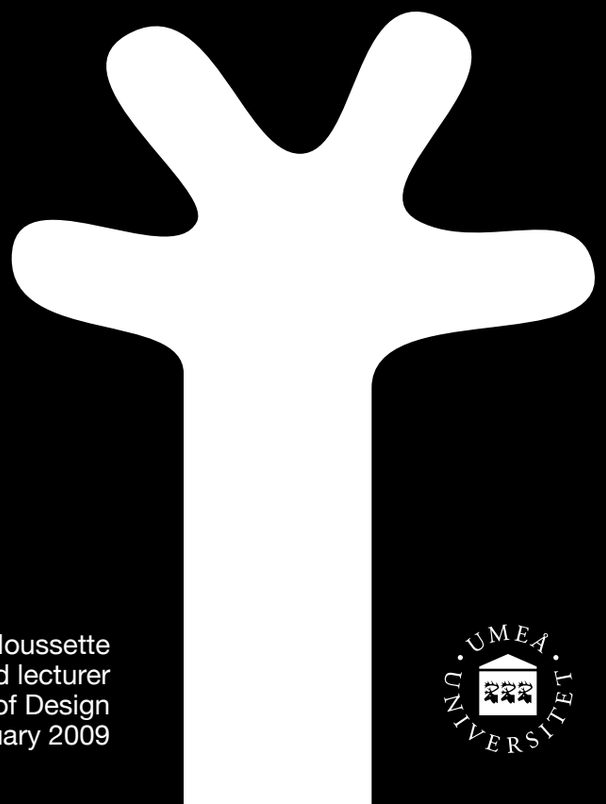
Sketching haptic and multimodal interaction

Interaction'09 | Vancouver



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February 2009

Sketching haptic interaction

Is it possible to sketch haptic and multimodal interaction and can (interaction) designers do it?

What is haptic?

Sketching and prototyping

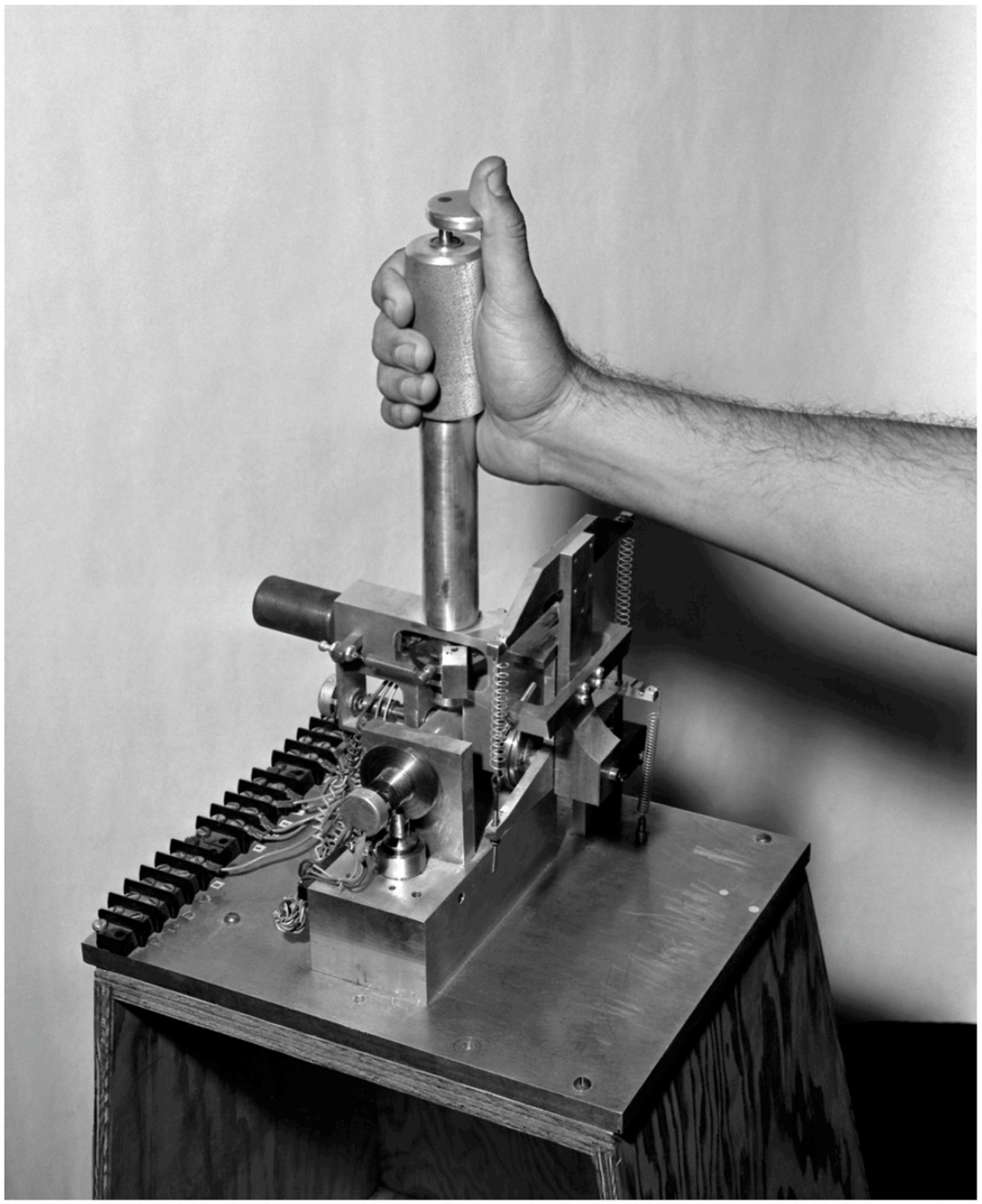
Examples

Challenges and difficulties

Suggestions and guidelines

Multimodality

Haptic interface



NASA Dryden Flight Research Center Photo Collection
http://www.dfrc.nasa.gov/gallery/photo/index.html
NASA Photo: E-2633 Date: 1956

Three axis control stick used on Iron Cross Attitude Simulator

Haptic technology

*Haptic technology refers to technology which interfaces the user via the sense of touch by **applying** forces, vibrations and/or motions to the user.*

Wikipedia, 2007

A touchscreen is not a haptic interface
The iPhone is a poor haptic device!

Haptic perception

Combination of somatosensory perception on the skin and proprioception

First sense to develop in humans and may be the last to fade.

20x faster than vision, we can notice two stimuli just 5 ms apart.

Can sense displacements on our palm as low as 0.2 microns in length.

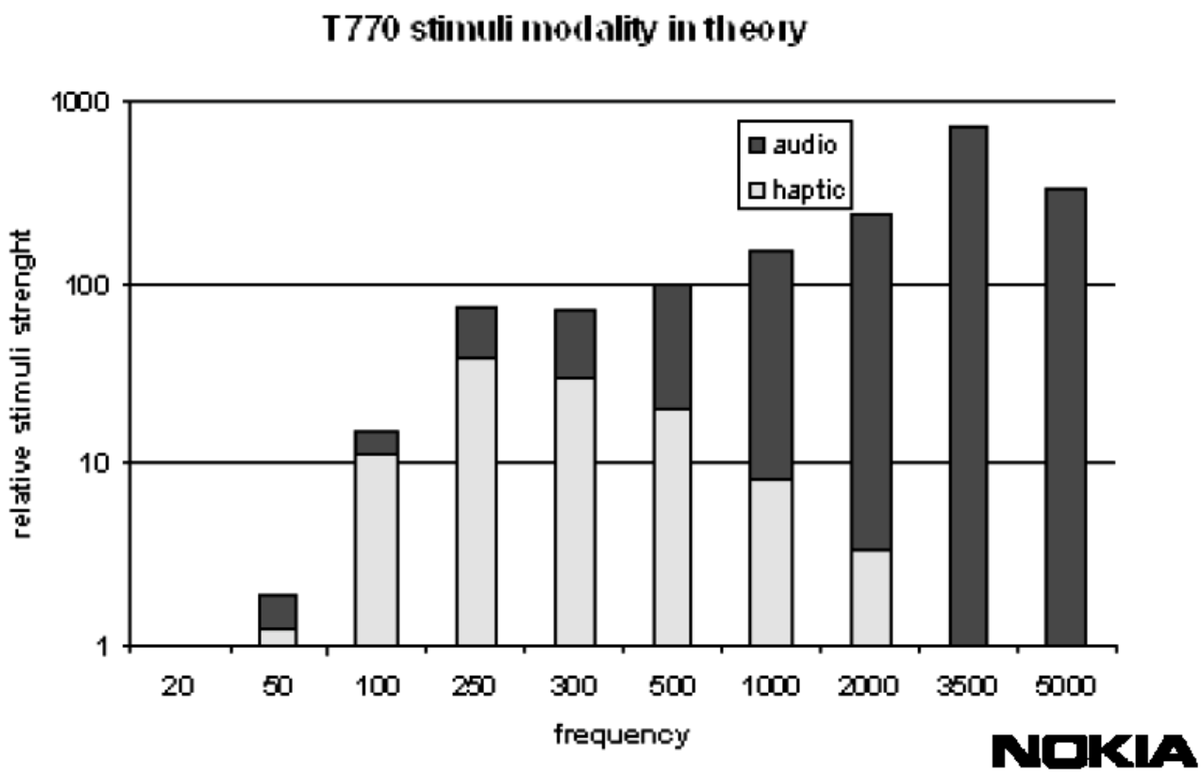
Highly sensitive to vibration up to 1000 Hz, with the peak sensitivity around 250 Hz

Haptic perception

Active vs passive touch

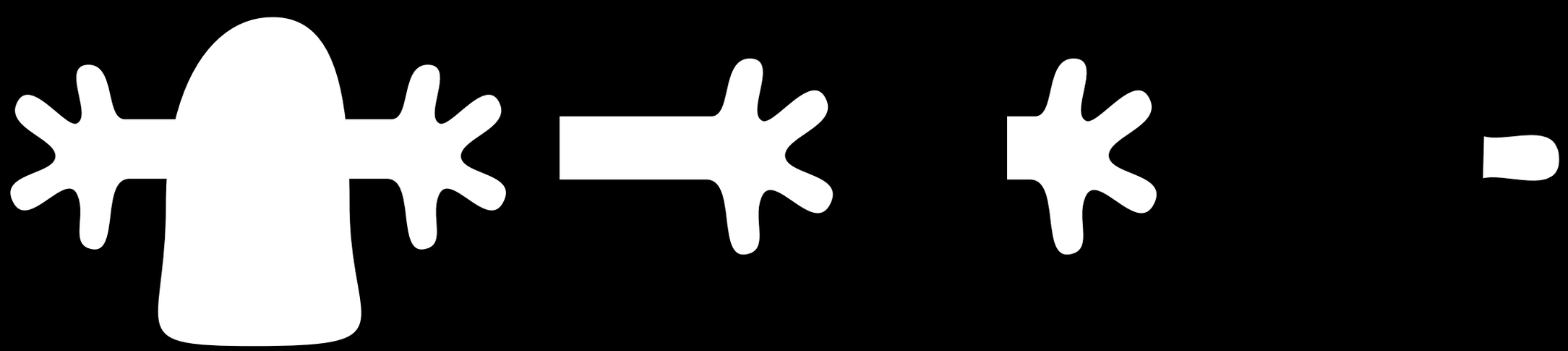
Haptic interaction is very often **multimodal**
Visual or audio cues can augment haptic perception

