Haptic Playground: Empowering Inclusive Haptic Design for Everyone

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ABSTRACT

While haptic technology is rapidly maturing, training for haptics is in its infancy. Disciplinary siloing has contributed to fast but fragmented growth of the haptics industry; graduate courses mainly exist for individual STEM fields, such as device development for mechanical engineers or study design for psychologists. Despite increasing broad interest to use haptics, many potential researchers and practitioners face barriers to learning how to design and study haptics, especially when their background is outside of STEM fields.

This one-day workshop will bring together both expert and new or aspiring hapticians to work together to break down disciplinary silos. Expert hapticians with expertise in design justice and haptics community development will give invited talks to frame the discussion. Attendees will work with two interactive tangible tools to design haptic sensations, then reflect on their process, challenges faced, and successful strategies. By adhering to the principles of inclusive design during the process, we aim to render haptic design accessible to a wider audience, recognizing and respecting the unique design needs of each individual. The result will be a more comprehensive understanding of tangible tools' crucial role in the haptic technology design process, while offering vital insights on inclusive design, ultimately supporting further development of a multidisciplinary, diverse practice of haptic design and research.

CCS CONCEPTS

• **Human-centered computing** → **Haptic devices**.

KEYWORDS

haptic design, inclusive design, tangible tools, collaboration

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1 BACKGROUND

Designing and creating haptic experience is a complex task that requires skills and knowledge in electronic circuits, motors, hardware-level programming codes and more [1]. Despite being an integral part of our everyday lives, from smartphones to virtual reality (VR) and automobiles, haptic technology remains a challenging domain to navigate, particularly for individuals outside of the STEM fields [5, 11, 12]. The increasing interest in haptics has led to its implementation in arts, agriculture, accessibility, and other areas [13, 15, 16]. However, technical barriers often deter these enthusiasts from fully utilizing the potential of haptic effects beyond those already available in commercial devices. There is a pressing need for user-friendly haptic design tools and design knowledge to bridge this gap. The availability of these tools and knowledge would help democratize the haptic design space, allowing individuals, regardless of their background, to create, innovate, and contribute to the advancement of haptic technology.

Multimodal and touch-based feedback have a wide range of applications and significantly enhance user experience and accessibility [3, 8]. These benefits extend beyond the STEM fields and can be creatively utilized and implemented by anyone for various use cases. To make haptic technology design and development accessible to individuals without any hardware or software knowledge or skill restrictions, we plan to use simple, tangible haptic toolkits in this workshop. These toolkits will enable individuals to design and create haptic experiences immediately. Studies have shown that these toolkits effectively assist designers in their creative process [9, 10, 17].

The concept of inclusive design, often called universal design, represents a transformative progression within the design landscape. It transcends the conventional practice of accommodating specific demographic groups, instead recognizing that actual disparities emerge when designs fail to encompass the entirety of human abilities and experiences [6, 14]. Central to the principles of inclusive design is the fundamental placement of individuals, irrespective of their diverse backgrounds, at the core of the creative process [4]. Haptic feedback which relies on the sense of touch leverages the human body's largest sensory organ, necessitates the consideration of design principles that make haptic experiences

gender-neutral and universally accessible, ensuring a consistent and inclusive experience for a broader audience. Schneider et al. [11] highlight the challenge of achieving a universal haptic experience, necessitating the consideration of a diverse user base, and the efficient and consistent delivery of haptic cues to a wide audience. Further, Seifi et al. [12] emphasize the need for comprehensive design tools and theory to support novice hapticians in their practice and training. We are organizing this workshop to acknowledge these challenges and work towards finding guidelines and checklist that can empower aspiring designers to develop more inclusive designs for haptic technologies.

This workshop has a dual purpose: firstly, it aims to **promote the exchange of ideas and designs among individuals interested in designing or using haptic technology**, utilizing tangible toolkits that require no prior knowledge of hardware, electronics, or haptics software to explore how these tools enhance the design and discussion sessions. We believe having a user-friendly, common design tool can streamline the design process.

