Interaction Design for a Purpose

Manaswi Saha
Liang He
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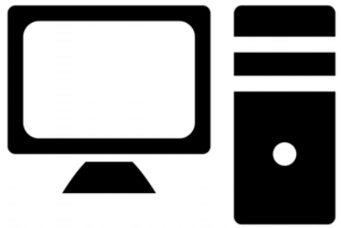
Majeed Kazemitabaar

Nov 3rd 2016

HCIL UNIVERSITY OF MARYLAND

Powered by TECHNICA

Technica: Tech + Design



power of computation

interaction design

"design of **interactive technologies** that **enhance** human capabilities and **bring joy**, rather than frustration"

Technica: Tech + Design

We will describe the **iterative design process** and how interaction design can be used to **impact socially relevant areas** like accessibility, STEM and the Maker community

Technica: Tech + Design

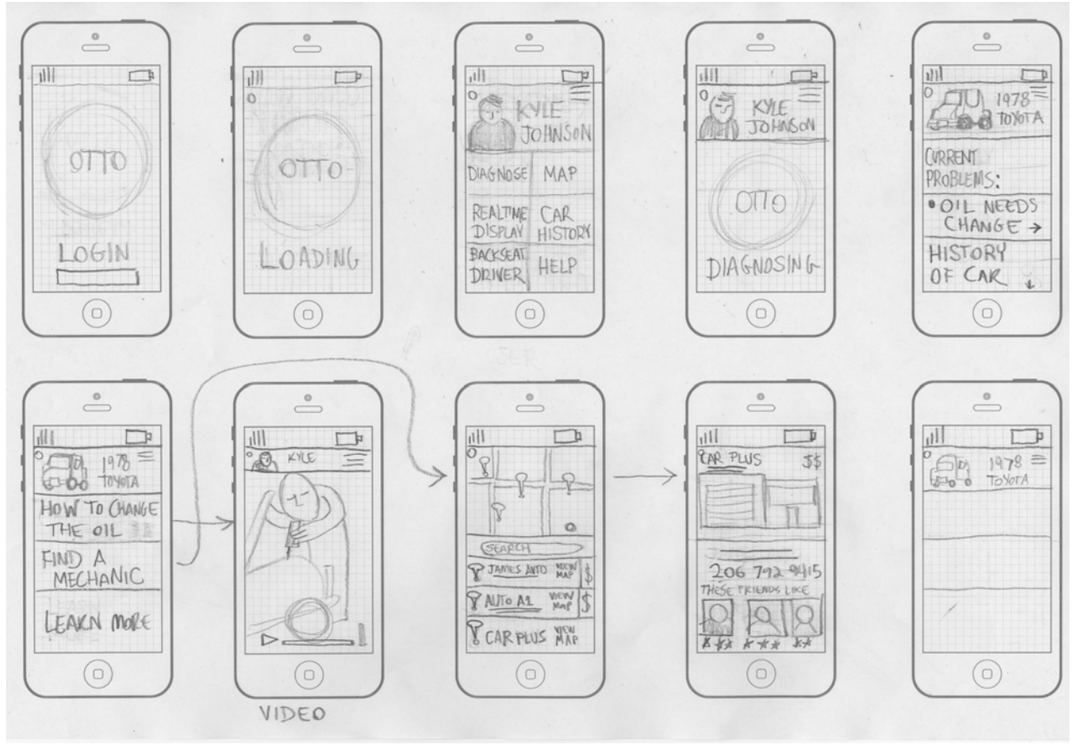
Prototyping Activity

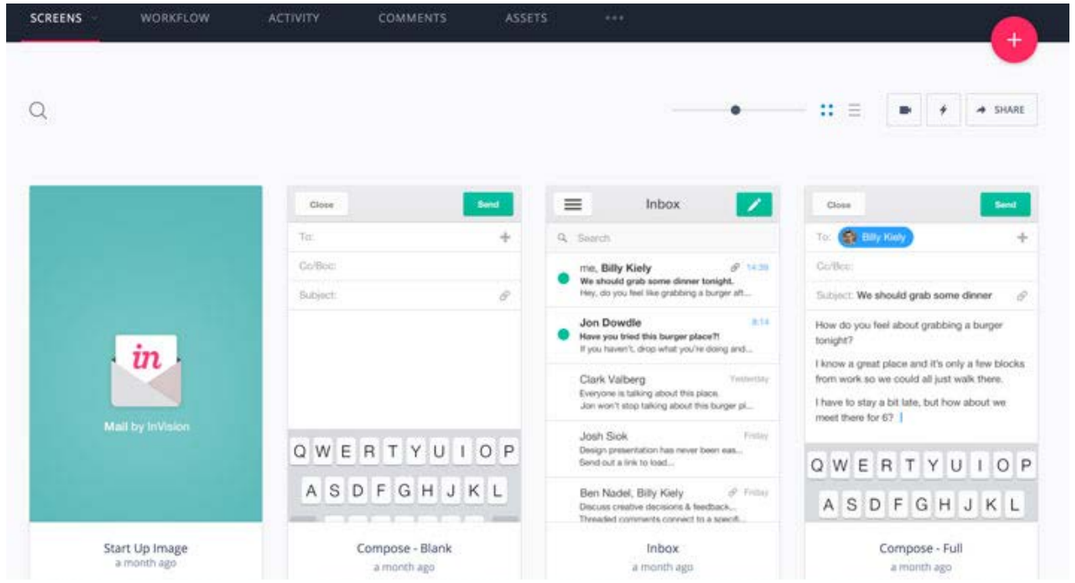
Brainstorming ideas

Quick Sketching Activity

Getting feedback

Making sketches interactive (using InVision)





MakerWear

EARLY EXPLORATIONS OF WEARABLE CONSTRUCTION KITS FOR CHILDREN

MAJEED KAZEMITABAAR
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ALEX JIAO
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TECHNICA: TECH+DESIGN
NOV 3, 2016