No clear boundary between sound and vibration, natural overlap



Haptic interface

Body	Arm	Hand	Fingertip
1-3 m	20-100 cm	1-20 cm	under 1 cm

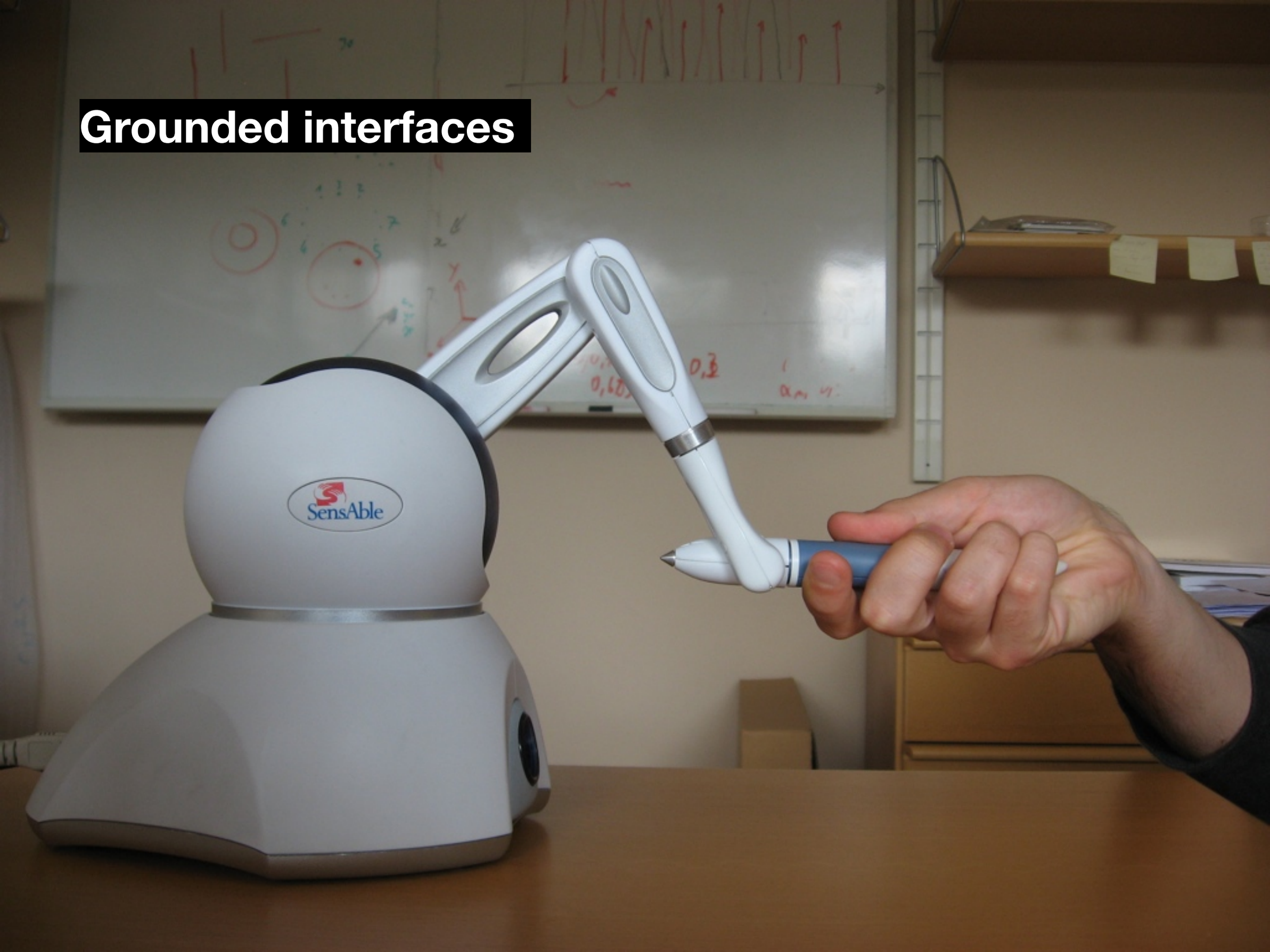


Haptic interface

Hand

1-20 cm

Grounded interfaces



Ungrounded interfaces

Sketching and prototyping haptics?

The Anatomy of Prototypes

Lim, Y.-K., Stolterman, E., and Tenenberg, J. 2008

Prototypes are **filters** that traverse a design space and are **manifestations** of design ideas that concretize and externalize conceptual ideas.

A “good” prototype is very dependent on what you are trying to explore, evaluate, or understand.

The Anatomy of Prototypes

Lim, Y.-K., Stolterman, E., and Tenenberg, J. 2008

The Principles of Prototyping

Fundamental prototyping principle

Prototyping is an activity with the purpose of creating a **manifestation** that, in its simplest form, **filters** the qualities in which designers are interested, without distorting the understanding of the whole.

Economic principle of prototyping

The best prototype is one that, in the **simplest** and the **most efficient way**, makes the possibilities and limitations of a design idea visible and measurable.

Sketching and prototyping haptics

The Art of Nonrealistic Usefulness and Realism Through Shortcuts

Hayward & MacLean, 2007

Sketching and prototyping haptics

Necessary to avoid costly mistakes (fail early and fail often) [Buxton]

Almost essential for the touch sense as we have limited abstract represention and/or vocabulary to fall back to

Unlike GUIs and the visual sense, initial unfamiliarity with the subject, useful to get started

How do you start?

Adobe

How do you start?