Secondly, we aim to **uncover ways to make haptic design more inclusive for a broader audience**. By leveraging insights from individuals across different disciplines, we intend to compile a haptic design checklist that can cater to the diverse needs of each individual, promoting inclusivity while respecting individual unique design requirements.

To achieve these objectives, we will facilitate keynote presentations featuring distinguished researchers who will share their design methodologies. Furthermore, the workshop will include interactive discussion sessions, enabling participants to collaborate in brainstorming and explore potential factors that could enhance the inclusivity of haptic technology for a broader audience.

2 ORGANIZERS

Oliver Schneider is an Associate Professor, human-computer interaction researcher, and haptician at the University of Waterloo in the Faculty of Engineering (Department of Management Science and Engineering). His research aims to enable anyone, anywhere, to work with haptic technology as fluidly as we work with any other media.

Bibhushan Raj Joshi is a PhD student at the University of Waterloo. His research focuses on understanding the processes followed in the product development cycle of haptics. He is also passionate about software development, product management and creative research involving human-computer interaction.

Anchit Mishra is a master's student at the University of Waterloo. His work involves data-driven haptics, and focuses on creating software tools that enable developers and users to create, experience and evaluate haptic feedback in various contexts. He enjoys working with physical simulations and other computer graphics techniques.

Sandeep Kollannur is a PhD student at the University of Southern California. He works on creating research toolkits around haptic systems, including creating open-source hardware, software, and mobile applications. He also researches touch perception systems and how to enhance human touch based on various neuroscience-based techniques.

Tommy Nguyen is currently pursuing a Master's degree in Computer Science at the University of British Columbia. Under the guidance of Dr. Karon MacLean, his research focuses on building trust and community with small teams, especially those working on haptics projects in hybrid physical and virtual settings. Tommy's passion lies in the intersection of human-computer interaction design and education.

3 PRE-WORKSHOP PLANS

The goal of this workshop is to bring together individuals interested in haptic design and technology from a variety of backgrounds. We aim to engage with researchers from a broad range of fields within Human-Computer Interaction (HCI), including social justice and education, health and others. We are particularly interested in observing "how" these individuals will utilize the tangible haptic toolkit in their design process, "where" they apply haptic feedback, and "what" inclusive design principles they would consider in their design process.

To facilitate this, we are developing a website, accessible at https://uw-hapticexperincelab.github.io/HapticPlayground/. This website will include a call to action, a workshop schedule, a list of speakers who will present their vision, and eventually, a summary of the workshop's outcomes.

To connect with potential participants, we will utilize mailing lists (such as the HCI mailing list), online networks (like the Canada Haptics, or "CanHaptics" group), and personal contacts within research labs and companies interested in haptic technology.

We are committed to ensuring that the workshop is guided by principles of accessibility and inclusion. If the number of applicants exceeds our capacity, participant selection will be guided by a commitment to diversity.

4 KEYNOTE SPEAKERS

We are both honored and delighted to announce the distinguished lineup of speakers who will share their expertise and visionary perspectives on haptic design and technology at our workshop. Each keynote presentation will last approximately 10 minutes. Following these enlightening presentations, our program includes an interactive 30-minute panel session. Our ultimate goal is to create an open session where participants can actively ask questions, contribute, and gain a deeper understanding of the realm of haptics and inclusive design. We list the speakers in alphabetical order in the following.

Allison M. Okamura is a professor in the Mechanical Engineering department at Stanford University, holding a courtesy appointment in Computer Science. Before Stanford, she was a professor and Vice Chair of Mechanical Engineering at Johns Hopkins University. Currently, she's the Editor-in-Chief of the journal IEEE Robotics and Automation Letters. She has held key editorial roles in various IEEE publications and has received numerous awards throughout her career, including the 2020 IEEE Engineering in Medicine and Biology Society Technical Achievement Award. Her research interests include haptics, teleoperation, virtual environments, medical robotics, and more.

Heather Culbertson is a Computer Science Professor at the University of Southern California, specializing in haptic technology.

