Designing Through Making: Exploring the Simple Haptic Design Space

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ABSTRACT

In this paper we describe the development and realization of basic haptic design tools. A series of devices or setups allow designers and other stakeholders to adopt a hands-on approach to haptics, and ultimately develop a greater sensitivity and understanding of haptic concepts. By offering tangible manifestations that are relatively abstract and modular, designers can relate to, explore and discuss haptic interfaces and possible variations with greater ease and confidence.

The five Simple Haptics devices that we built offer a basic platform to play and experiment with haptic interfaces. Each setup starts with a simple haptic idea and provides a graspable and experienceable unit to support discussion and variation related the haptic design activities.

Author Keywords

Haptics, Design Tools, Interaction Design, Tangible Interfaces.

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

Designing haptic interfaces is absolutely not trivial. Despite an already established research field [1,6,10], designers are generally unfamiliar with the haptic domain. The challenges can be very daunting at first, as the current haptic systems are commonly very complex, expensive and/or highly technical. Our main hypothesis is that designers can refine their mastery and develop a heightened sensitivity to haptics only if their work with and through the material.

Hayward and McKlean [5,15] published an overview of the challenges and technical issues around building haptic interfaces. Their work, presented under the Do-It-Yourself (DIY) movement, directly aims at demystifying and democratizing haptics, opening the field and lowering the barrier to entry for non-experts. They note, like many others [3,9,12,13], the surprisingly limited body of knowledge around the activities and processes of designing haptics.

TEI'11, January 22–26, 2011, Funchal, Portugal.

Designing for our touch sense remains unnatural to most of us. We, designers and users alike, usually experience these sensations and haptic stimulations directly, but we do not usually verbalize and communicate them explicitly in details. The lexicon and vocabulary around the subject is sure limited but nevertheless growing, [15, 19]. The reliance on prototypes, actuated artifacts and semi-working models is almost a necessity to develop a shared understanding and evolve haptic design ideas.

DESIGNING THROUGH MAKING

Transitioning from ideation to materialization is particularly difficult in the haptic realm. Haptic concepts or ideas presented visually or orally have limited reach and usefulness. To fully appreciate and evaluate haptics proposals, stimulations and forces need to be applied on our skin and body. Moving, actuating and influencing the world and its atoms require its load of energy and some level of control. Sketching haptics require a different set of constraints and skills than traditional design sketching activities (interfaces mockups, hand-written drawings, volumetric models, etc).

From the start, we decided to embrace our medium and rely on the process of making to experiment, understand, and critically explore the subject. Our hypothesis was that by building things, manifesting ideas quickly, testing alternatives and variations, making mistakes, truly feeling what works and what doesn't, we would develop a heightened sensitivity to haptics [2,3]. By sketching in hardware [7,16], designing through making [18], and by being fully engaged in the matter, important knowledge and understanding of haptics would be acquired.

SIMPLE HAPTICS

Our work intentionally explores simple actuated mechanisms that we started calling Simple Haptics. They are directly inspired by Hayward's self-contained non-programmable mechanical devices made to explore haptic illusions [4]. We purposely avoid the typical arm (or finger) force-feedback systems as they are highly technical and generally deliver low quality stimuli compared to real physical interaction with the world.

Our Simple Haptics devices make use of natural qualities of the materials and of the assembly mechanisms, i.e. glued versus screwed. When inert and non-actuated, these devices have certain qualities and characteristics, from an industrial design perspective at least. Our goal with Simple Haptics was to leverage these qualities, and augment them with actuation or basic mechanism to produce simple haptic interfaces.

It is important to state that our devices are not final haptic proposals or interfaces per se. We view these devices as platforms and building blocks to sketch, understand, explore, experiment quickly, build variations and develop a design sensitivity of the subject. They were built as design tools or tangible work artifacts to engage and discuss while designing haptics.

We decided to arbitrarily limit our work to five setups or haptic concepts. For each of them, we explored and built numerous versions and variations. All the devices, with associated electronic controls and user interfaces, were built during a 12-week period using readily available workshop materials and simple electronics.

Slacker

The idea at the origin of the Slacker device is to have a device with a fixed shell or case, but the inside can *feel* different: being loose or solid, shaky or secure, reactive or inert.

Figure 1. Inspiration and Slacker device. The internal parts can be "clutched" (loose or solid).

