience is not the first instance of a realization like this. It left me wondering, what other perspectives have I overlooked?

You may ask, how does the way you remove the pit from an avocado relate to this thesis? There are times where you think you know the right way to do something because it's something you have been doing for so long. Because it's

the way you were taught, and the generations before you were taught. There's nothing considerably wrong with your current way, yet we cannot discount other ways of knowing how to do something.

People have the ability to inspire others to break away from their strongholds and restructure the way they think about a problem or space. Most importantly, it is not that person or group's solution to a problem needed fixing or replacing, but insights to another perspective proposed a new way to look at a problem or solve it.

We call to action people that can recognize and bring in these versatile perspectives to the field of haptics. Broadening representations of the haptician, democratizing haptics knowledges, and empowering others with the skills they need to creatively explore haptics to their hearts desire.

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Appendix A

Study Documents

A.1 Study Recruitment Message

The SPIN Research Group in the UBC Dept. of Computer Science is looking for participants for a study investigating the design of haptic (sense of touch) phenomena. You will be compensated \$15 for your participation in a single 1-hour session. This study will be held virtually using an online video conferencing platform like Zoom.

We will ask you to talk about your experiences with haptic sensations, devices, and related technologies and training. We may ask you to describe your experiences with haptics, your interests, as well as how you may identify yourself within your field of expertise. We may ask you to discuss one or more haptic ideas to inform us of how you currently seek out haptic knowledge online and in person such as any of brainstorming practices, experience design, prototyping, or problem solving.

Please visit [URL] or contact me to sign-up for the study. You may also contact me directly if you have any questions. Please be informed, if you are encountering this posting through public social media and choose to like, follow, or share this posting, you will be publicly identifying yourself with the study.

We will follow COVID-19 protocols to be in accordance with current BC Provincial Health Order and UBC recommendations. If you have any concerns or complaints about your rights as a research participant and/or your experiences while participating in this study, contact the Research Participant Complaint Line in the UBC Office of Research Ethics at [phone number] or if long distance e-mail [email] or call toll free [phone number].

A.2 Study Consent Form



STUDY CONSENT FORM

Department of Computer Science
2366 Main Mall, Vancouver, BC, Canada V6T 1Z4
tel: [REDACTED]

Project Title: Investigation of Tools and Techniques for Haptic Design Processes
(UBC Ethics #H13-01620)

Principal Investigator: Karon MacLean, Professor, UBC Dept. of Computer Science, [REDACTED]

Co-Investigators:
Hannah Elbaggari, Graduate Student, UBC Computer Science, [REDACTED]

The purpose of this study is to gather feedback to inform the design of haptic (sense of touch) resources, e.g., haptic sensations or physical objects. We may ask you to interact with computer applications or technologies relating to the design or knowledge of haptic or tangible objects. We will ask you about your experience interacting with these technologies and/or your experiences in the field in order to test and improve our designs.

This study will be conducted virtually using Zoom. Should you agree to participate, please log in using only a nickname or a substitute name or research code given ahead of time. You also always have the option, if it will make you more comfortable, of turning off your camera, and you can mute your microphone (if it is not needed).

You may refuse or skip any tool, task, or question without affecting your reimbursement.

- REIMBURSEMENT:** We are very grateful for your participation. You will receive monetary compensation of \$15/hour for this session.
- TIME COMMITMENT:** 1 × 1 hour session
- RISKS & BENEFITS:** This experiment contains no more risk than everyday computer use. There are no direct benefits to participants beyond compensation.
- CONFIDENTIALITY:** *You will not be identified by name in any study reports. Any identifiable data gathered from this experiment will be stored in a secure Computer Science account accessible only to the experimenters.*
- AUDIO/VIDEO RELEASE:** *You may be asked for audio or video to be recorded during this session. You are free to say no without affecting your reimbursement.*
 I agree to have AUDIO recorded: Yes No
 I agree to have VIDEO recorded: Yes No
 I agree to have ANONYMOUS VIDEO OR AUDIO EXCERPTS presented with the findings: Yes No

You understand that the experimenter will ANSWER ANY QUESTIONS you have about the instructions or the procedures of this study. After participating, the experimenter will answer any other questions you have about this study. Your participation in this study is entirely voluntary and **you may refuse to participate or withdraw from the study at any time without jeopardy**. Your signature below indicates that you have received a copy of this consent form for your own records, and consent to participate in this study.