Her research focuses on creating realistic touch experiences with haptic devices and their applications in virtual reality, medicine, and human-robot interaction. She has received prestigious awards, such as the NSF CAREER Award and the IEEE Technical Committee on Haptics Early Career Award, for her contributions to the field. Currently, she serves as the Publications Chair for IEEE Haptics Symposium.

Karon MacLean is a highly respected Computer Science Professor at the University of British Columbia. Her extensive background in biology and mechanical engineering, with degrees from both Stanford and MIT, has enabled her to make significant contributions to the field of human-computer interaction, robotics, and haptics. As the head of the Sensory Perception and Interaction (SPIN) Research Group, Dr. MacLean's research focuses on how people interact with technology through touch and emotion, covering areas from robotics to touch screens. Her work has earned her numerous accolades, including the NSERC Accelerator (2013), Charles A. McDowell Award (2008), and IEEE Fellow 2022, CRC Chair 2022, CHI 2020 Honorable Mention Award, among others. Dr. MacLean's work has played a pivotal role in advancing the understanding of human-computer interaction and has helped to drive the development of new technologies that better serve the needs of users.

Table 1: Detailed schedule of the one-day in-person workshop.

	Duration	*Description*
Open	**25 minutes**	**Introducing the workshop**
	5 minutes	On-boarding
	20 minutes	Participant introductions
Talks	**75 minutes**	**Keynote talks and panel discussion**
	20 minutes	*Keynote by Prof. Allison Okamura*
	20 minutes	*Keynote by Prof. Karon MacLean*
	20 minutes	*Keynote by Prof. Heather Culbertson*
	15 minutes	*Panel Discussion (including any Q/A)*
Break	15 minutes	
Setup	**10 minutes**	**Haptic tools introduction**
S #1	**40 minutes**	**Haptic design and reflection session**
	30 minutes	Teams try out toolkit-1
	20 minutes	Preliminary results and discussion
Lunch	60 minutes	Catered/ordered lunch in workshop space
S #2	**40 minutes**	**Haptic design and reflection session**
	30 minutes	Teams try out toolkit-2
	20 minutes	Preliminary results and discussion
Break	10 minutes	
S #3	**80 minutes**	**Sharing session with other groups**
	60 minutes	Discussion about outcomes
	20 minutes	Final guideline and results
Break	5 minutes	
Close	**15 minutes**	**Synthesize and conclude**
	15 minutes	Lesson learned
	5 minutes	Concluding remarks

5 IN-PERSON, HYBRID OR VIRTUAL-ONLY

This workshop will be conducted in-person as it requires participants to engage with and design using tangible toolkits provided during the session. As effective haptic evaluation and studies require participants to experience the feedback firsthand.

6 WORKSHOP STRUCTURE

The workshop will last a full day, approximately 6 hours, and will include keynote talks, a panel session, and a haptic design and reflection session. The latter will be divided into two comparable sessions, each focusing on a distinct tangible device, as outlined in Table 1.

6.1 Keynote

The workshop will start with presentations from three distinguished speakers (section 4), each allotted approximately 20 minutes to share their past experiences and valuable principles in haptic design. Following the presentations, a 15-minute panel discussion will be held, offering participants the opportunity to ask questions and engage in meaningful discussion. Our workshop emphasizes active engagement, encouraging participants to interact with each other and the experts during these sessions, fostering a learning environment for sharing experiences and insights into haptic design.

6.2 Design and reflection using toolkits

This session is divided into two parts. In the first part, participants will design haptic experiences with a Tickle Trunk (subsection 7.1). They will create haptic effects either using prompts provided by the organizers or for use in contexts where haptic feedback is not commonly employed. Participants will be provided with markers, pens, charts, and writing sheets to sketch and articulate their design intentions. These design guidelines must be listed and comments should adhere to inclusive design principles. The intermediate results will then be shared within their team for discussion and evaluated in a 20-minute session. After a 60-minute lunch break, participants will continue with a similar session, this time focusing on another tangible device - a VibroHarness System (subsection 7.2).