HCIL Human Computer Interaction Laboratory
makeability lab
COMPUTER SCIENCE UNIVERSITY OF MARYLAND
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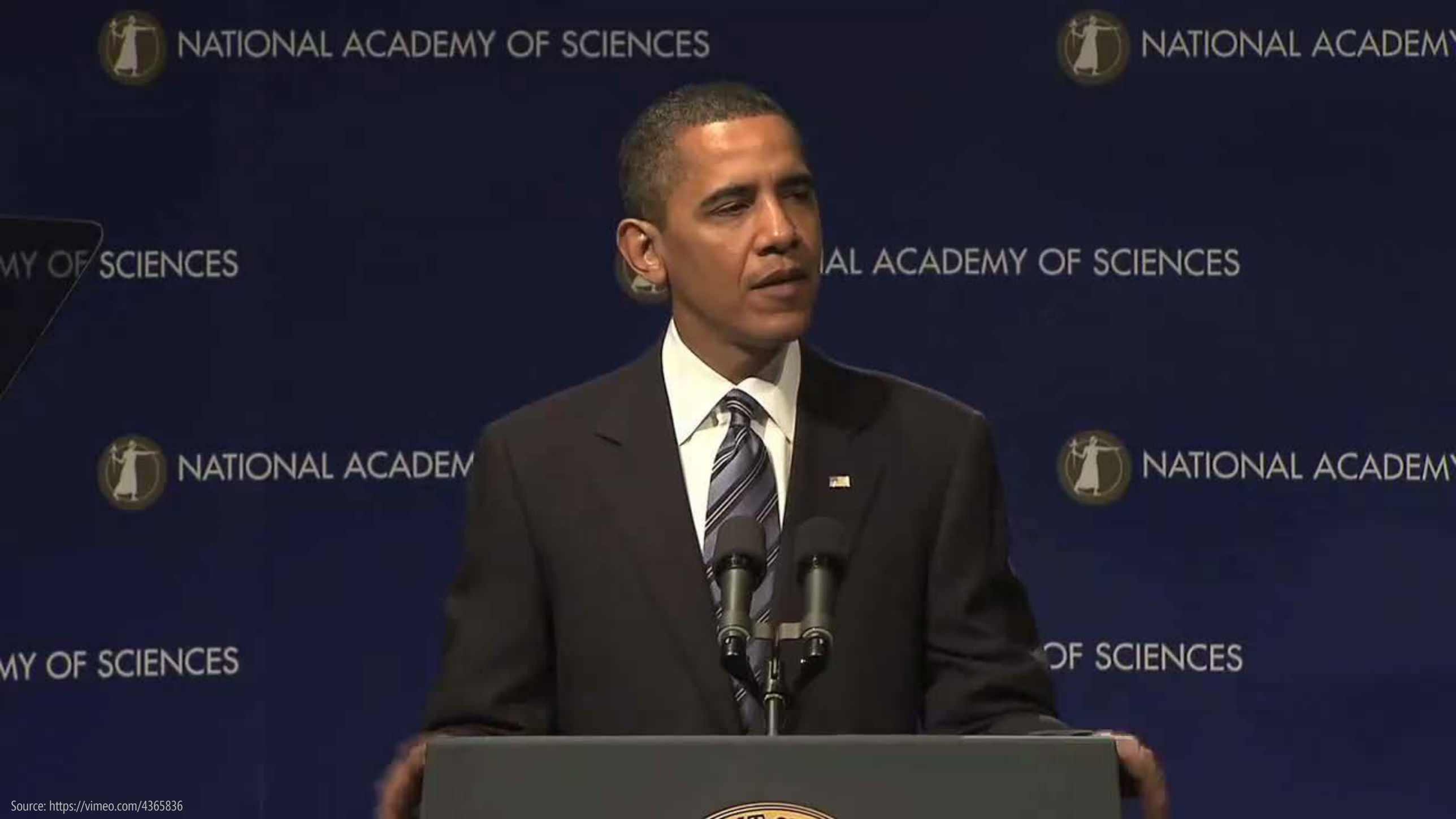


Source: https://vimeo.com/4365836

"...to be **makers of things**, not just consumers of things."

President Barack Obama

Remarks to the National Academy of Sciences, 2009

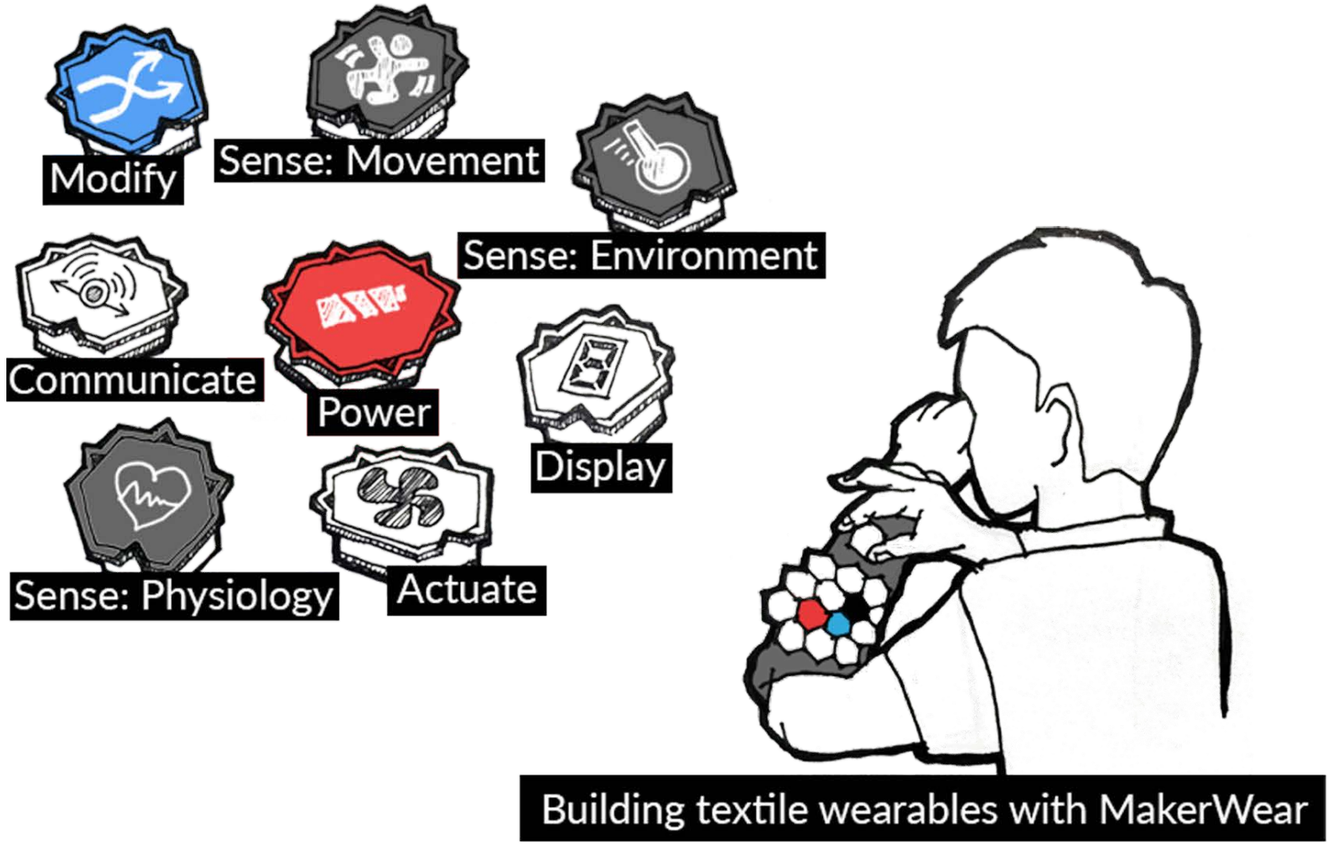
Source: https://www.whitehouse.gov/the-press-office/remarks-president-national-academy-sciences-annual-meeting

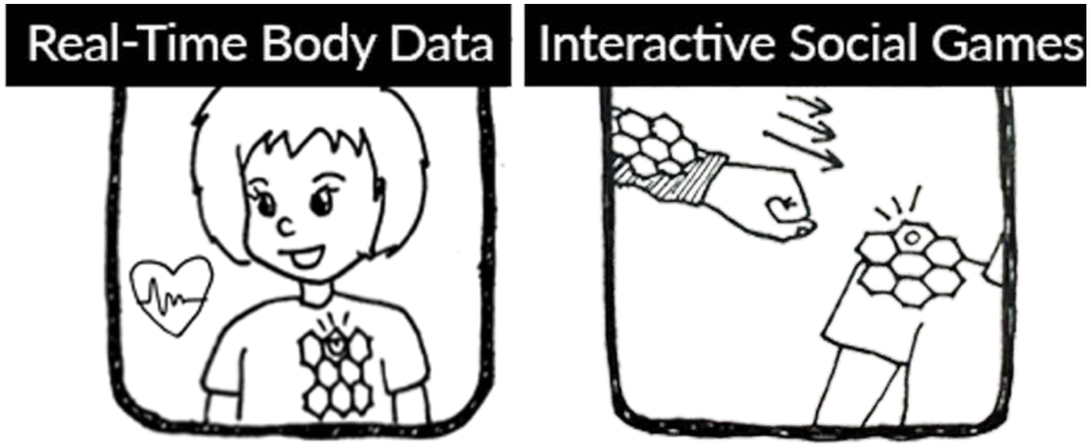
Research Vision

MakerWear

A new construction kit aimed at **enabling children** to **design** and build their own **interactive wearables**.

With only a **few components**, children can build a **wide range of designs**...





Research Vision

MakerWear

A new construction kit aimed at **enabling children** to **design** and build their own **interactive wearables**.