Create haptic sensations artificially: 4 dominant methods

Vibrotactile devices

Force feedback systems

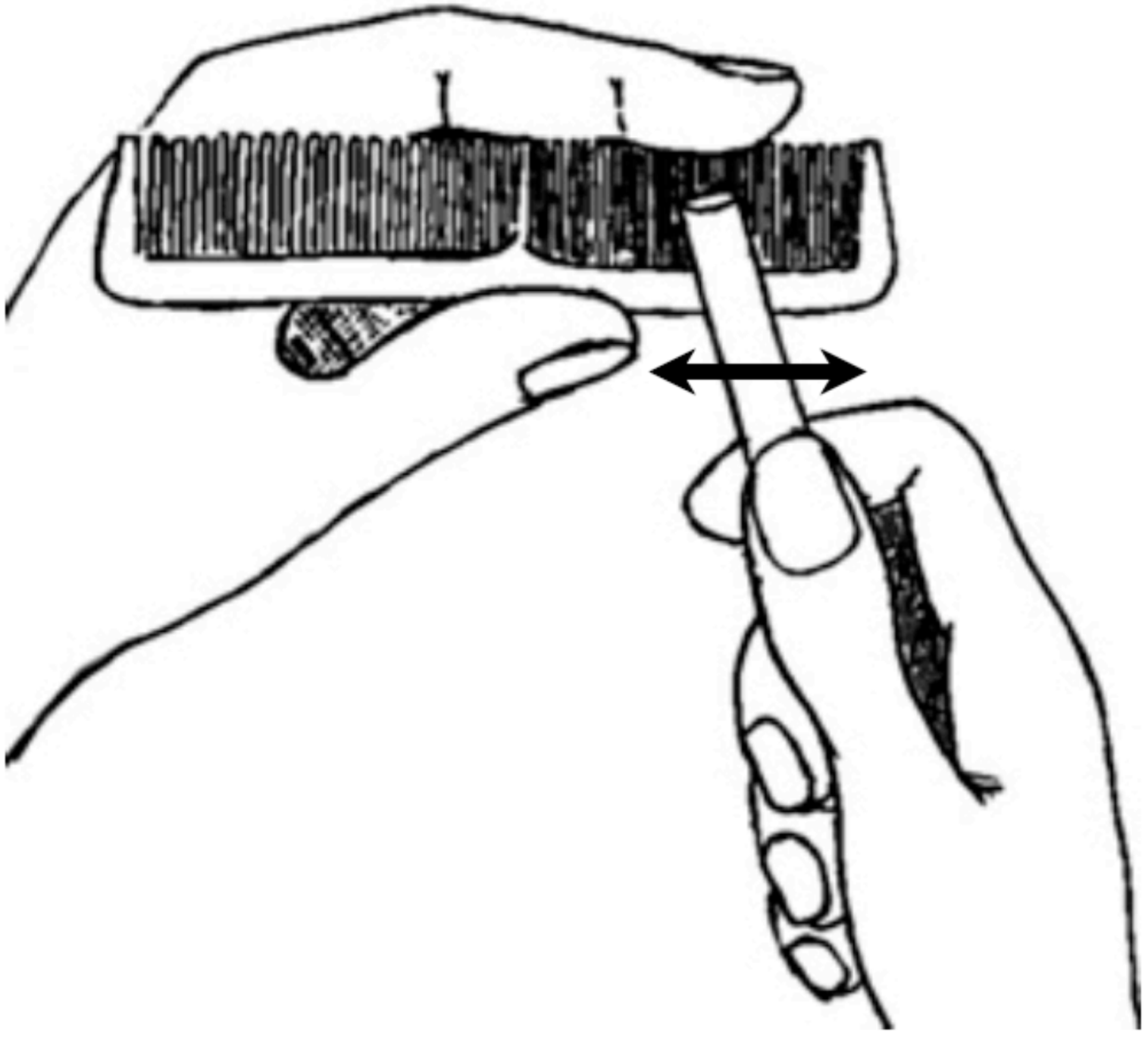
Surface displays

Distributed tactile displays

Vibrotactile devices

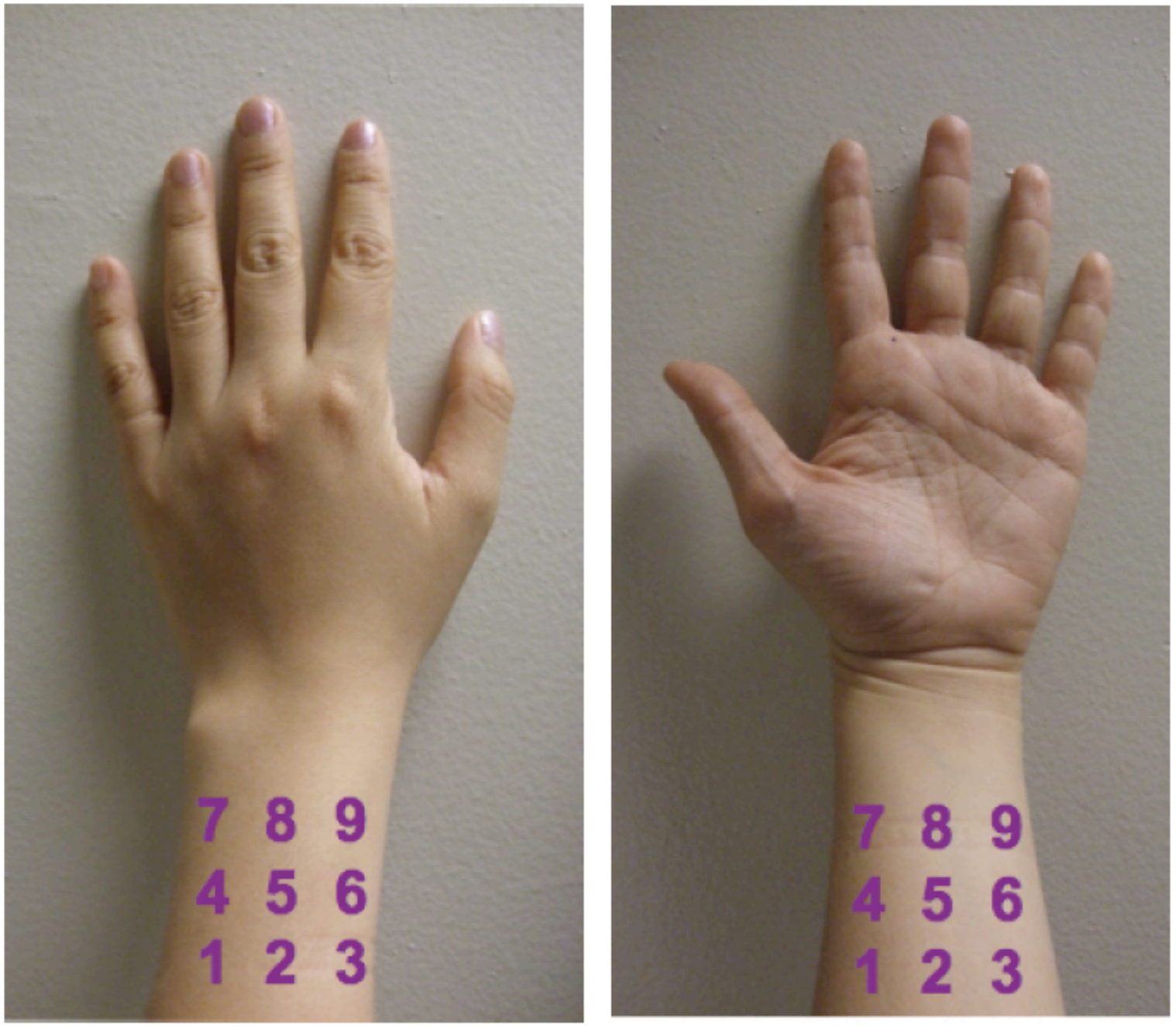
Force feedback systems

Surface displays



“Comb illusion”, Hayward, 2008

Distributed tactile displays



Hsiang-Yu Chen, Joseph Santos, Matthew Graves,
Kwangtaek Kim, and Hong Z. Tan, 2008


Technocentric ↔ Human Centric

Sketching and prototyping levels

Minutes and hours

Hours, one day

Multiple days

Week

Minutes and hours

Rough

Crude

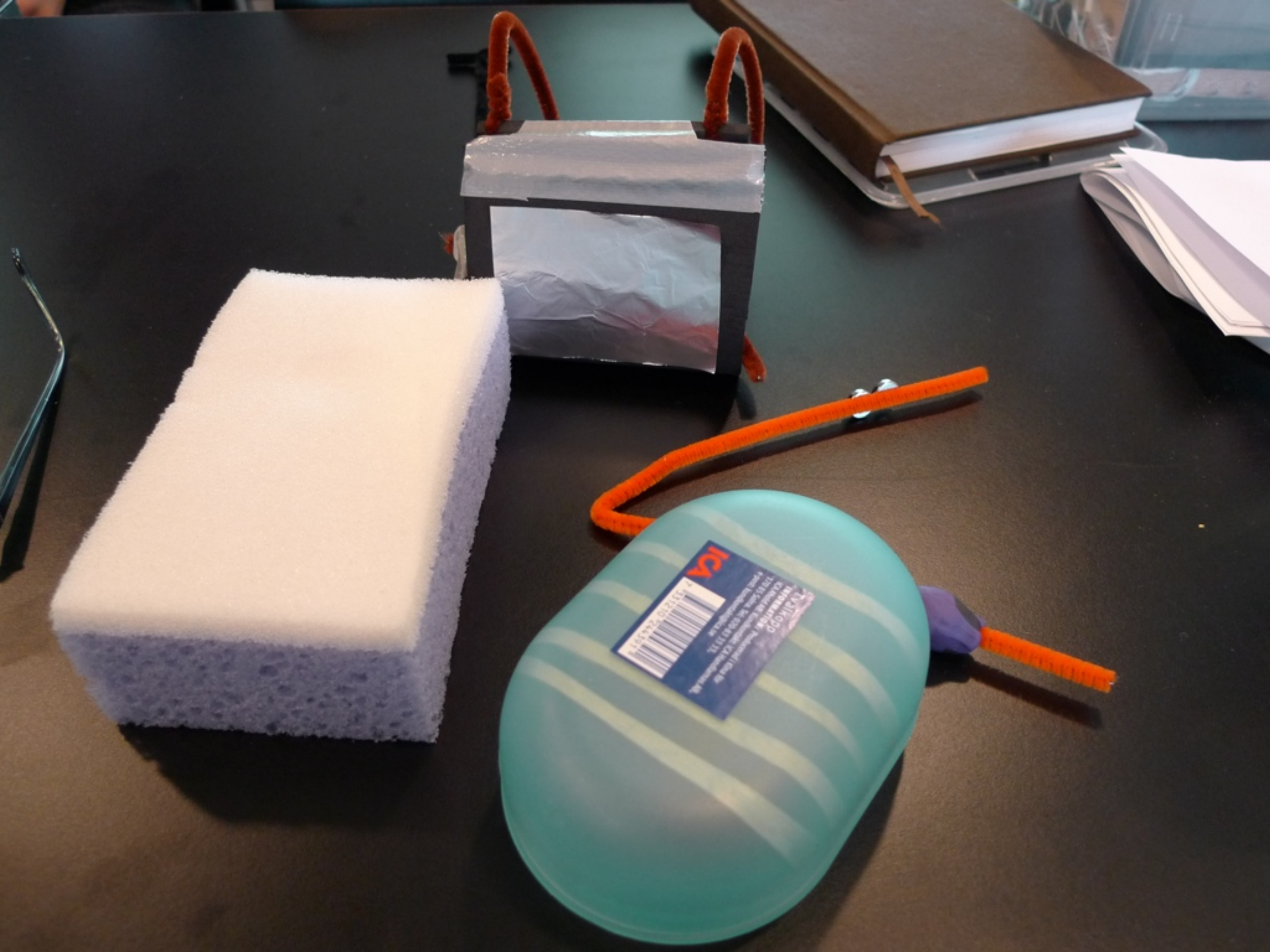
Human actuated, Wizard of Oz

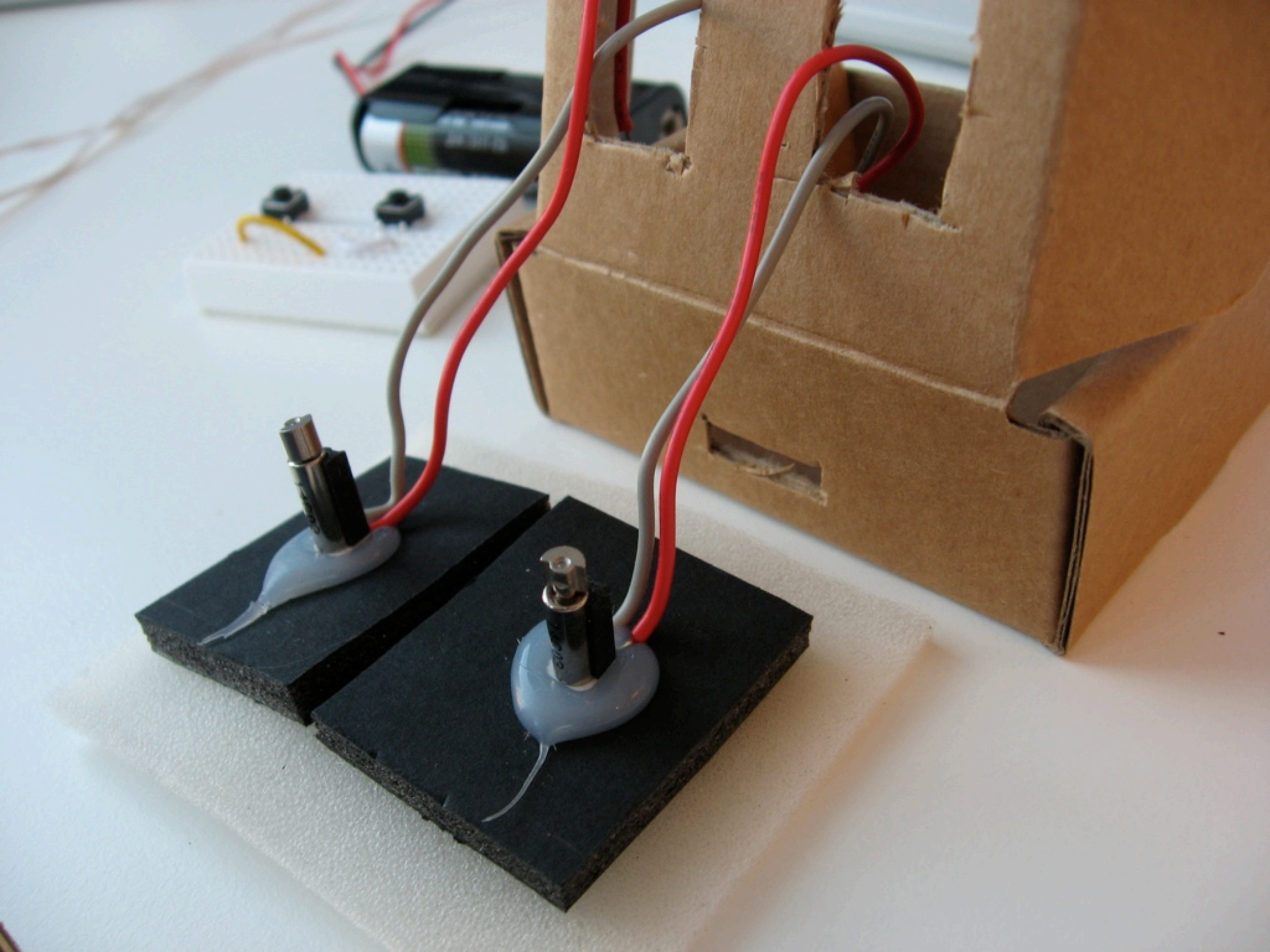
Quick and dirty “how does this feel”