The first version had a simple button or responded to a mouse click on the computer to trigger/release the mechanism. The final iteration used an accelerometer to detect movement (shake) and activate/deactivate the clutch accordingly. The default configuration chosen for the device was the *Shake to Solidify* pattern, but other testers found the reverse *Shake to Release* more intuitive at first. There are no right or wrong configurations. It really depends on the designers' intention in building a more final and specific solution.

Springer

Springer evolves from today's visual interfaces that often spring back when dragging or scrolling an object out of bound. The simple proposal is to have the haptic perception that an internal physical object is really springing back as the user interface does so.

The main challenge was to create a setup that crank and release a dead-weight attached to elastic cords inside the device. The final solution has the springing user interface on an adjacent computer, but ideally this visual interface would sit on top of the device.

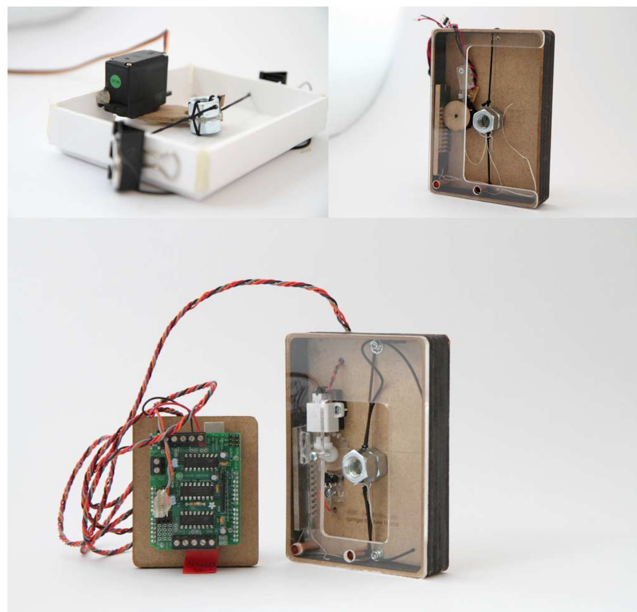

Figure 2. Evolution of the Springer device.

Winder

The Winder setup offers a mechanism to move weight along one axis of the device. This way, the center of mass of the whole unit can be moved. The load can be easily modulated by adding or removing steel nuts.

The prototypes use a common type of miniature geared-motor, available in different gear ratio configurations. Variations of speed and torque (thus working load) can be tested whilst keeping the same electronics and control program.

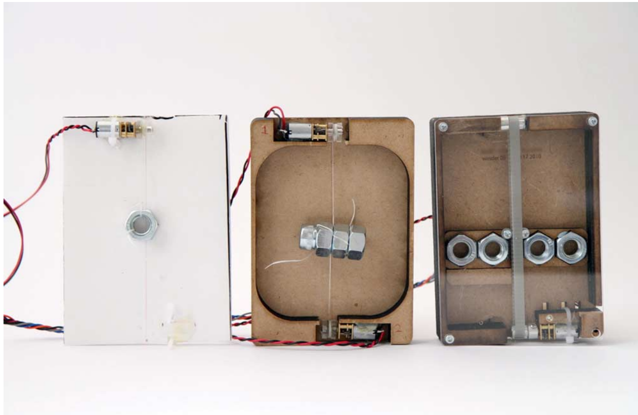

Figure 3. Three iterations of the Winder device.

Spinner

The principle of the Spinner is to simply have a rotating weight inside the device. If the weight spins fast, it feels similar to slow and cyclic vibration. If moved sequentially, the center-of-mass of the whole unit can be positioned around. Again, the speed, position and load can be varied at the designer' s will.

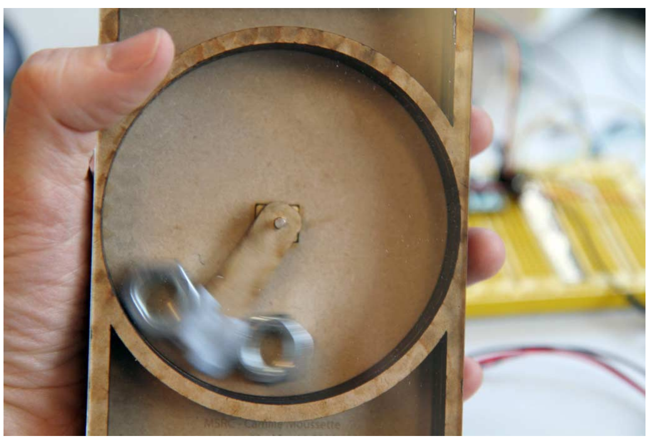

Figure 4. First version of the Spinner device.