With only a **few components**, children can build a **wide range of designs**...

MakerWear Examples

Design Inspirations

Design Inspiration

Light-Up Shoes

Children love light-up shoes

Interactive

Responsive

Expressive

Fun

Not modifiable

Not extensible

Not programmable

Design Inspiration

Fashion Customization

Children enjoy customizing their clothing, & collecting and sharing designs

Not interactive

Not programmable

Design Inspiration

LilyPad Arduino

Incredibly successful e-textile microcontroller platform.

Open-ended

Programmable

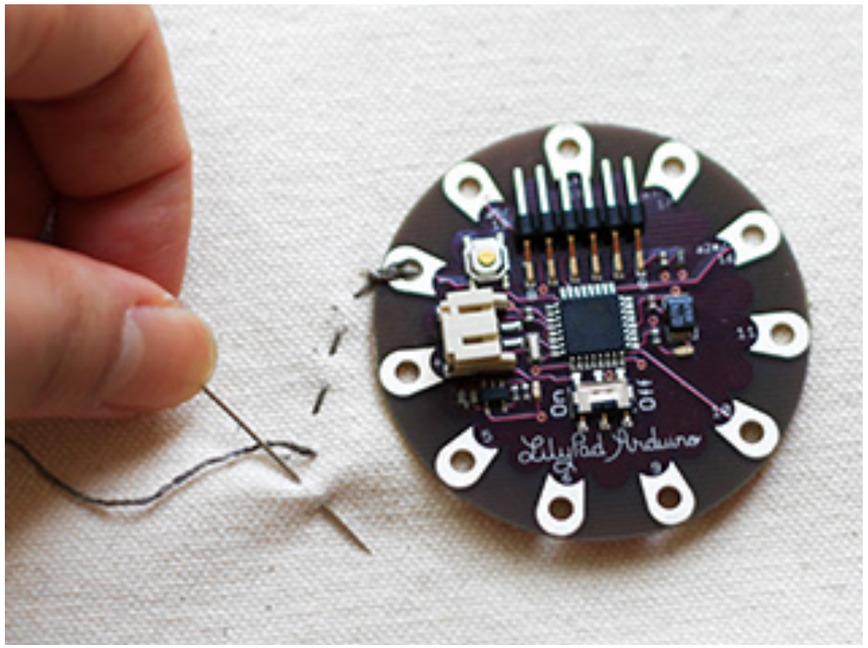
Wearable

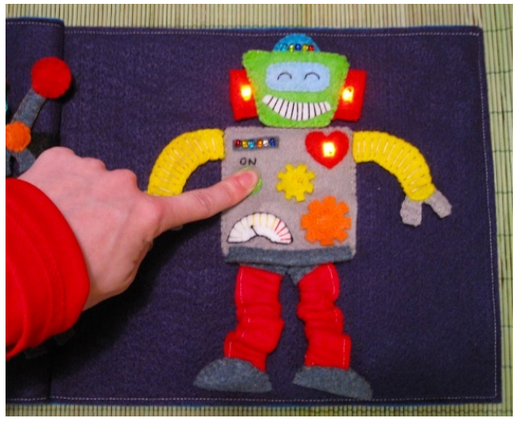
Not designed for children

Requires sewing

Requires programming

Requires basic electronics





Source: Buechley *et al., CHI'08, DIS'10*

Design Inspiration

Digital-Physical Construction Kits

Robotics (*e.g.*, Cubelets)

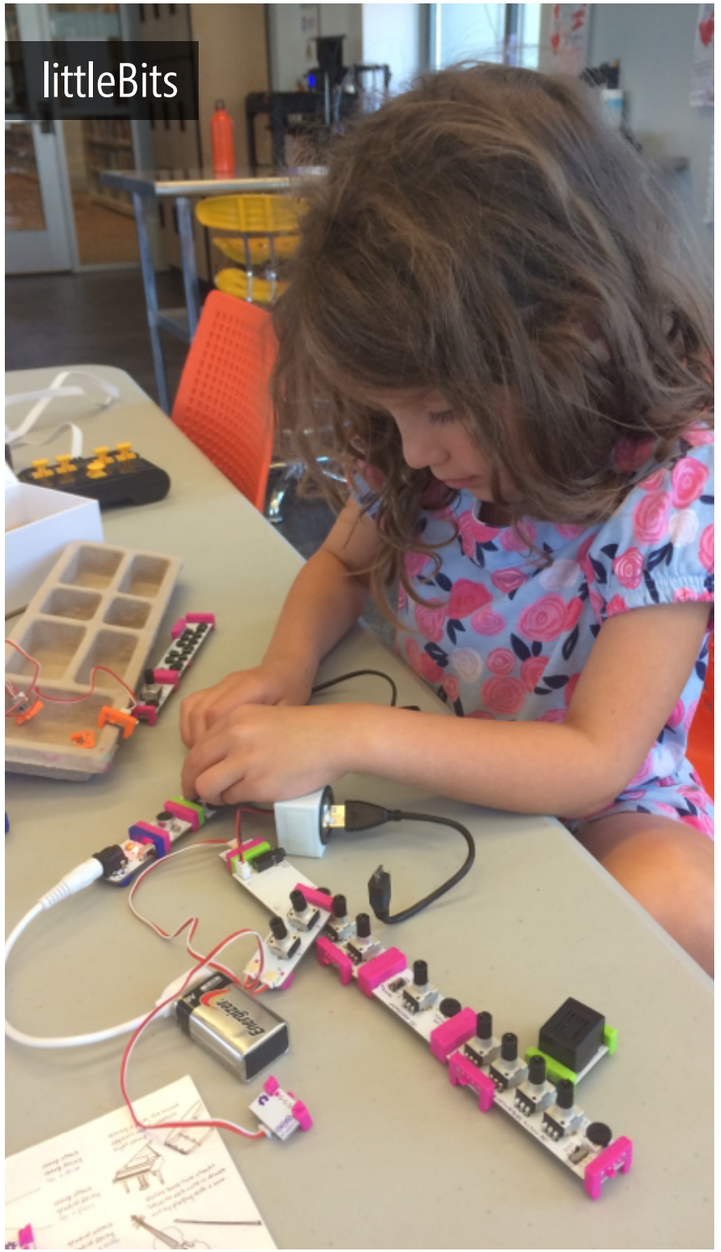
Electronics (*e.g.*, littleBits, SAM)

Circuits (*e.g.*, LightUp)

Often programmable

Modular

Snappable (typically magnetic)