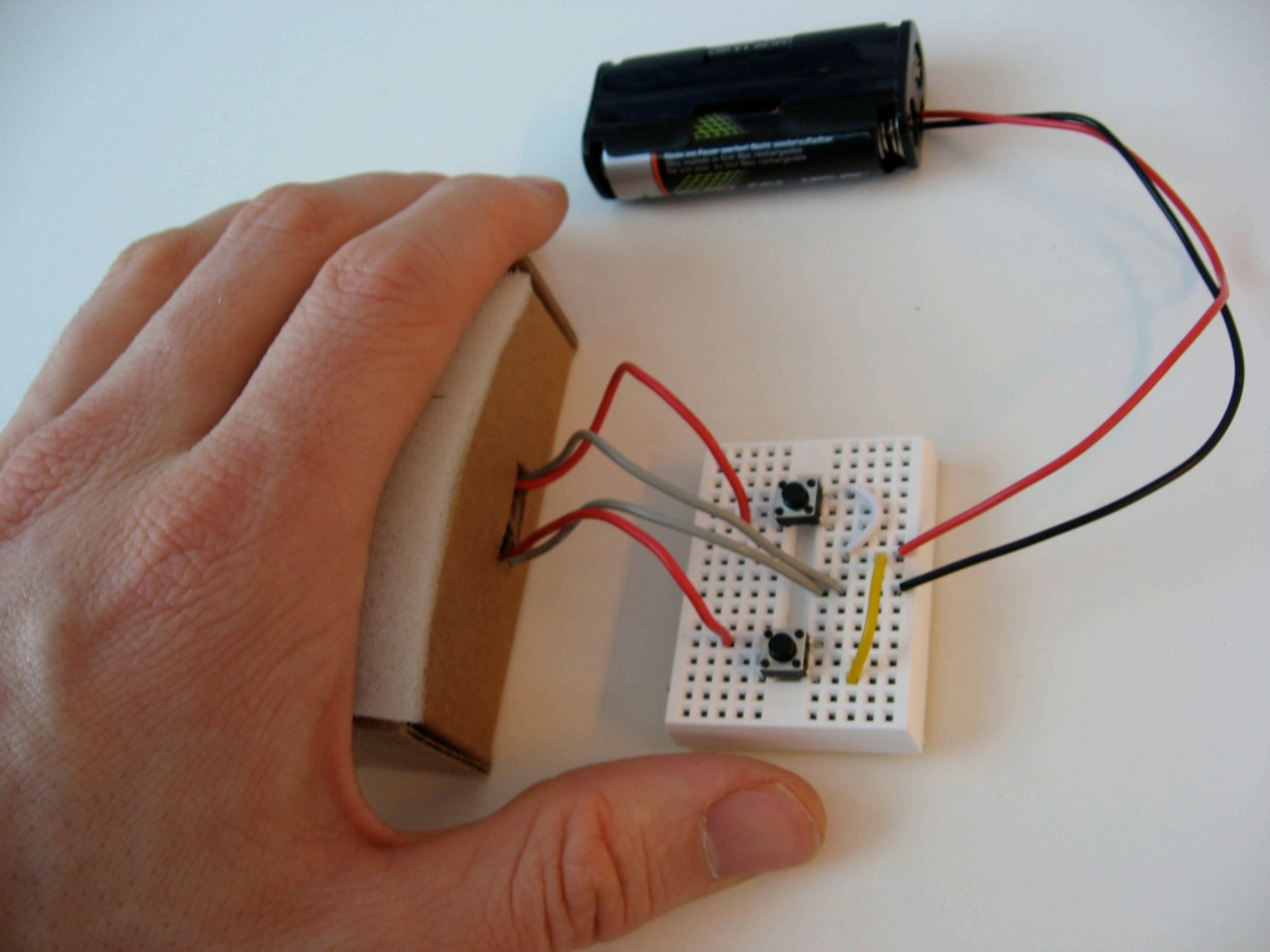
PD like (brainstorm, ideation workshop)

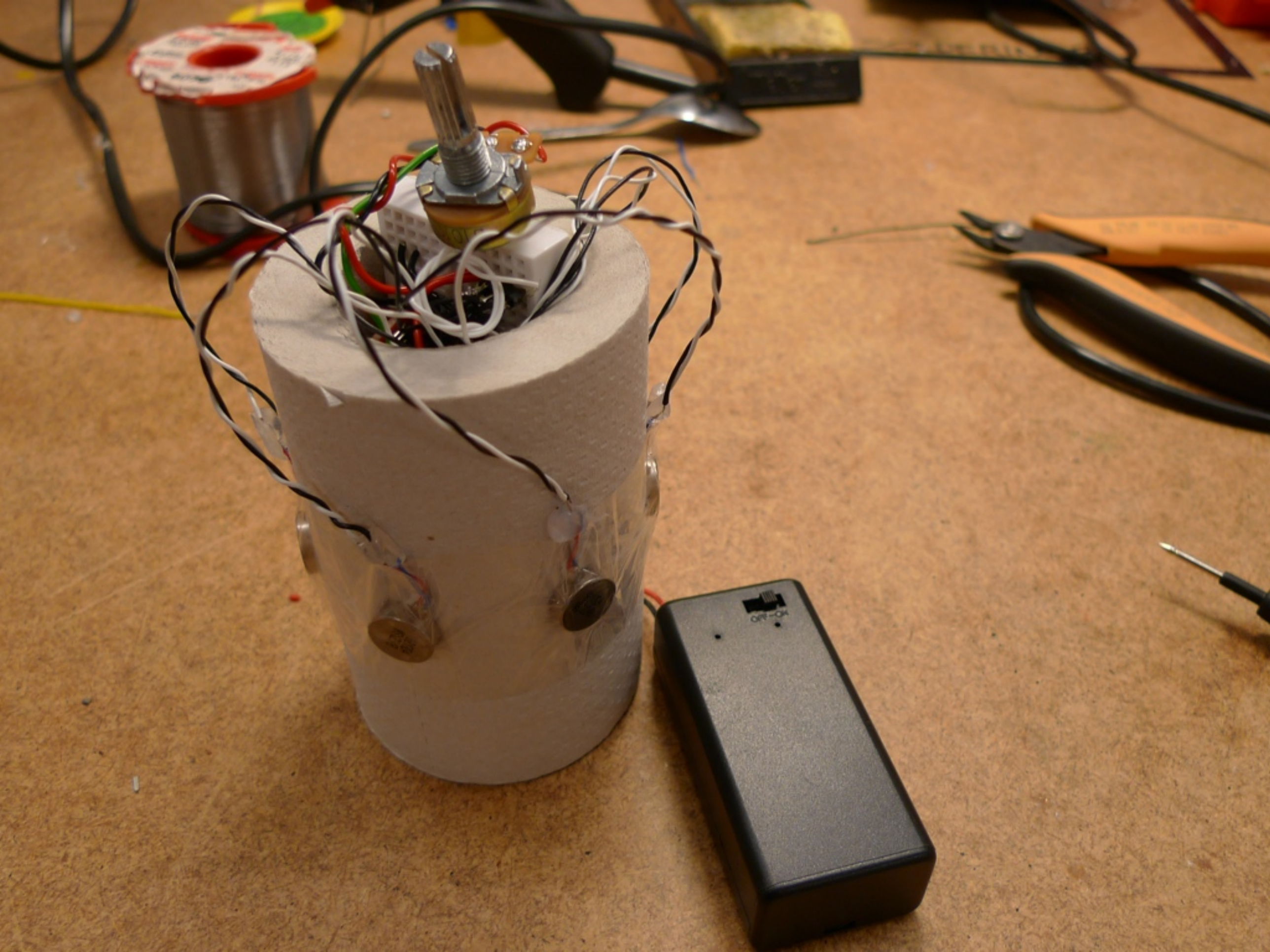
What you can do on your desk/table

Low-tech (usually), low-fi (not necessarily)








OFF
ON

Hours, one day

Explore variations

Not as clunky

Human actuated, Wizard of Oz

Basic assembly and construction elements

Simple trigger or control mechanism

What you can do in your “garage”

Low-fi (not necessarily)