6.3 Sharing session

This is the final session, which is approximately 80 minutes long, where every team will share the haptic design they have built with the other teams. They will discuss the design process they followed and the considerations necessary for inclusive design. The first 60 minutes of the session will be dedicated to each team sharing their experiences and fostering active discussion among the participants. The remaining 20 minutes will be spent finalizing the collective guidelines created from every participant's experiences.

At the end of the workshop, there is a short time slot for participants and organizers to share lessons learned and concluding remarks.

7 TOOLKITS

In this workshop, we have two tangible toolkits to help participants design and create haptic experiences. These devices are listed below.

7.1 Tickle Trunk

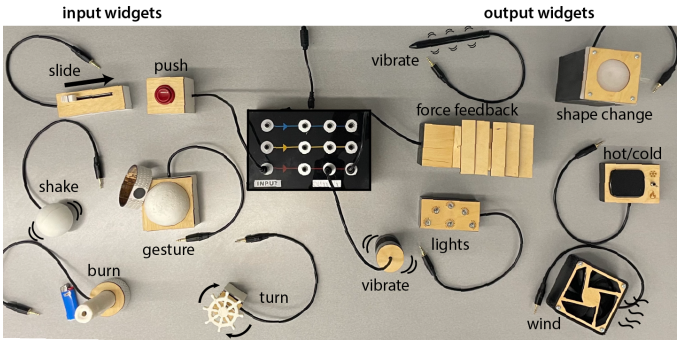

Figure 1: The Tickle Trunk is a plug-and-play device designed to demonstrate various haptic experiences through input and output interactions.

The Tickle Trunk [2] is an open-source, hardware-based toolkit that provides a playful and accessible means of experiencing and prototyping haptic feedback. Using a plug-and-play design that makes use of various haptic modalities, users can explore and brainstorm different haptic effects, simplifying the task of communicating their ideas with collaborators. The toolkit provides a variety of tangible objects or 'widgets' that users can compose as inputs and outputs, to experiment with different haptic interactions. The input widgets provided in the toolkit include a simple push button, a flame sensor, a haptic slider, a wheel that supports rotation, a shake sensor and a proximity sensor. Similarly, examples of output modalities provided include vibration, temperature, force feedback, wind and pressure.

7.2 VibroHarness System

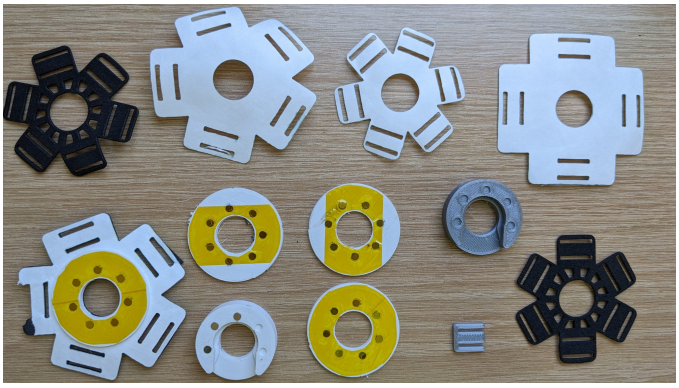

Figure 2: The programmatic generated VibroHarness Materials

Drawing on the emerging needs for versatile, immersive, and inclusive haptic experiences, we introduce the VibroHarness System[7], a *work-in-progress* research from the University of Southern California. This system is designed around the *inclusive design* principles of modularity, catering to users' diverse body shapes and sizes and promoting rapid prototyping and innovation. Built predominantly from laserable materials such as Tyvek and foam, combined with elements from 3D printing, the VibroHarness promises an ultra-low-cost yet efficient solution. The inherent modularity allows easy cleaning and customization, ensuring maximum participant comfort. Users can seamlessly don and doff the wired components, providing an unrestrictive experience. Furthermore, its design is programmatic, thereby enabling higher levels of customization. Much like the Tickle Trunk (subsection 7.1), which provides an accessible means of haptic prototyping, the VibroHarness System seeks to enable researchers of vibrotactile feedback, making it more inclusive, user-centric and adaptable to the ever-evolving research landscape.