Design Inspiration

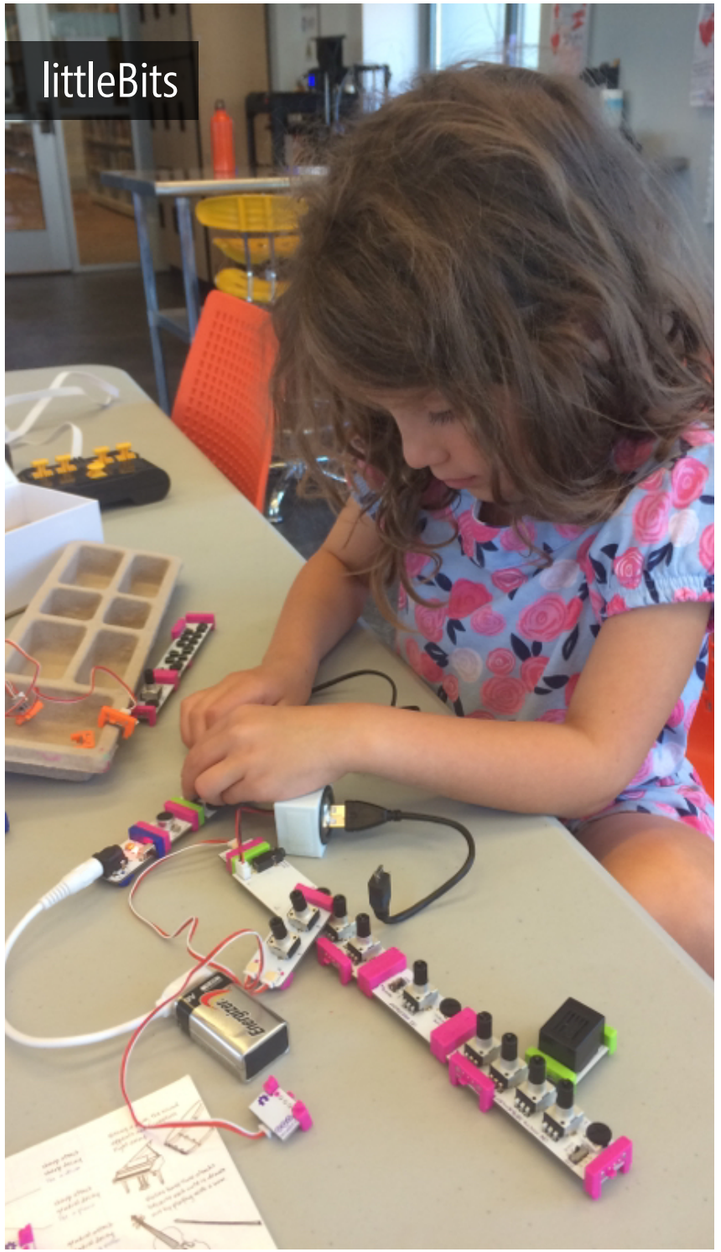
Digital-Physical Construction Kits

Designed & used in static spaces

Not wearable

Not intrinsically shareable

Children not designing for the self, their changing contexts



Clothing is a Unique Design Context

Constructions are wearable &, thus, inherently social, mobile, & always available

Clothing is a Unique Design Context

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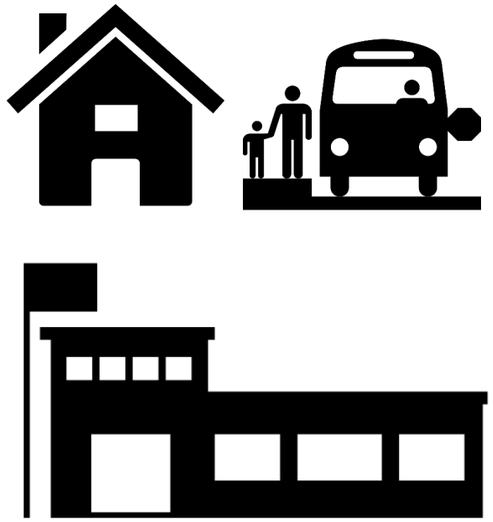
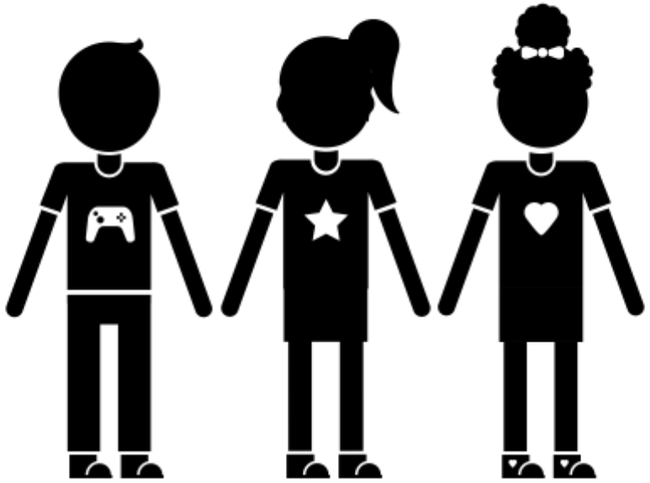


Changing environments



Social Interactions

Daily Life

MakerWear Design Process

What do children want to make? and how do they want to make them?

Design Process

Cooperative Inquiry

A **participatory design** method for collaboration between **adults** and **children** to brainstorm, design, develop, and test technology for children.

What do children want to make? and how do they want to make them?

1st Co-design session

A ‘blue sky’ open-ended method to elicit unbounded ideas for interactive wearables.

Shoes
adhesive cardboard
large post-it pads
markers

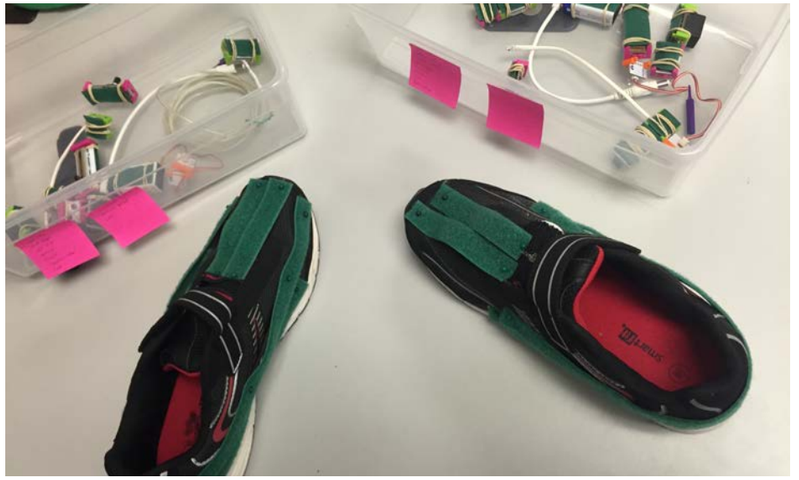
What do children want to make? and how do they want to make them?

2nd Co-design session

Rapid prototyping session with:

littleBits
Velcro
Shoes
Sticky Notes

5 children + 5 adults

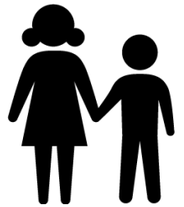


Morse Code Shoes

2nd Co-Design Session: Rapid Prototyping

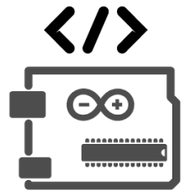
Initial Design Goals

Responsiveness



Easy & Accessible

Self-Expression



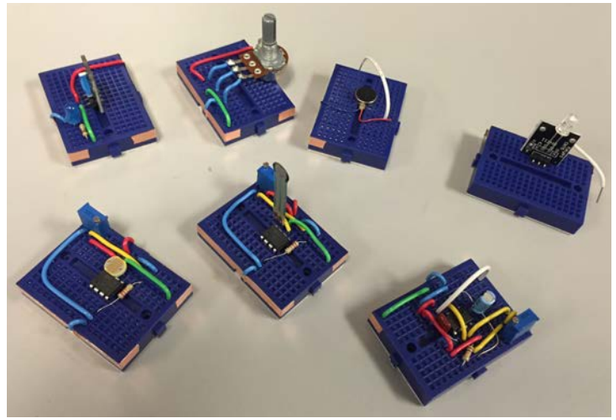
Programmable

Fun & Playfulness

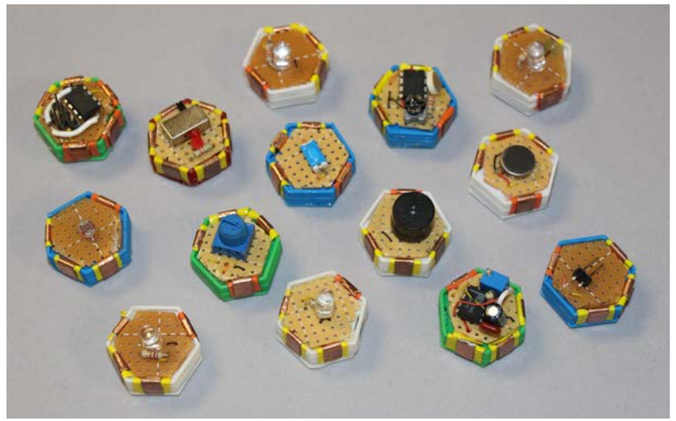
System Design

Iterative Design

Cardboard prototypes



Breadboard Prototypes



1st Prototype

System Design

Co-Design Sessions

Evaluating the 1st working prototype:

Module Icons & Names

Understandability of modules

Likes/Dislikes/Design Ideas

How children make things

System Design

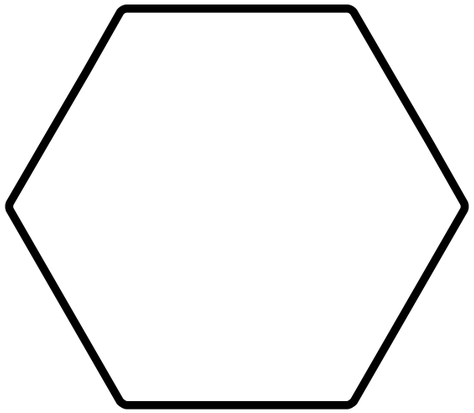
Design Probe

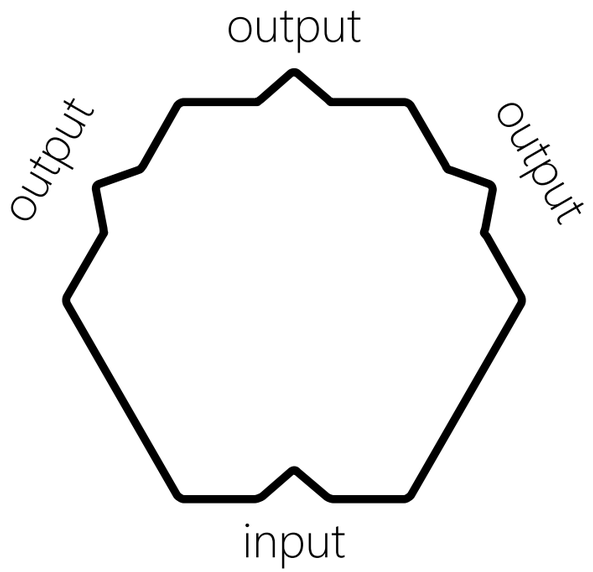
Get feedback from professional STEM educators:

Feedback on the system

How to organize workshops with children