Multiple days

Adjustability and more control

Repeatability

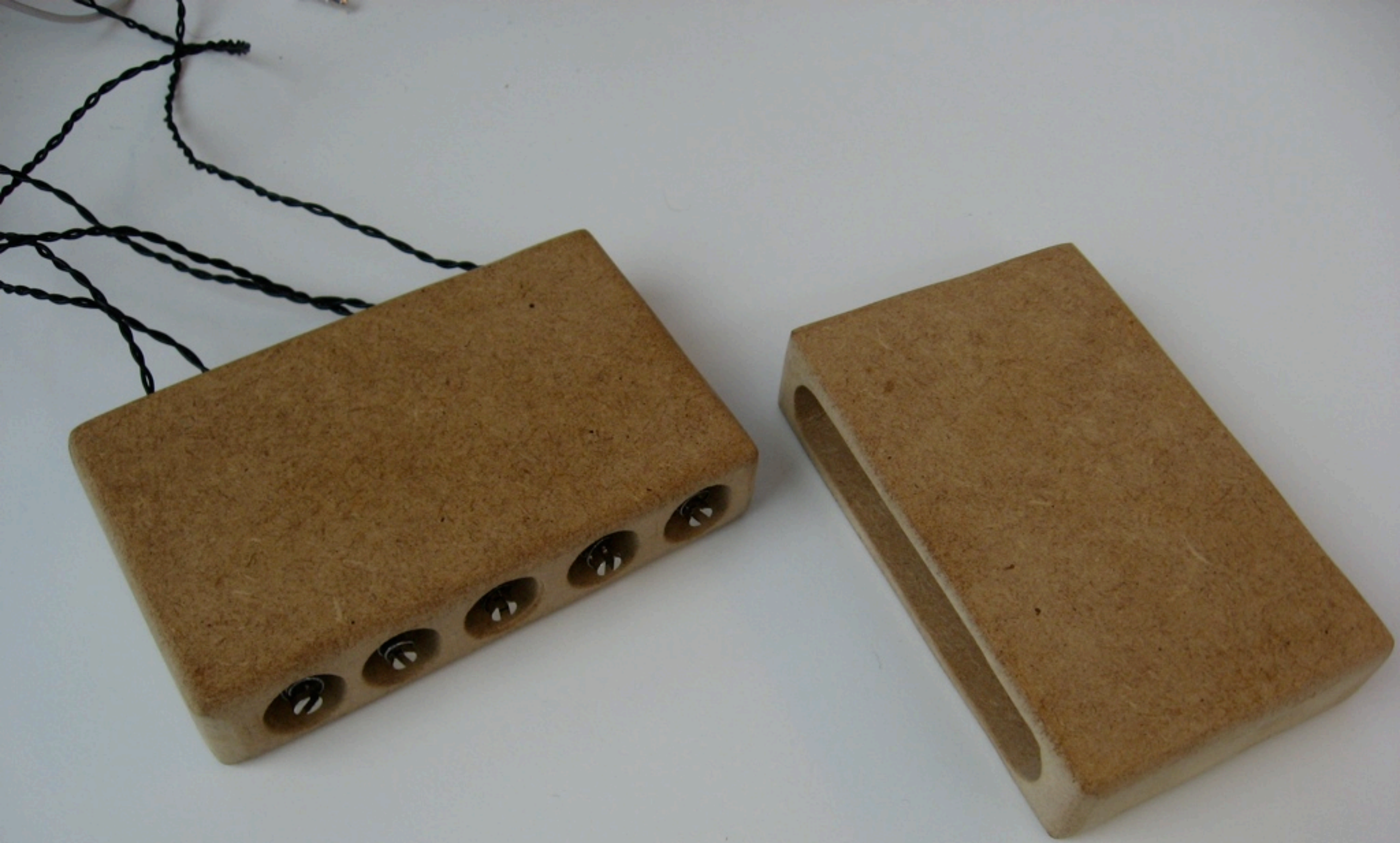
Some machine control

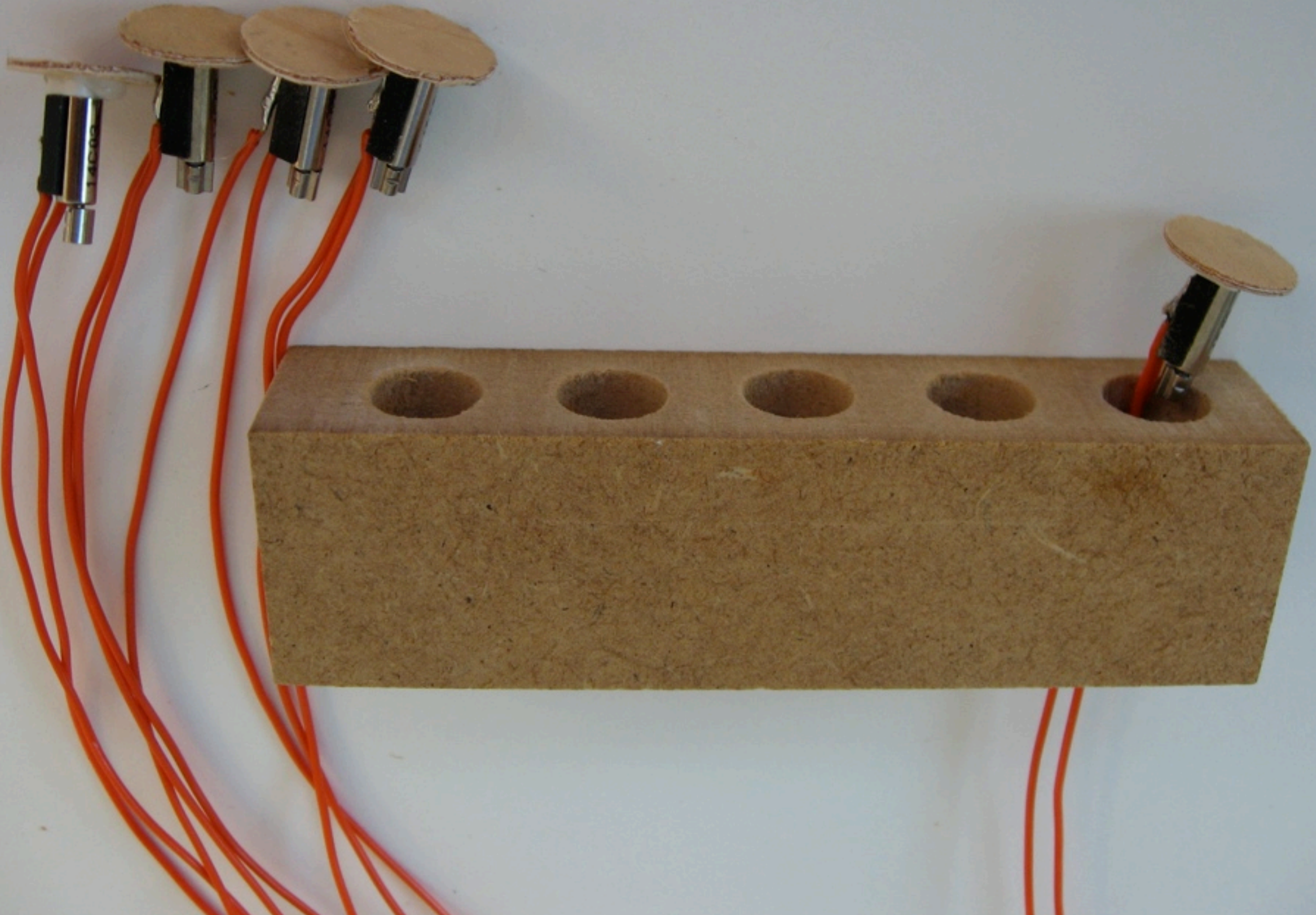
Fancier mechanisms or actuation systems

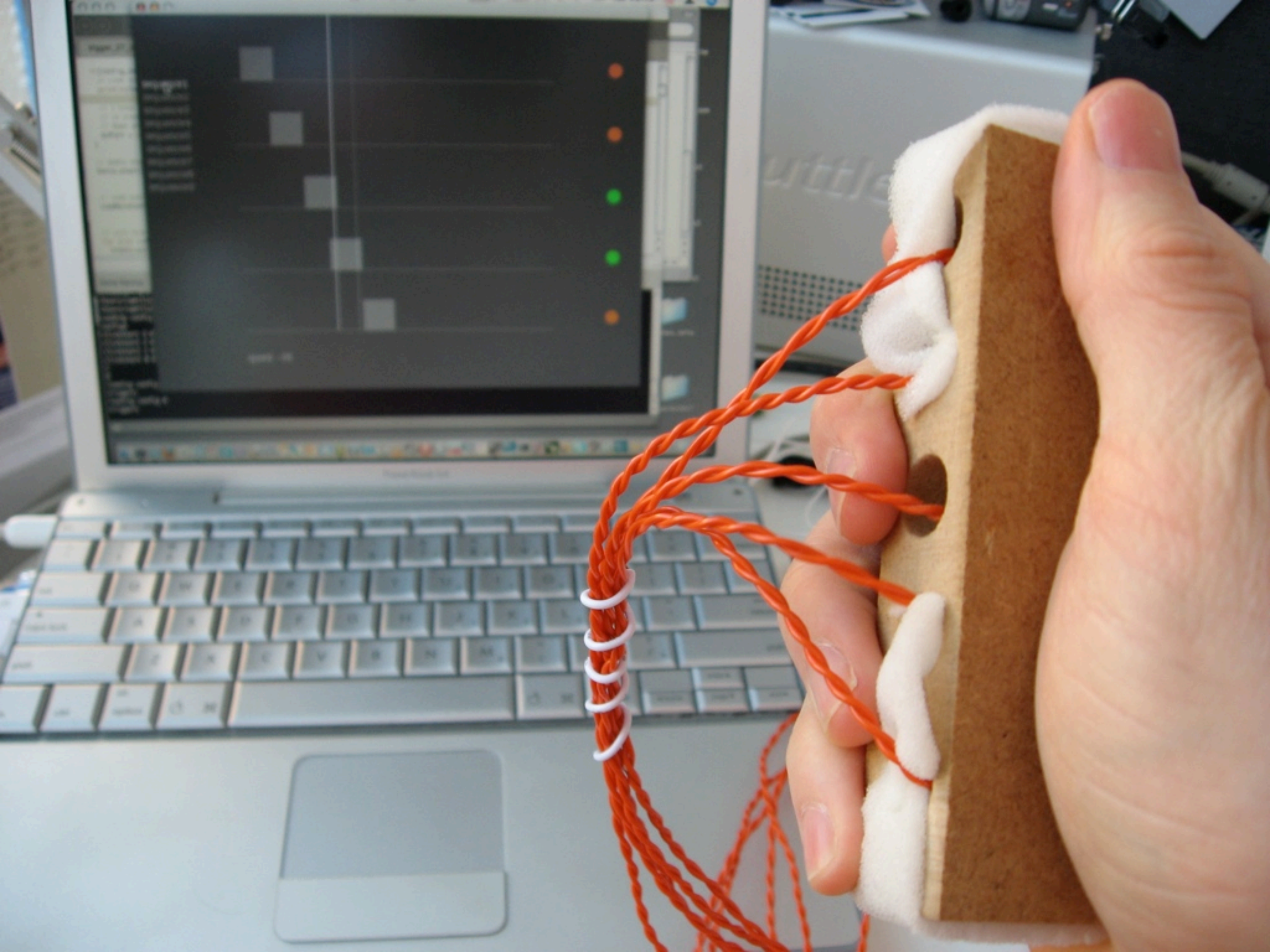
Electronics (maybe) and measuring capabilities