8 POST-WORKSHOP PLANS

The design discussion will be structured in such a way as to encourage systematic documentation in writing and sketches. Each design created by the participants will be clearly written down, along with its associated design process. A brief overview of the inclusive design principles followed by the participants, as well as the identified problems and strategies to improve and sustain the practice, will also be listed.

These written documents will serve as the basis for an essay that we intend to publish. The essay will serve as an opinion piece on guidelines or checklists for inclusive design in haptics, with a summary of open research questions. The essay will be aimed at junior researchers searching for PhD topics, and will guide grant proposals by more senior researchers. Depending on how systematically the topics cover the space, we will decide on a venue for submission.

The published essay, as well as supplementary material, will be made available on our website. This website will also serve as an archive of sorts, linking to existing haptic design libraries, toolkits, and other resources for inclusive design in haptics.

Participants will also be invited to attend follow-up online interviews and to provide more in-depth information about their experiences and lessons learned from the workshop. This study has been reviewed and received ethics clearance from the University of Waterloo Research Ethics Board (REB #44481). We are awaiting approval of the protocol from the Ethics Board of the University of Southern California. The result from the study will be published as a journal or a conference paper.

9 WEBSITE

Details regarding the workshop will be available at https://uw-hapticexperincelab.github.io/HapticPlayground/ . Participants will be given the opportunity to publish their position papers on this platform. Additionally, findings from the workshop will be reported and made accessible through the same website.

10 CALL FOR PARTICIPATION

The primary aim of this workshop is to bring together individuals interested in designing haptic experiences with different backgrounds and levels of expertise and provide them with tangible

tools to support collaboration and prototyping, taking into account the principles of inclusive design.

Similar to a playground environment, this workshop promotes a collaborative and friendly atmosphere, welcoming individuals from all backgrounds, knowledge levels, and skill sets. Participants will have the opportunity to experiment with a haptic toolkit, engage in insightful haptic discussions, and test haptic designs within a group setting. This approach will facilitate the exploration of various design requirements and the development of solutions for their implementation. To further support this, we will host an open discussion on the current state of haptic design, following keynote presentations. These will provide an introduction to inclusive haptic design and processes.

The workshop is open to anyone with an interest in haptic design with backgrounds including domains such as design, HCI, storytelling, health, gaming, education and social justice. Individuals from non-STEM fields are particularly encouraged to join the workshop. The event will be held in-person only, as participants are required to experience and use the tangible toolkits, which will be available for use during the workshop.

** **Important Dates** **

Submission Deadline	–	February 25th, 2024
Notification	–	March 10th, 2024

** **Invited Speakers** **

Allison M. Okamura	–	Stanford University
Heather Culbertson	–	University of Southern California
Karon MacLean	–	University of British Columbia

If you are interested in participation, please submit a two to four page position paper using the *publication* version of the ACM Master Article Template[1]. Please use this form to upload your manuscript https://forms.gle/3RpkJtipodk8yrCt6.

Your position paper should clearly provide prompts for the toolkit design session or provide suggestions on inclusive principles that need to be incorporated during the design session.

The paper should begin with a brief introduction of yourself or your team, followed by an overview of what you believe are significant works in your chosen area. Subsequently, it should present the specific challenges you encounter in your work or research, which could potentially be resolved through the application of haptic technology. You may want to emphasize how you plan to address these challenges and problems by utilizing haptic technology.

These position papers will serve as the foundation for discussions and will be shared with other members before the workshop. Ideally, these topics will foster better engagement and discussion among participants during the workshop. Lastly, authors will also have the opportunity to have their accepted position paper published on the workshop website. Please note that at least one participant from a group that submitted an abstract must attend the workshop and all participants must register for the workshop must register for workshop for at least one day of the conference.

For more information on the workshop and on submitting position papers, please visit: https://uw-hapticexperincelab.github.io/HapticPlayground/.

[1]https://chi2021.acm.org/for-authors/chi-publication-formats

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Ana Lucia Diaz de Leon Derby built The Tickle Trunk as part of a comprehensive paper intended for conference submission, with a focus on its design and implementation.

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