MakerWear Design

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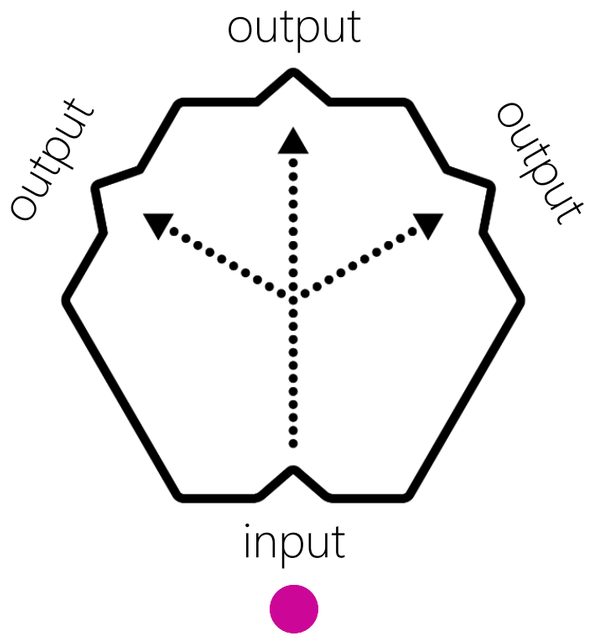
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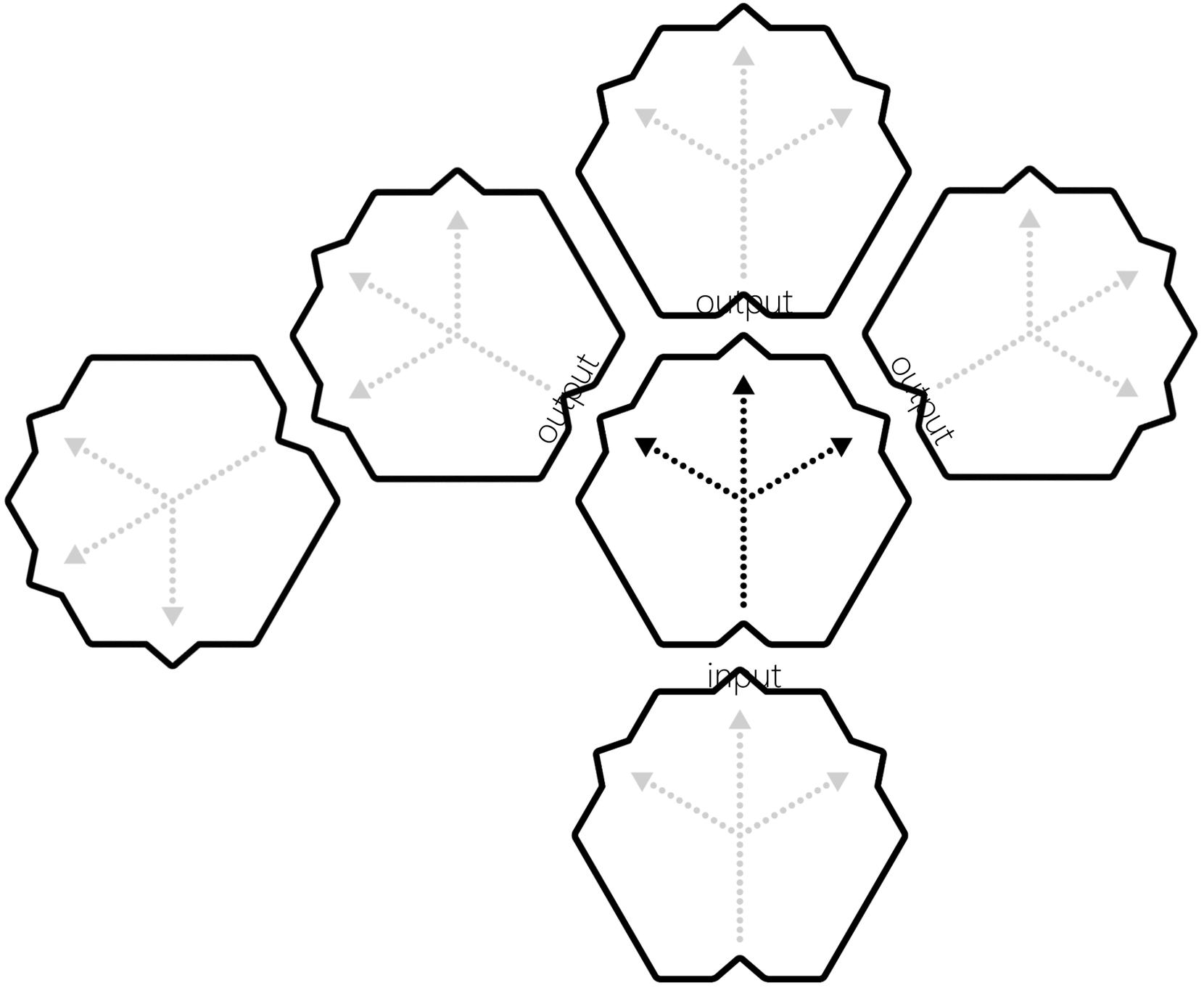
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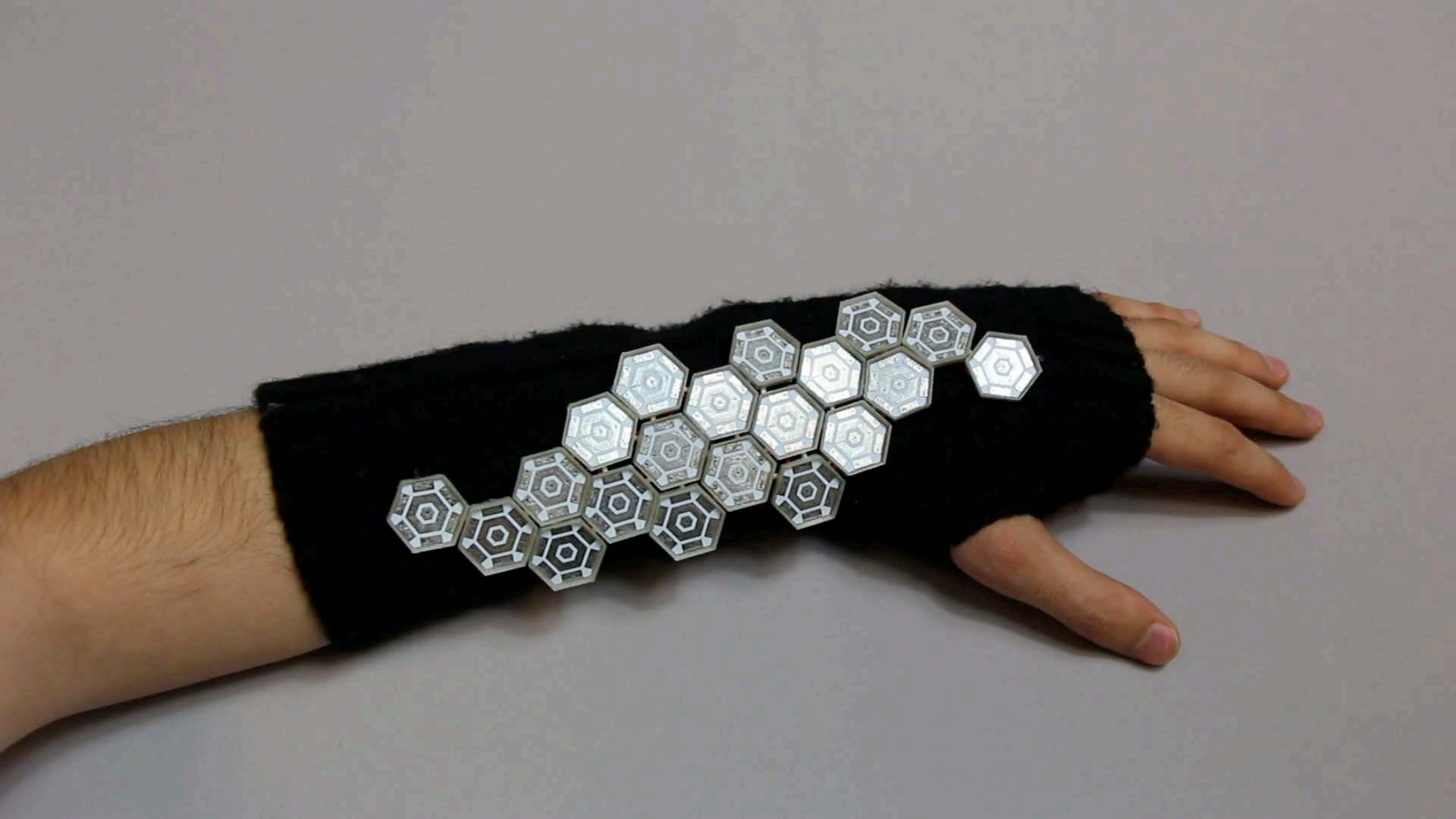
Final Prototype