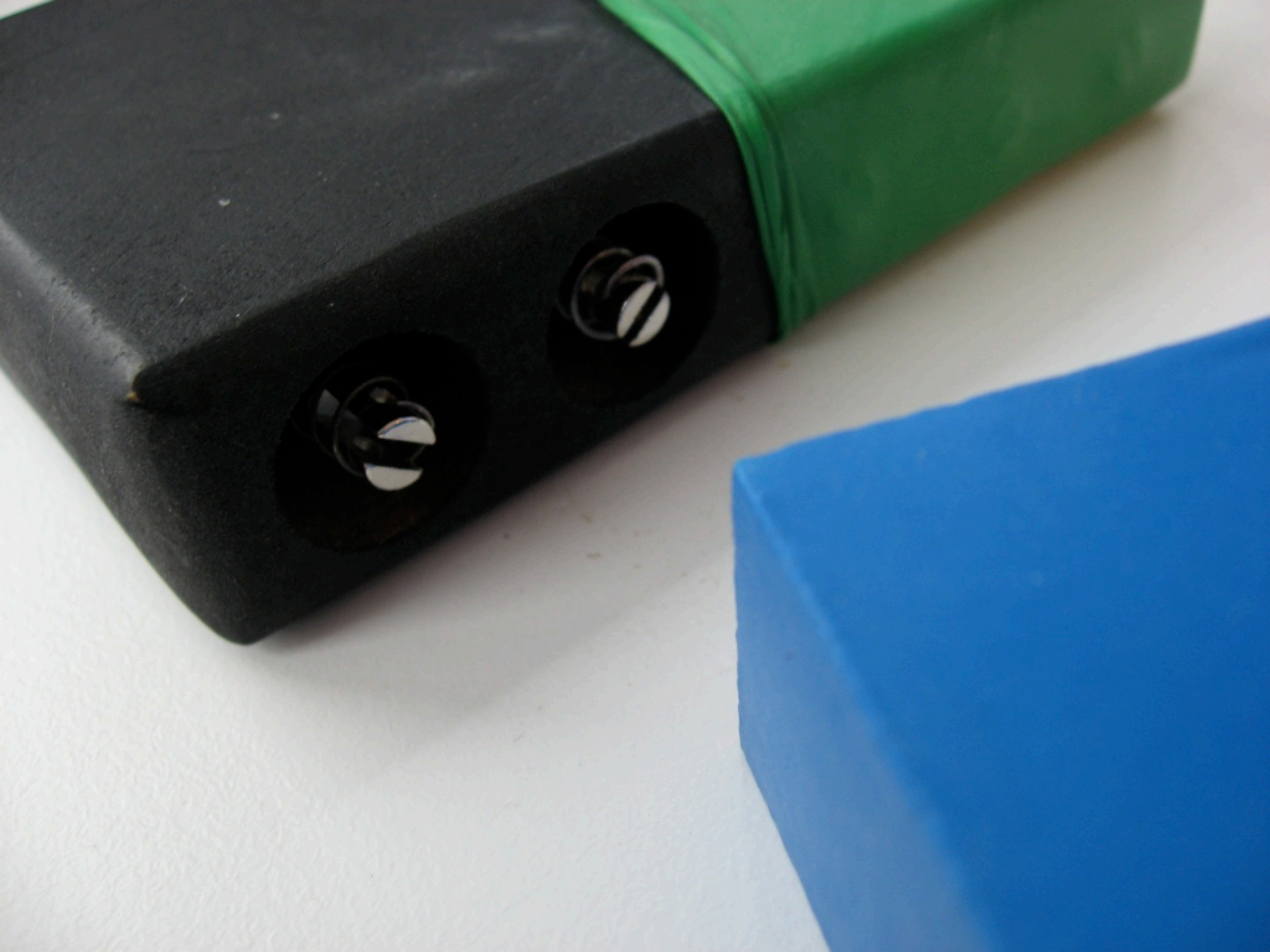
What you can do in a workshop

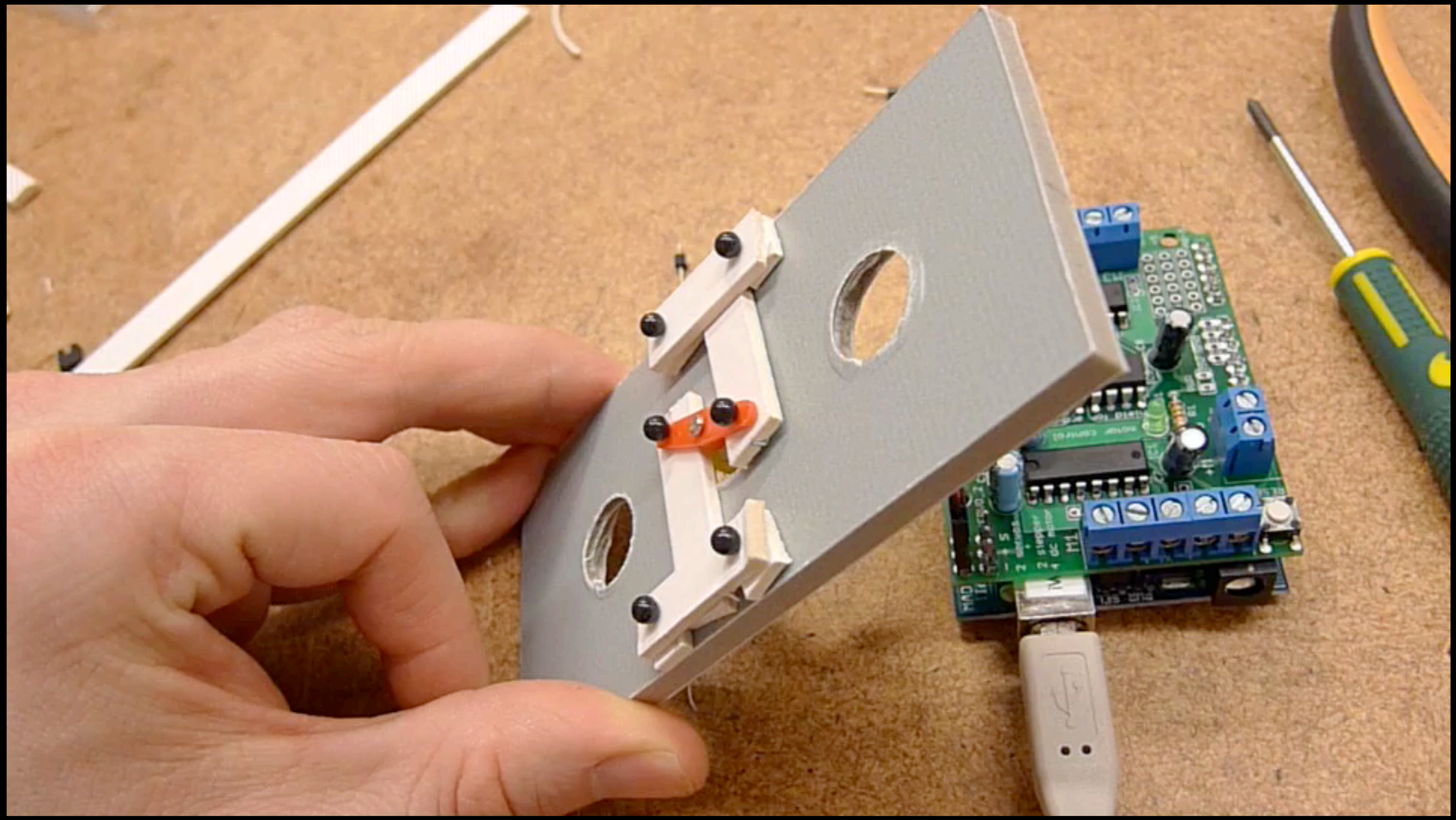
Full range of fidelity

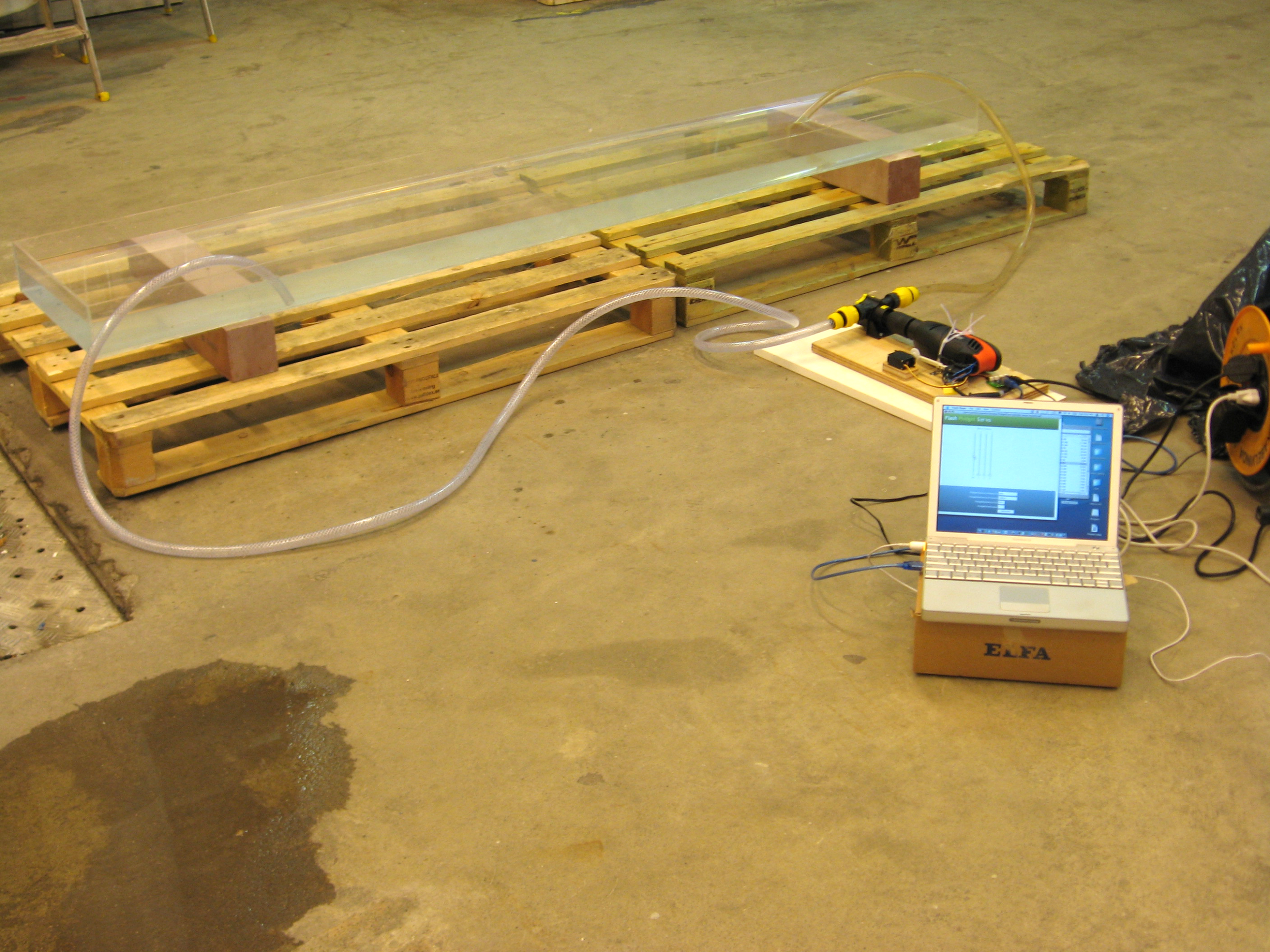











EAFA

Week

Finer control

Costly but necessary

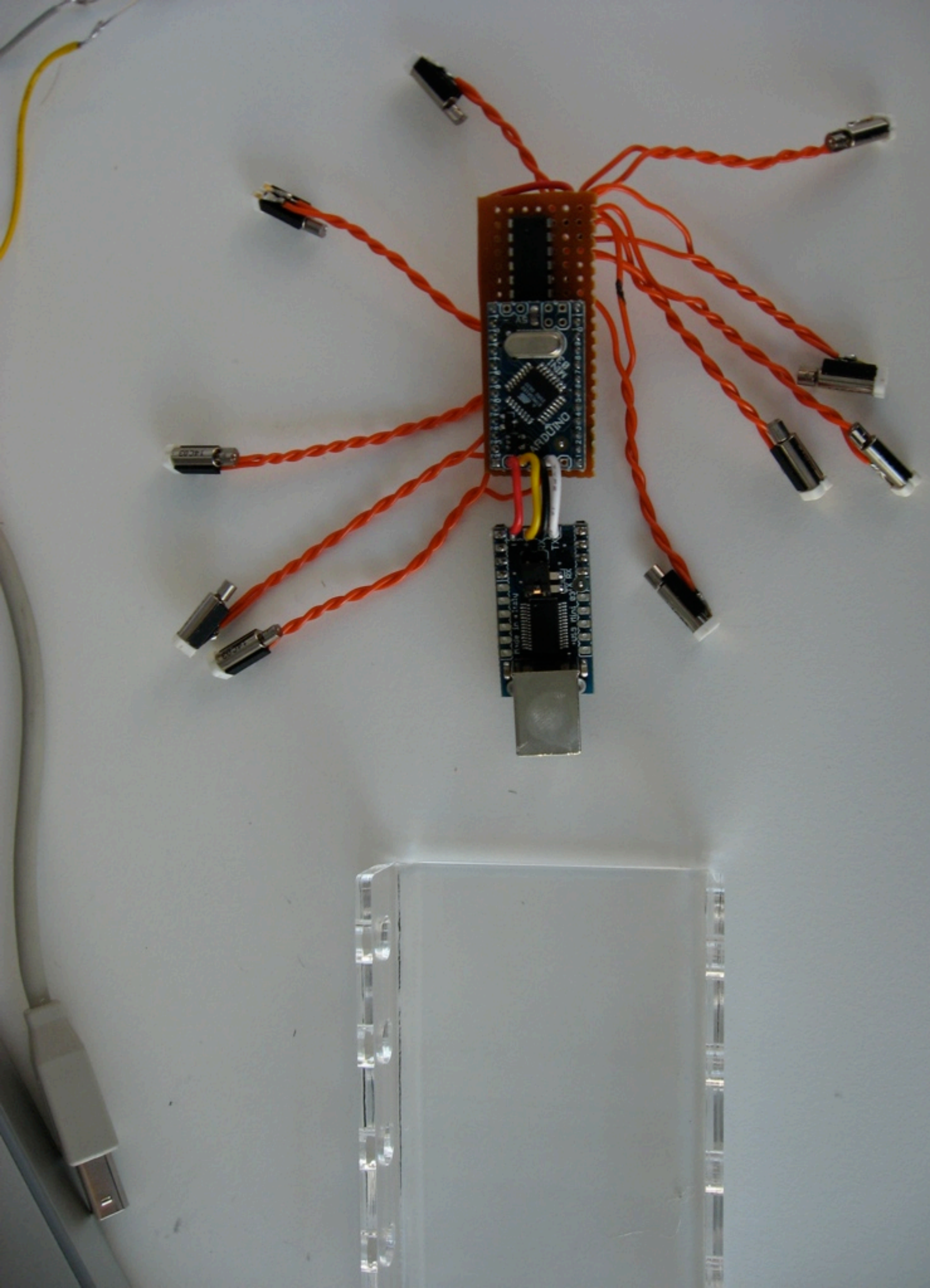
Machine autonomy

Optimized but fixed configurations

A mix of hardware, software and humanware

Dedicated haptic modules and equipment

Almost the *real* thing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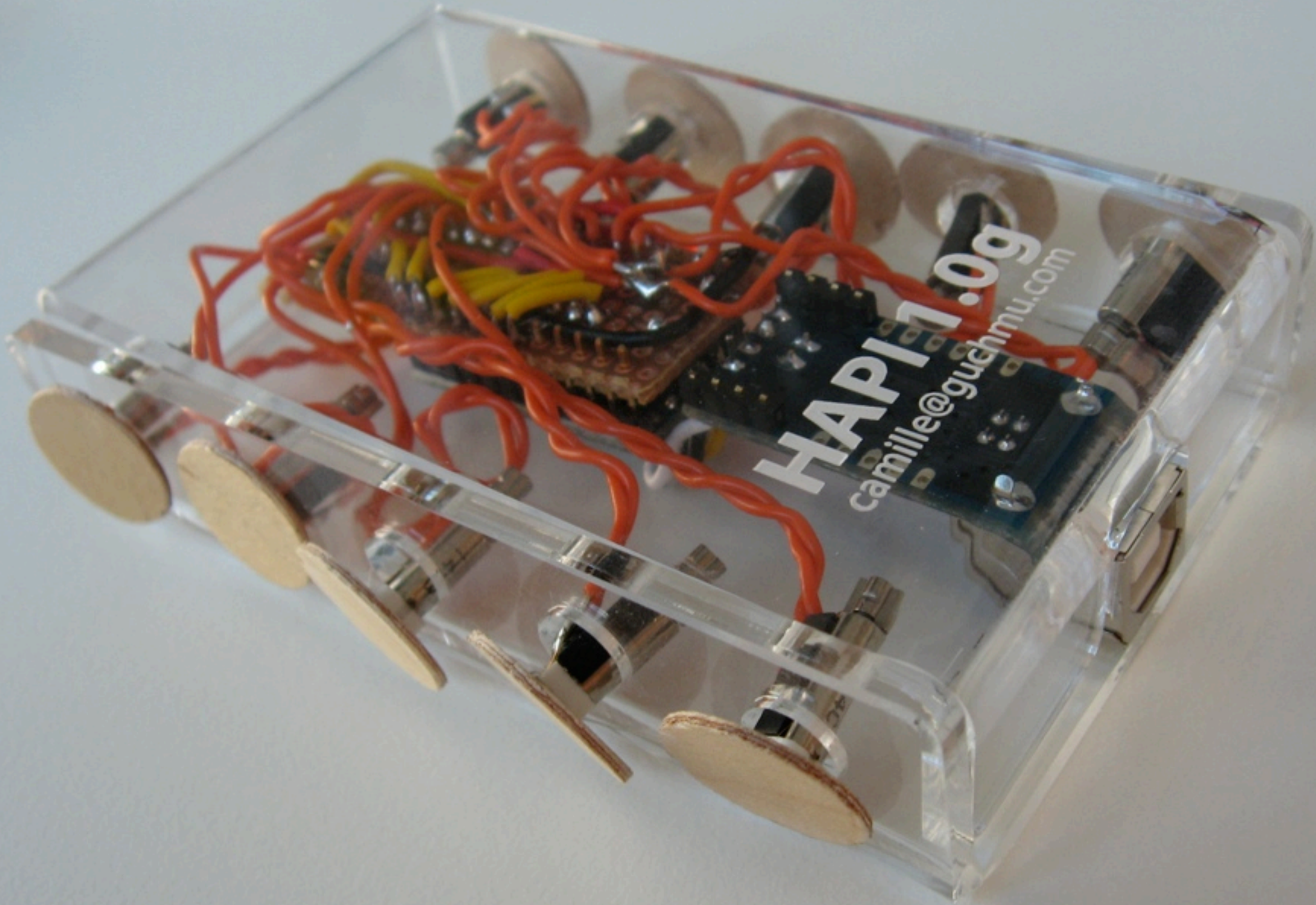
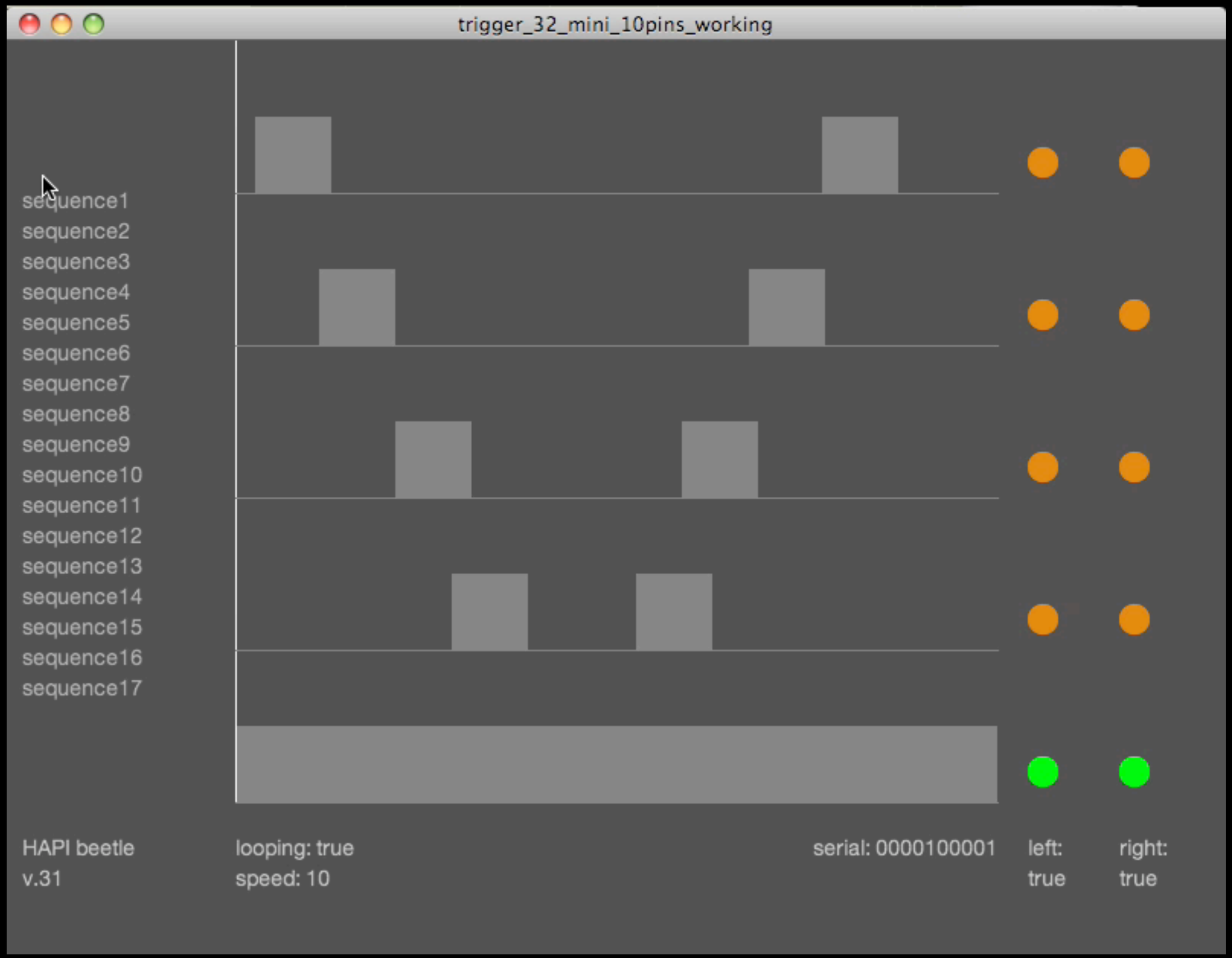

HAPI1.0g
camille@guichmu.com


ARDUINO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sequence2
sequence3
sequence4
sequence5
sequence6
sequence7