If you have any concerns or complaints about your rights as a research participant and/or your experiences while participating in this study, contact the Research Participant Complaint Line in the UBC Office of Research Ethics at [REDACTED] or if long distance e-mail [REDACTED] or call toll free [REDACTED]

You hereby CONSENT to participate and acknowledge RECEIPT of a copy of the consent form:

PRINTED NAME _____ DATE _____

SIGNATURE _____

A.3 Pilot Protocol

HAPHUB INTERVIEW PROTOCOL

Pre-study preparation:

- Virtual interview → send zoom link to participants with clear scheduled time
- Have consent forms ready
 - Will be virtually signed by participants and sent back
- **CONSENT FORM**

Copy paste this into the chat:

Here are a few links we will use during this study:

Brainstorm task:

<https://docs.google.com/document/d/1onIqB1Rm1oHAFhQjwDck5droy2zi-z-bhpWavDKZFGI/edit?usp=sharing>

Mockup prototype link:

<https://www.figma.com/proto/vjsYdXR1CWcv3g4JDqj2aS/HapHub-L-o-fi?page-id=0%3A1&node-id=5%3A10016&viewport=241%2C48%2C1&scaling=min-zoom&starting-point-node-id=5%3A10016>

Compensation form:

https://ubc.ca1.qualtrics.com/jfe/form/SV_77c5ZTPTiqmMqG

Introduction [5 mins]:

- "Hello, my name is _____ and thank you for agreeing to participate in this study today. As we jump into some of the questions I have for you today I would like to let you know that these are all quite open ended questions and they are more to get your personal insight on some of these topics as they relate to haptics, design, and the emerging haptic design ecosystem. If it is ok with you I will start recording our session."
- **Live transcription!!**
- **HIT RECORD**
- "For the sake of this study can you please introduce yourself briefly, your pronouns, and tell me what experience level of haptics you have, this can be a novice, expert, or any other way you would like to explain it"

Narrative Interview [20 mins]:

- What is your topical background and what are your hobbies?
-
- How do you define design?
- How do you define experience design?
- How do you define haptics?
- How would you define haptic experience design?

- If a haptician is someone who designs, creates, and researches haptics, how would you define a...
 - novice haptician?
 - Expert?
- Now in relation to these definitions you provided, you have also identified yourself as a _____ haptician. Can you explain this vision of your haptics experience a bit further?
- Would you say you have an interest in tech or design in general? How do you see haptics fitting into this interest and where do you see yourself taking it?
- What is your experience with haptics whether it be using or designing experiences?
 - Projects? General interest in learning? Exposure through other interactive devices?
 - Yes experience
 - Describe what brought you to haptics? Where did you gain interest in taking on haptics? Did you have a goal/project?
 - Where have you gone to find learning materials?
 - No experience
 - How could you imagine you start?
 - Where would you first look?
- How accessible do you think the field of haptics is for people interested in it? Please explain your reasoning.

Task brainstorm [15 mins]

- “We will now move onto the task portion of the study.”
- “I will now ask you to look at a few prompts, do some preliminary browsing, and ask you to share your screen if you are comfortable with it. During the task I will ask you to talk aloud and walk me through your thoughts and decision making processes during the task. If you would like some guidance or ideas to help you get started let me know.”
- “Here are a few ideas for applications of haptics. Read over these applications and try to brainstorm ways you would go about starting these. Some center devices, others are more conceptual uses of haptics. Try to get through ideating a plan as well as some hypothetical prototyping scenarios you might envision.”

TASK LINK TO SHARE

Here are three different applications for haptics. Pick one and pretend you are about to start this project. Where would you start looking and please walk me through this process. You will have 10 uninterrupted minutes to begin to find resources for one of these ideas.