Sensors **Actions** **Modifiers** **Power & Misc**

Demo!

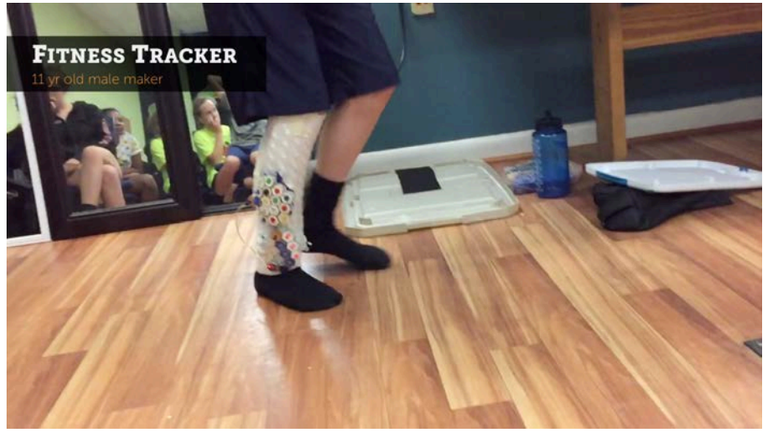


MakerWear Creations

Workshop Final Projects

MakerWear Creations

Final Projects



Wrecking Ball

6 yr old male maker

Wrecking Ball

6 yr old male maker

Smart Lacrosse Stick

9 yr old female maker

Smart Lacrosse Stick

9 yr old female maker

Pokémon Doppelgänger

9 yr old male maker

Pokémon Doppelgänger

9 yr old male maker

Fitness Tracker

11 yr old male maker

Fitness Tracker

11 yr old male maker

Jogging Clothes

10 yr old female maker

Jogging Clothes

10 yr old female maker

Light-Up Shoes

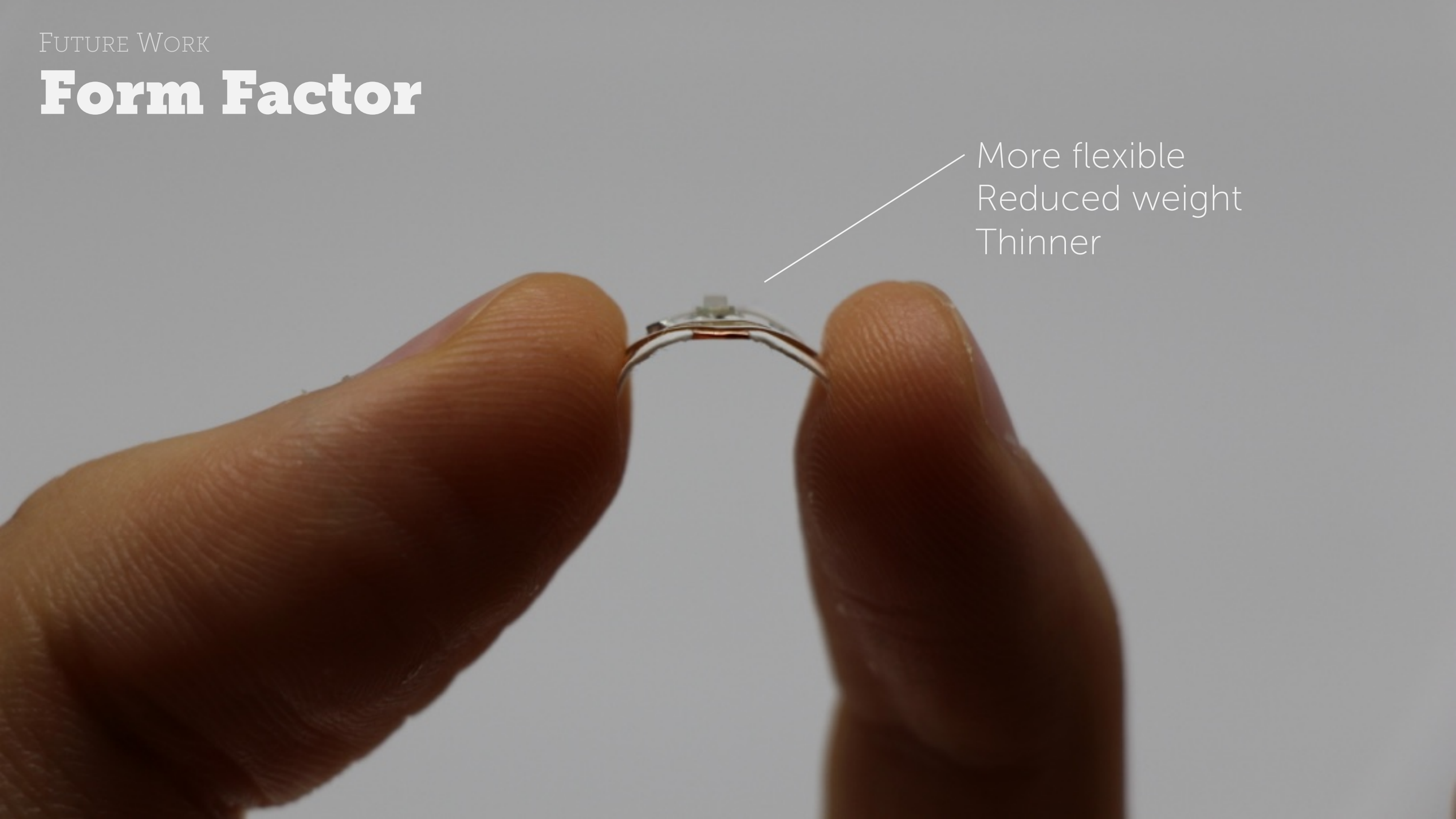
7 yr old male maker

Light-Up Shoes

7 yr old male maker

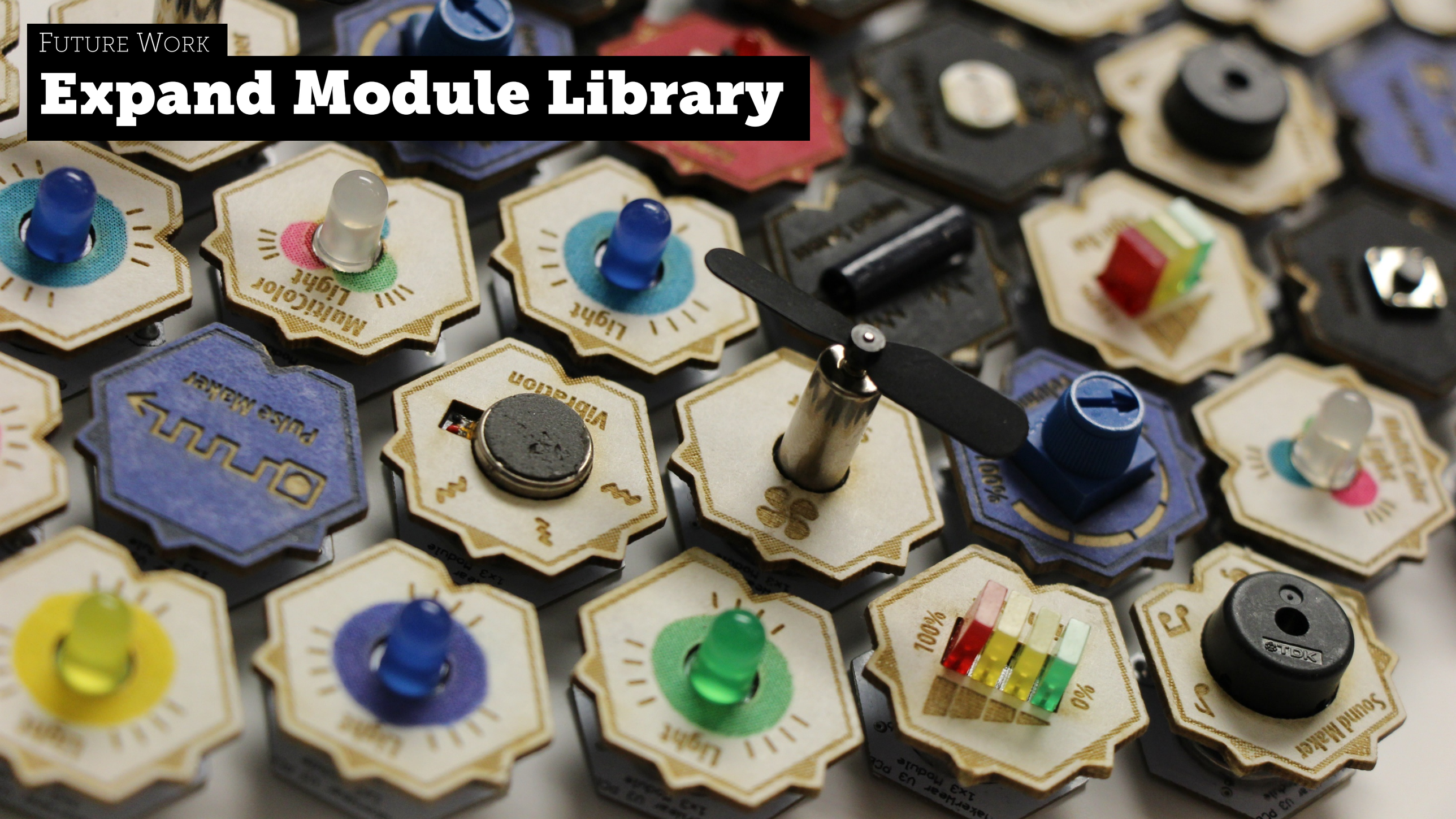
Future Work

Form Factor



Future Work

Expand Module Library



Future Work

Expand Module Library

Greater emphasis on unique aspects of wearability: social, environmental, movement

Wireless Programming Interface

Modules will be wirelessly programmable via a custom tablet programming interface

Tickle
https://tickleapp.com/

SAM Labs
https://samlabs.com

In Summary

MakerWear

A new construction kit aimed at **enabling children** to **design** and build their own **interactive wearables**.

A compelling pathway to engage children in **STEAM-related** activities

A new way for children to **think about** and **develop electronics/code**

MakerWear

EARLY EXPLORATIONS OF WEARABLE CONSTRUCTION KITS FOR CHILDREN

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TECHNICA: TECH+DESIGN
NOV 3, 2016