sequence8
sequence9
sequence10
sequence11
sequence12
sequence13
sequence14
sequence15
sequence16
sequence17
HAPI beetle
v.31
looping: true
speed: 10
serial: 0000100001
left:
true
right:
true

Challenges and difficulties

Describing/designing haptic stimuli: vocabulary, representations, lexicon

Problems verbalizing and communicating sensations

Synthesizing movement and haptic feedback is not trivial

Often technical problems/issues completely kill the interaction

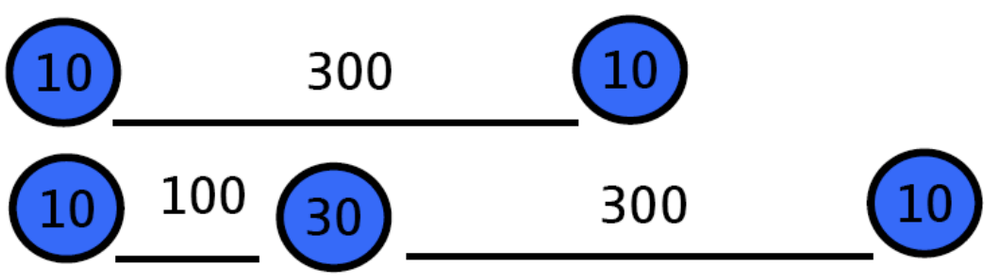
Formal evaluation and comparison is impossible

Have to build stuff to inform/grasp/evaluate/discuss

How do you describe and design haptic I/O?

Lexicon?

Notation system for I/O? Music, sequencer, etc.