- *Please share your screen if you are using the computer*
- *If you are taking notes, please walk me through what you are writing or drawing to brainstorm (send a picture later)*
- *Please say your thoughts out loud. Reminder: task is not about completion but about process to finding the information you need to move forward with your planning*

- 1) *Play around with this simulation of a mouth making different sounds: <https://dood.ai/pinktrombone/>. Haptics has the ability to help communicate different parts of speech by conveying frequency and amplitude in various contexts. This application of haptics would help convey these concepts.*
- 2) *ASMR videos of people typing on mechanical keyboards are quite popular. This application of haptics tries to leverage what is satisfying with the ASMR videos into something you can actually feel as well as hear. For example here's a typing ASMR: [link](#)*
- 3) *Learning activities can be enhanced through the use of haptics. Do you ever walk through a museum and wish you could touch more things? This application of haptics leverages virtual reality and the sense of touch to simulate walking through a history museum with ancient artifacts that cannot be touched physically.*

[PROTOTYPE] After Task Questions [10 mins]

- What are your main takeaways from this task? Feelings/emotions, stand-out points?
- You have described ____ as working for you, why do you think that is?
- You also have described ____ as being difficult, can you elaborate on why?
- How could you envision "novices" navigating this space?
 - Where do you think they will struggle?
- How could you envision "experts" navigating this space?
 - Where do you think they will struggle?
- If you were to propose a solution to helping others learn haptic design concepts, what would it be?

After Answering Task Questions [5 mins]

[LINK TO SHARE](#)

- Take a look at this low-fidelity mockup, what are your general takeaways of a platform like this?
- Do you think this would cultivate an accessible approach to haptics for those entering in the field?
- Would you use it?
- What can be improved?

END THE STUDY

- If the participant needs to be reimbursed, figure out how they should be paid
- "Thank you for participating in this study today. I appreciate you taking time out of your day to talk to me! I am particularly interested in the intersection of haptic design accessibility and concepts of design justice. Currently recognized accessibility efforts and representations of the "novice" in haptics are geared towards people with engineering and computer science backgrounds, so I plan to help break down some of this barrier through developing a community based resource that hopefully will be taken up into a haptic design ecosystem."

- “If there is a follow up portion of this study would you like to be contacted to participate at a later date?”
- STOP RECORDING!!!!
- “Thanks again! This study pays \$15 Canadian. I can either Interac e-transfer you which goes from canadian bank account to canadian bank account directly. I can also purchase a gift card for you such as amazon or another online store if that is something you would prefer. Is the email you have provided to participate in this study the one to send you reimbursement?”
- As I am sending you the money can you please begin to fill out this reimbursement form for our records? https://ubc.ca1.qualtrics.com/fe/form/SV_77c5ZTPtigpmMqG
- “Thanks again, and do you have any other questions for me? If not, have a good rest of your day!”

PayPal message: Thank you for participating in Investigation of Tools and Techniques for Haptic Design Processes

A.4 Interview Protocol

HAPHUB INTERVIEW PROTOCOL

V1:

https://docs.google.com/document/d/1f2CvzjMkESaCGjalBlmJp_TiZL2YfW5Hav10bMEZl/edit

Haptics Interest Interview Personas 12/07:

<https://docs.google.com/document/d/1hUKdShPU99IP-WBKMYQTfM-q9tiBcXylbmyFDP51FdU/edit>

Pre-study preparation:

- Virtual interview → send zoom link to participants with clear scheduled time
- Have consent forms ready
 - Will be virtually signed by participants and sent back
- **CONSENT FORM**

Copy paste this into the chat:

Here are a few links we will use during this study:

Mockup prototype link:

<https://www.figma.com/proto/vjsYdXR1CWcv3g4JDqj2aS/HapHub-Lo-fi?page-id=0%3A1&node-id=5%3A10016&viewport=241%2C48%2C1&scaling=min-zoom&starting-point-node-id=5%3A10016>

Compensation form:

https://ubc.ca1.qualtrics.com/jfe/form/SV_77c5ZTPTiqpmMqG

Introduction [5 mins]:

- "Hello, my name is _____ and thank you for agreeing to participate in this study today. As we jump into some of the questions I have for you today I would like to let you know that these are all quite open ended questions and they are more to get your personal insight on some of these topics as they relate to haptics, design, and the emerging haptic design ecosystem. We are not trying to evaluate your knowledge on the topics and questions here, we are trying to gain your perspective of the field from your personal experience. If you have not heard of any of the terms and have difficulty understanding a question, please feel free to interrupt and ask for clarifications. If it is ok with you I will start recording our session."
- **Live transcription!!**
- **HIT RECORD**
- "For the sake of this study can you please introduce yourself briefly, your pronouns, and tell me what experience level of haptics you have, this can be a novice, expert, or any other way you would like to explain it"