Slider

The concept behind the Slider is to offer a moveable source of actuation and explore to what extent users can perceive the dynamic source compared to a static source. The device is built around a motorized slider, and offer two different sources of haptic stimulation: a vibrating one and a poking one (solenoid). The source position, speed, cycle time and actuation rhythm/power can be changed via an user interface on the computer.

One important characteristic of this setup is the ability to change material at the interface (back panel) between the dynamic source and the user's hand. The intention is to let the designers explore different materials and feel for themselves how the haptic qualities are changing in relation to the different variables.

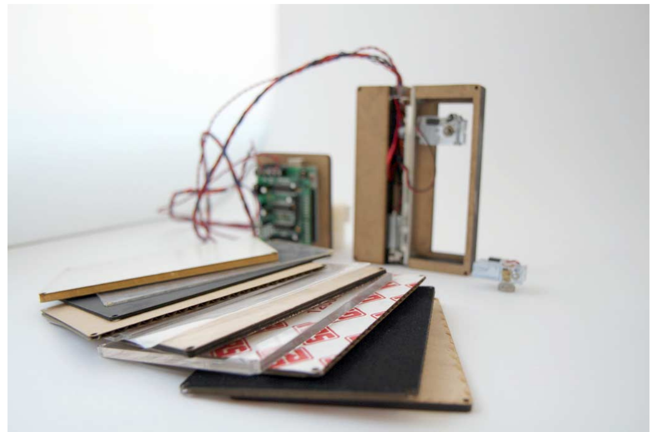

Figure 5. Slider device, with 2 dynamic sources, and the different materials for testing.

DISCUSSION

Our initial hypothesis of acquiring haptic knowledge and expertise through making and sketching in hardware seems to hold true, at least partially. As designers we truly feel that we now have a more acute sensitivity and understanding of haptics after the 12-week period. We also acknowledged the use of a new vocabulary to communicate haptic concepts in our day-to-day design activities. We adopted terms like clutching, winding, solidify to document and explain key characteristics in the devices we built.

By constantly manipulating and trying out various configurations, we found that material properties and assembly techniques matter very much while designing haptics. Our perception on the sense of touch is all about a collection of small and converging cues. Finding a haptically interesting stimulation in relation to both aesthetic and functional qualities is very demanding. While developing our series of devices, we found that relative change/modification was more easily recognized and felt, compared to static stimulation. For example with the Winder unit, it is quite difficult to recognize where the load is on the first grasp. Once the load starts moving, then it is felt instantly and we are quite good at extrapolating the internal position/configuration of the device.

Overall, using the Simple Haptics devices provided a valuable platform for discussing and developing a shared understanding of haptics beyond oral communication and visual static depictions. Being able to "feel" haptics is crucial in designing haptic systems, even though some of the stimulations are not perfect or in refined forms.

FUTURE WORK

In the near future, we plan to deploy the devices to designers and design students in order to evaluate their usefulness. We initially built only five setups and some of them were relatively crude. The possibilities to quickly exchange motors and actuators are limited. We would like to refine the modular aspect of the devices, to support quicker variations and a larger range of haptic explorations.

CONCLUSION

Our work initially set out to provide simple haptic design tools for designers to understand, play and expand their sensitivity to the haptic design activities. During 12 weeks, we decided to embrace our medium and rely on the process of making to experiment, understand, and critically explore the subject. Our hypothesis was that by building things, manifesting ideas quickly, testing alternatives and variations, we would develop a heightened sensitivity to haptics. Our preliminary results seem to support this assertion.

The resulting Simple Haptics devices that we built offer a platform to play and experiment with haptic interfaces. Each setup starts with a simple haptic idea and provides a graspable and experienceable unit to support discussion and variation related the haptic design activities. They were built as design tools or tangible work artifacts to engage and discuss while designing haptics.

ACKNOWLEDGMENTS

We would like to thank the Computer Mediated Living group at Microsoft Research Cambridge for their support and feedback for this work. The help of Nick Trim and the Social-Digital Systems group has been especially appreciated.

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