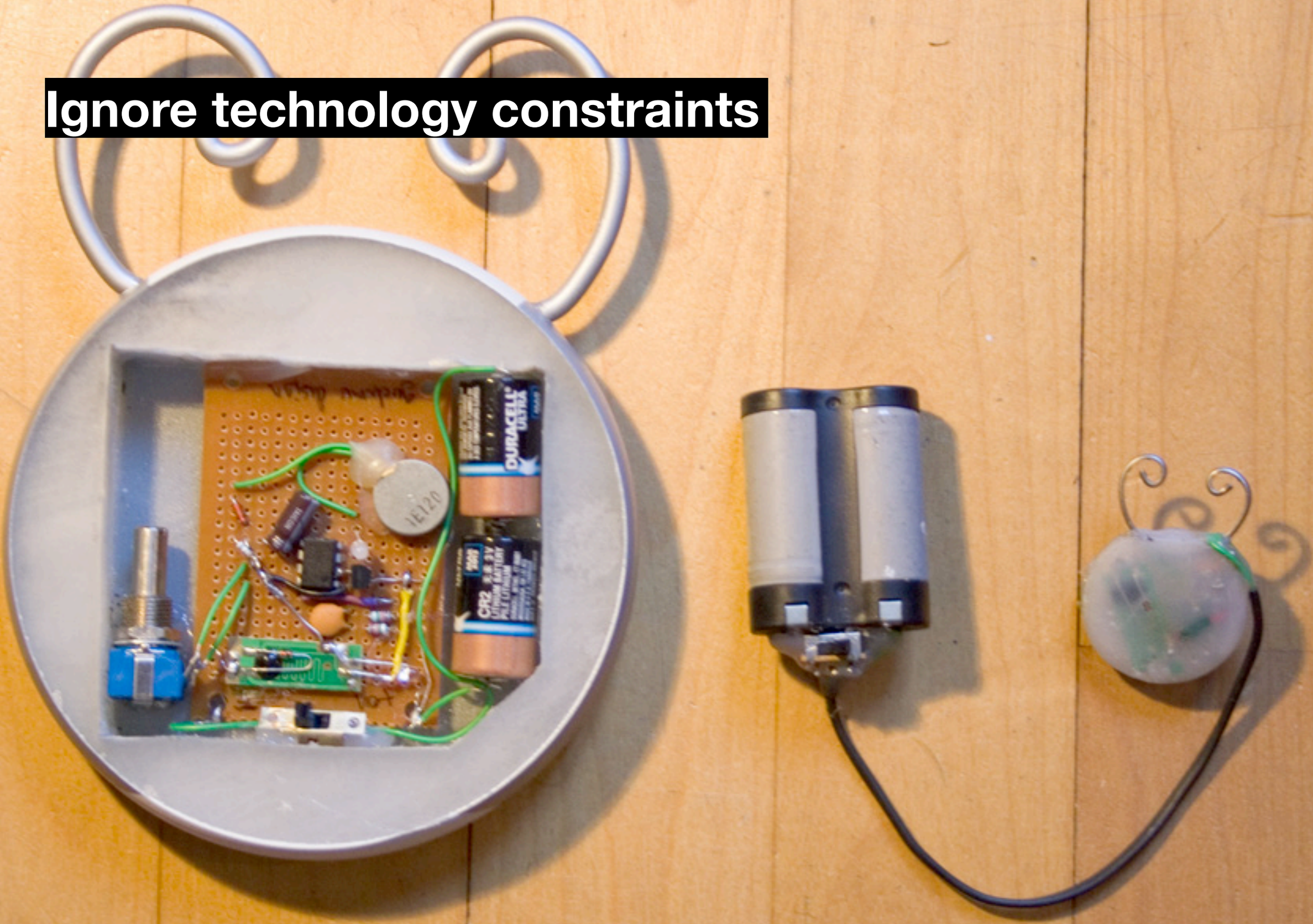
Measurement unit for haptic? Audio => dB

Hardware based or perception based?

Does it work across devices, humans, contexts, brands?

Suggestions and guidelines for sketching

Ignore technology constraints



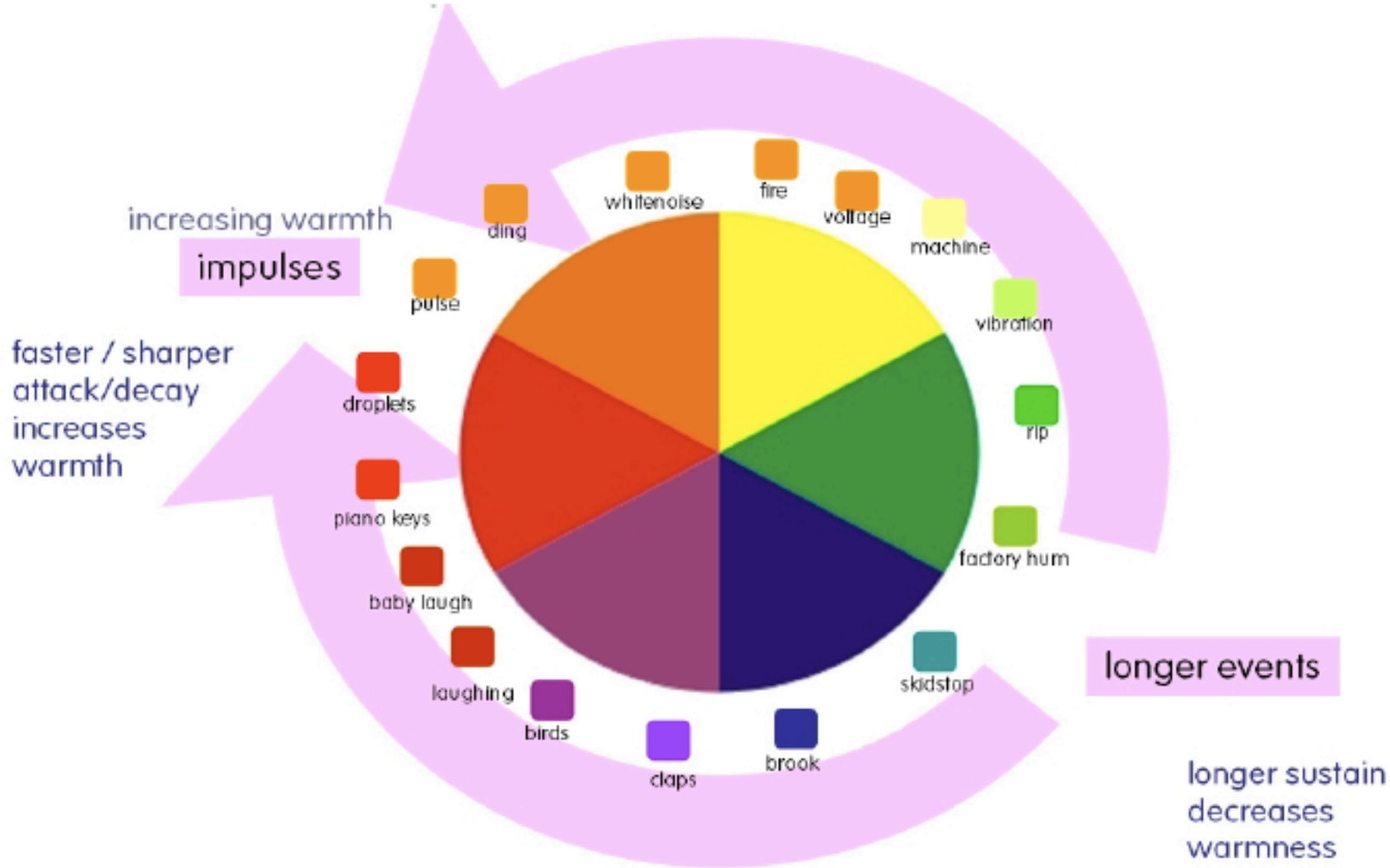
Fake as much as possible

Use the world to control the world

Salvage, use or repurpose common objects

Modular approach for mixing and mashup

Use of metaphor



Chang & O’Sullivan, 2008

Multimodality

Multiplication of possibilities = multiplication of possible problems/issues

Available in **parallel** (user's preference or context)
or **fused** (data fusion/fission by the system, fixed vs. adaptive)

Modalities have their own capabilities and limitations, impossible to transfer freely from one to another

Context influences the modalities used with devices/tasks

Major problem: **awareness of multimodal capabilities**

The OpenInterface Project focuses on the design and development of the platform for rapid development of multimodal interactive systems as a central tool for an iterative user-centered design process.

http://www.openinterface.org

Do It Yourself Haptics, Part I

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This article is the first of a two-part series intended as an introduction to haptic interfaces. Together they provide a general introduction to haptic interfaces, their construction and application design. Haptic interfaces comprise hardware and software components aiming at providing computer-controlled, programmable sensations of mechanical nature, that is, pertaining to the sense of touch. In this article (Part I), we describe methods which have been researched and developed to date to achieve the generation of haptic sensations, the means to construct experimental devices of modest complexity, and the software components needed to drive them. In Part II of this this series, we will describe some basic concepts of haptic interaction design together with several interesting applications based on this technology.

1 Introduction

Our purpose is to offer the newcomer to haptic interface design a roadmap to help navigate through physical principles, hardware limitations, stability issues and human perceptual demands that stand between her or him and the ideal of touching and feeling a virtual environment through an electromechanical device. Primary themes are awareness of how much performance is needed, guided by both physical and perceptual principles, as well as control ideas; and how different system elements may be played off one

2 Device Overview

Many methods have been proposed to create haptic sensations artificially. Until now, roughly four dominate. They can be used separately, or together in a single system. These methods comprise vibrotactile devices, force feedback systems, surface displays, and distributed tactile displays. Of these four, we discuss vibrotactile devices and force feedback systems to the greatest extent because they are the most researched and the most broadly applied. Implementation examples of these types of interfaces are given. We mention tactile displays only briefly.

2.1 Vibrotactile Devices

Many of us are familiar with the buzzing that we experience when we receive a call on a mobile phone when the vibration function is on. Generating these "vibrotactile" sensations is by far the easiest and currently the most widespread means of providing haptic feedback. It can be used for many purposes such as providing silent and invisible alerts (pagers), warnings, messages coded temporally and spatially [1], or sonotopically [2]; with some of the earliest applications being found in sensory substitution (1927) [3] and avionic controls (1965) [4]. Today, the dominant application of vibrotactile devices is the haptic enhancement of games in

HCI Beyond the GUI

Design for Haptic, Speech, Olfactory, and Other Nontraditional Interfaces

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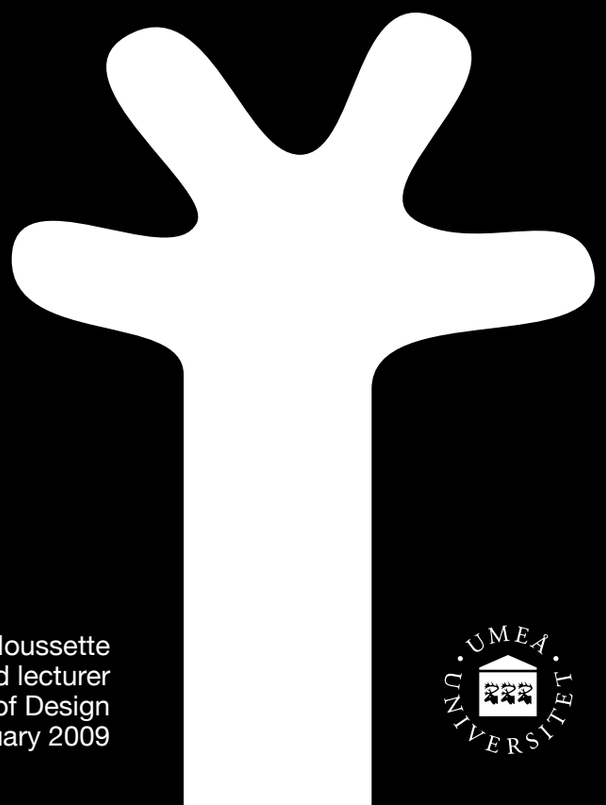

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