Narrative Interview [30 mins]:

- Can you give me a bit more specifics as to why you have defined yourself as a _____ haptician?
 - Can you put some of what you are saying about your experience in context with some of the projects you have attempted?
 - Where do you think you struggled the most? And where do you think you succeeded the most in the projects?
- What is your topical background and what are your hobbies?
- What types of hands-on, creative projects have you worked on? This can be anything like arts and crafts, a science fair submission, website design, learning something off youtube etc.
 - [probe into this, what part are they doing, who do they design for?]
- What does "design" look like to you?
- Do you consider yourself a designer?
 - Why? What do you do? Do you work with a team? What parts do you enjoy?
 - Do you design for yourself or for others? Who is your audience when you design?
- What does the word "haptics" mean to you?
 - As you have described haptics as _____, we can say that a haptician is someone who [insert something they said about haptics]. Now, how would you define a...
 - novice haptician?
 - Expert?
 - What is the context you have come in contact with the term "haptics"?
- If you were to guess, what does "haptic design" mean?
- What is your experience with haptics whether it be using or designing experiences?
 - Projects? General interest in learning? Exposure through other interactive devices?
 - Yes experience
 - Describe what brought you to haptics? Where did you gain interest in taking on haptics? Did you have any goals and projects in mind when you first started exploring the field of haptics?
 - What tools, websites, forums, resources supported you in the process of learning about this field?
 - Are there walls you hit?
- Would you say you have an interest in tech or design in general? How do you see haptics fitting into this interest and where do you see yourself taking it?
- How easy do you think the entry into the field of haptics is for people interested in it?
 - Can you explain where you can imagine people struggling in the process of learning? How about succeeding?
- If you were to propose a solution to helping others learn haptic design concepts, what would it be?

[PROTOTYPE] After Answering Task Questions [10 mins]

- Please take a look at this low fidelity prototype. What I want you to do with the prototype is go through the menu items and try to evaluate whether this would be something you would like to see become a reality. Think about whether you would come to a website like this. If you need help, would this be something that could support your questions? If you are looking for collaboration, would you see support for forming those relationships? When you are browsing are there things you could find interesting? Overall, HapHub aims to remain open source, community supported, and educational at its roots. Please be as honest as you can and as you are navigating through please talk aloud and tell me your thoughts.

[LINK TO SHARE](#)

- Take a look at this low-fidelity mockup, what are your general takeaways of a platform like this?
- Do you think this would cultivate an easy approach to haptics for those entering in the field?
- Would you use it?
- What can be improved? Is there anything here you wish was there, but isn't?

END THE STUDY

- If the participant needs to be reimbursed, figure out how they should be paid
- "Thank you for participating in this study today. I appreciate you taking time out of your day to talk to me! I am particularly interested in the intersection of haptic design accessibility and concepts of design justice. Currently recognized accessibility efforts and representations of the "novice" in haptics are geared towards people with engineering and computer science backgrounds, so I plan to help break down some of this barrier through developing a community based resource that hopefully will be taken up into a haptic design ecosystem."
- "If there is a follow up portion of this study would you like to be contacted to participate at a later date?"
- STOP RECORDING!!!!
- "Thanks again! This study pays \$15 Canadian. I can either Interac e-transfer you which goes from canadian bank account to canadian bank account directly. I can also purchase a gift card for you such as amazon or another online store if that is something you would prefer. Is the email you have provided to participate in this study the one to send you reimbursement?"
- As I am sending you the money can you please begin to fill out this reimbursement form for our records? https://ubc.ca1.qualtrics.com/jfe/form/SV_77c5ZTPTigpmMqG
- "Thanks again, and do you have any other questions for me? If not, have a good rest of your day!"

A.5 Haptics Commons Protocol

HAPTICS COMMONS STUDY PROTOCOL

Last updated: Apr 2, 2022

Study: Usability Study

Duration: ≤ 1 hour

Location: Virtual

Platform: Zoom Meetings

Device & Tools: Desktop, browser, internet

Compensation: CA \$15 (Hannah will send this)

Preparation (For the Observer)

- Prepare blank consent form to be sent (number with individual participants to not confuse them)
 - /ubc/cs/research/imager/project/spin/people/elbaggari,hannah/Mar22-Consent_Recruitment/Blanks
- Save time by receiving SIGNED consent form in-advance via UBC email**
- Ensure [compensation form](#) is live
- Check [prototype link](#) in a privacy browser (*i.e.*, *Incognito Mode*) to ensure it loads without requiring an account login
 - *Presets are done (don't make any changes to the link):*
 - Screen is set to fill, Disabled default keyboard navigation (*arrow keys*), Disabled hotspot hints, Disabled sidebar, Disabled Figma UI
- Ensure research-conducting computer is charged and is strong enough to run Figma alongside Zoom with video, audio, and an additional screen share
- Check prototype for performance and surface functionalities by clicking through the upper navigation bar (*Home, About, Resources, Get Involved*) on the conducting device
- Zoom link is prepared for appropriate time and *Waiting Room* feature is available to control when participant enters
- Check for video & audio functions of research conducting devices
- Prepare some sort of timer / stopwatch
- [Coding sheet](#)
 - Check boxes as needed
 - Take notes under the relevant box, the page heading or *NOTES*
 - If no box, put it under the the page heading (*i.e.*, *HOME*) or in *NOTES*
 - Shift + Scroll to horizontally scroll

HDJ Prototype Usability Study Protocol

Introduction

"Hello *Participant*. My name is *Observer* and I will be overseeing this study. Thank you for taking the time to participate in this. We will be conducting a usability test on a prototype that we have implemented for haptics-related content. The entire study should take **no longer than 1 hour.**"

Consent

If missing consent:

"Before we continue, please take **10 minutes** to read, sign, and send back this consent form which I will provide in the Zoom chat."

- Send consent form
- Receive appropriately signed consent form **via UBC affiliated email**
- Assess what participant consent to (*i.e., recordings*)

"Do you have any questions or concerns given the consent form?"

Participant Preparation

"Throughout the study, you will share your screen and complete a series of tasks. While completing them, we ask that you think-aloud as much as possible—providing insight into how you are feeling, what you are seeing, what actions you want to take, your frustrations, and even what you find enjoyable. Doing so will greatly improve our data and help us understand our problems space. Remember that we are testing the interface, and not you, so feel free to speak your mind on any little details."

"Do you have any questions?"

- Send [link to prototype](#)

"I have just sent you a link to the prototype in the Zoom chat. Can you please click on the link? We recommend you open it up on a private or incognito browser to avoid any performance issues."

- Enable share screen for participants

"Once you have that open up, please share your screen for just the prototype on Zoom."

- Ask participant to share the prototype browser screen/tab
- Ensure participant is sharing correct screen/window/tab
 - If needed, ask participant to press 'Z' to cycle through screen resize to fill

HDJ Prototype Usability Study Protocol

"To check for performance, click through the images by clicking on the arrows."

- Ask participant to click through image carousel to check for performance
 - Ask to use alternate browser or incognito/privacy mode if noticing performance issues (*recommend Chromium-based browser in Incognito*)
- Ask to press 'R' to reset the prototype
- If consented, notify participant that you will **begin to RECORD screen and audio**

HDJ Prototype Usability Study Protocol

Usability Study

Context & Persona

"The usability test will be centred around a Figma prototype that represents a desktop resource and community webpage interface that aims to become a common ground for the haptics community to strengthen through knowledge sharing."

"Haptics refers to digital mediated touch. You're probably familiar with haptics in terms of haptic vibration feedback from your phone, game controllers, or those 4D D-BOX movie theatre seats."

"For the purpose of this study, we'd like you to take on a specific persona while you navigate our prototype. We'd like you to navigate as someone who recently became interested in haptics and is looking to explore more about it. You have a general understanding of what haptics is, but don't know how to further this interest of yours."

"Do you have any questions about the context or your persona?"

Tasks

"We will now begin the main portion of the usability study. I would like to remind you that this study is meant to test the prototype and not you, so please do not hesitate to vocalize any concerns, comments, questions, feedback of any sort. You'll notice that not everything on this prototype will be implemented. If something is not implemented, please vocalize what you would have expected. To keep things within our time constraint, some of your tasks will be time-bound and we will notify you when to move on."

Home

"For the first task, take no more than **2 minutes** to explore the home page. You can click around on the home page, but do not click on links on the Navbar—which would navigate you away from this page on the prototype."

"Next, locate and join the Discord Server."

Join the Discord server

"Close the Discord server promotional banner."

Close the banner

"Briefly explain what you think this website might be about and what it may provide."

Preliminary site summary

"What words might you use to describe the tone and feel of this website?"

HDJ Prototype Usability Study Protocol

- Initial tone & feel

"Now try to sign in to this web page. You can assume you have a Discord account."

- Login via Discord

About

"Take no more than **4 minutes** to briefly explore the About page. Remember to think aloud as you explore"

- "Describe what you believe the main takeaways from the design principles are"
- "Which design principles resonated most with you?"
- "Do you have any suggestions or concerns in regards to this page?"
- "What do you think the website is about now?"

Resources

"Before navigating to the resource page, what do you think it will contain?"

- Resource expectation

"Take **1 minute** to briefly explore the Featured Resources page and again think aloud as you explore"

"Just from this page, what do you think project, learning, and tools mean? What do you expect the difference between them to be?"

- Preliminary resource distinction

"Now, take **2 minutes** to explore the other resource tabs: *Projects*, *Learnings*, and *Tools*. Remember to think aloud as you explore."

- "Now how would you define:"
 - "What's a project?"
 - "What's a learning item?"
 - "What's a tool?"
 - "Currently the filters & sorts are all the same, what else might you want to filter or sort for in the different resource tabs?"

"Now, I would like to direct you back to the project tab. Take a look at the first card "DIY Haptic Glove w/ Arduino." Before clicking into that, what kinds of information and features do you expect to find inside this page?"

"Click into it now and take a moment to explore its content."

- "Is there any notable information you expected to be here that is missing?"

HDJ Prototype Usability Study Protocol

Get Involved

"Take **2 minutes** to explore the *Get Involved* page."

- "What do you think a local node is and what purpose could it serve?"
- "What do you expect the Discord community to provide?"
- "Are there any barriers present that you believe would prevent a novice to haptics from":
 - "Joining the Discord community?"
 - "Getting involved with a recruiting project?"
 - "Meeting up with a local node group?"

Overall

"Take **3 minutes** to go back and explore any of the pages and features. While doing so, please think-aloud on anything that comes to your mind."

Post-Test Questions

Allow participants to continue to explore if they want to during these questions.

"To finish off our study, I have some open-ended questions to ask you."

- "What do you think this website is about now, if that has changed?"
- "This isn't implemented, but what do you think having an account might provide you?"
- "Do you see yourself using this resource as the persona you provided?"
 - Why / why not?
 - What specific features or pages?
- "Do you see yourself using this page as yourself in general?"
 - Why / why not?
 - What specific features or pages?
- "What are some benefits or drawbacks you think this resource could provide for the haptics community?"
- "Do you think this resource is approachable and useful for someone who is a novice or is new to haptics?"
- "Do you think this resource is approachable and useful for someone who is more experienced in haptics?"
- "Do you have any other suggestions, critiques, or feedback you would like to provide?"

"And lastly, some demographic questions:"

HDJ Prototype Usability Study Protocol

- “What is your current main focus in your career?”
- “Is haptics a topic you consume or consciously interact with?”

Conclusion

“That is the end of our testing. Do you have any questions, comments, or general feedback?
I will now stop the audio and video recording. ”

- Stop recording

“You will be paid \$15 CAD for participating in this study. This will be sent through Interac
e-Transfer” (*offer PayPal if an alternative is needed*).”

“I will post the link for the reimbursement form in the Zoom chat. The money will be sent
from someone named Hannah, and the password for getting reimbursed is **“haptics”** ”

- Send reimbursement form for Hannah to send money.
 - https://ubc.ca1.qualtrics.com/jfe/form/SV_77c5ZTPTigpmMqG

Post-Study

- Check recordings work
- Rename recording to
- [Fill out general notes that may have been missed](#)