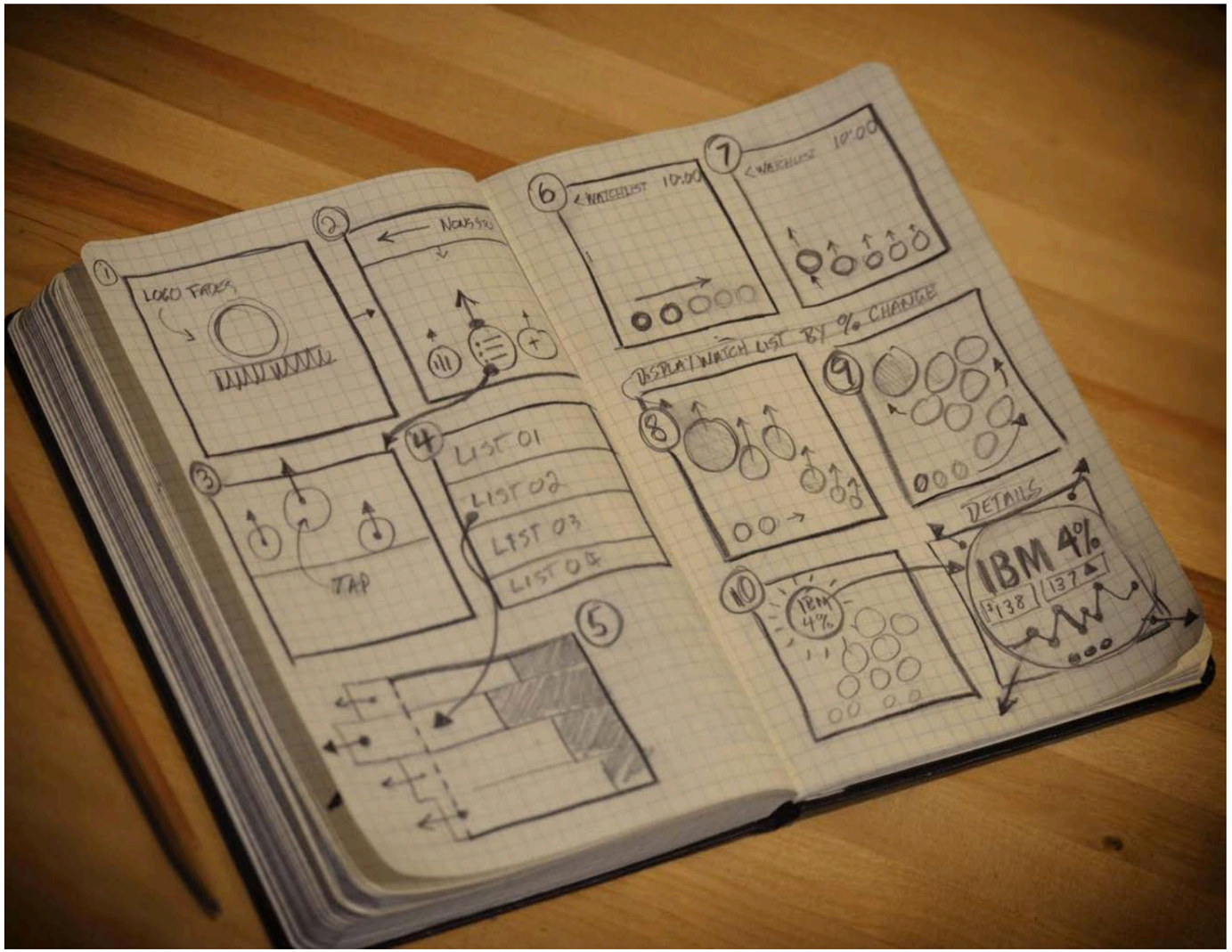
HCIL Human Computer Interaction Laboratory
makeability lab
COMPUTER SCIENCE UNIVERSITY OF MARYLAND
UNIVERSITY OF MARYLAND

Prototyping Activity!

Prototyping Activity

Get the materials

We will give you a couple of papers, and pens!



Sketching Activity

Brainstorming Ideas

Designing with a social value

Sustainability

Accessibility

Education/STEM

Health

Communication

Start with high level ideas, and then dive into the details.

Sketching Activity

Brainstorming Ideas

Designing with a social value

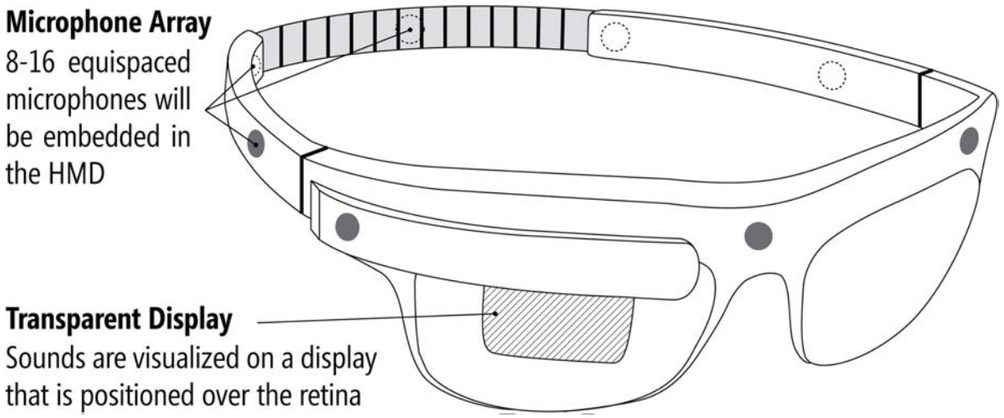
Sustainability

Accessibility

Education/STEM

Health

Communication



Sketching Activity

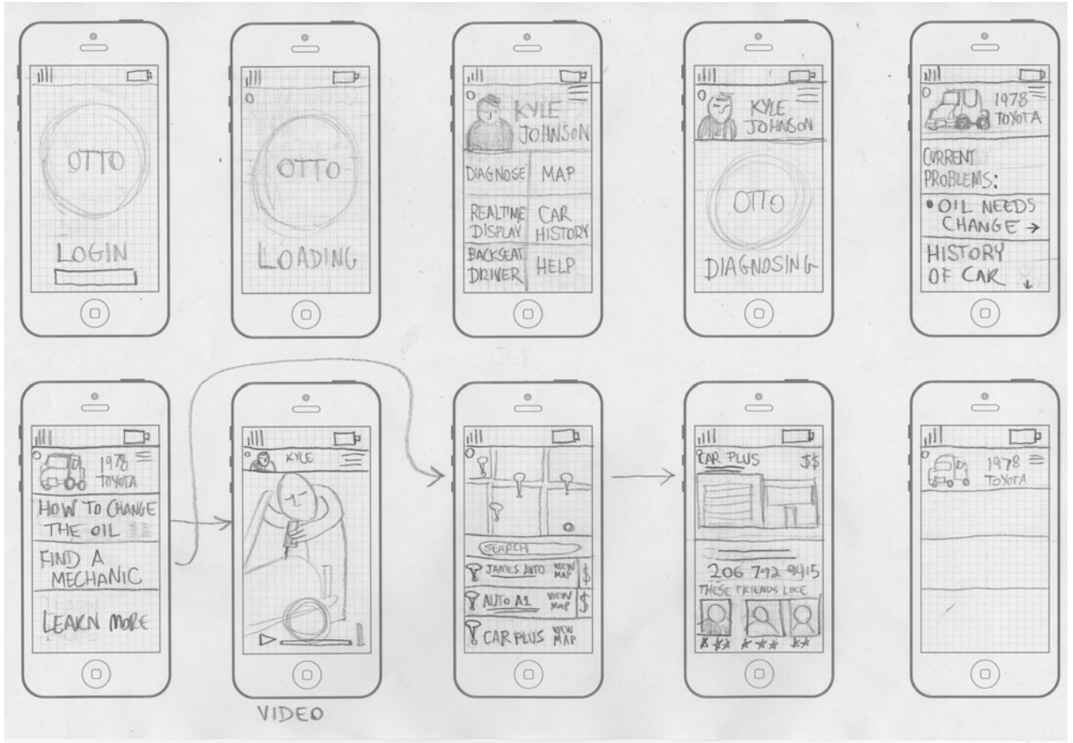
Sketching Prototypes

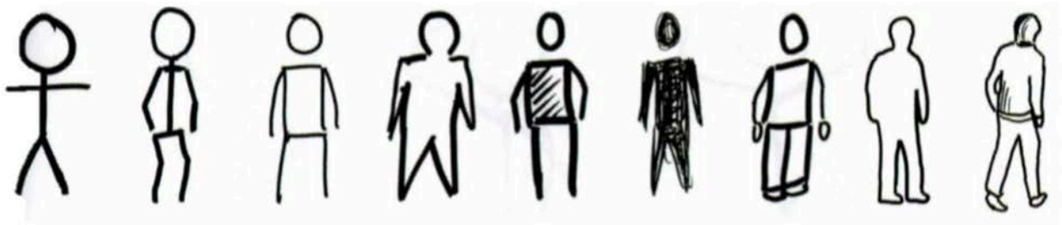
Sketching Principles:

1. **Quantity first, quality later.** Generate as many concepts as possible. Elaborate, then narrow.

2. **Generate, quickly.** Generate 4-6 concept sketches in 6-7 minutes.

3. **Use paper.** It's fast, flexible, easy to annotate, and levels the playing field-anyone can sketch (developers, executives, designers)

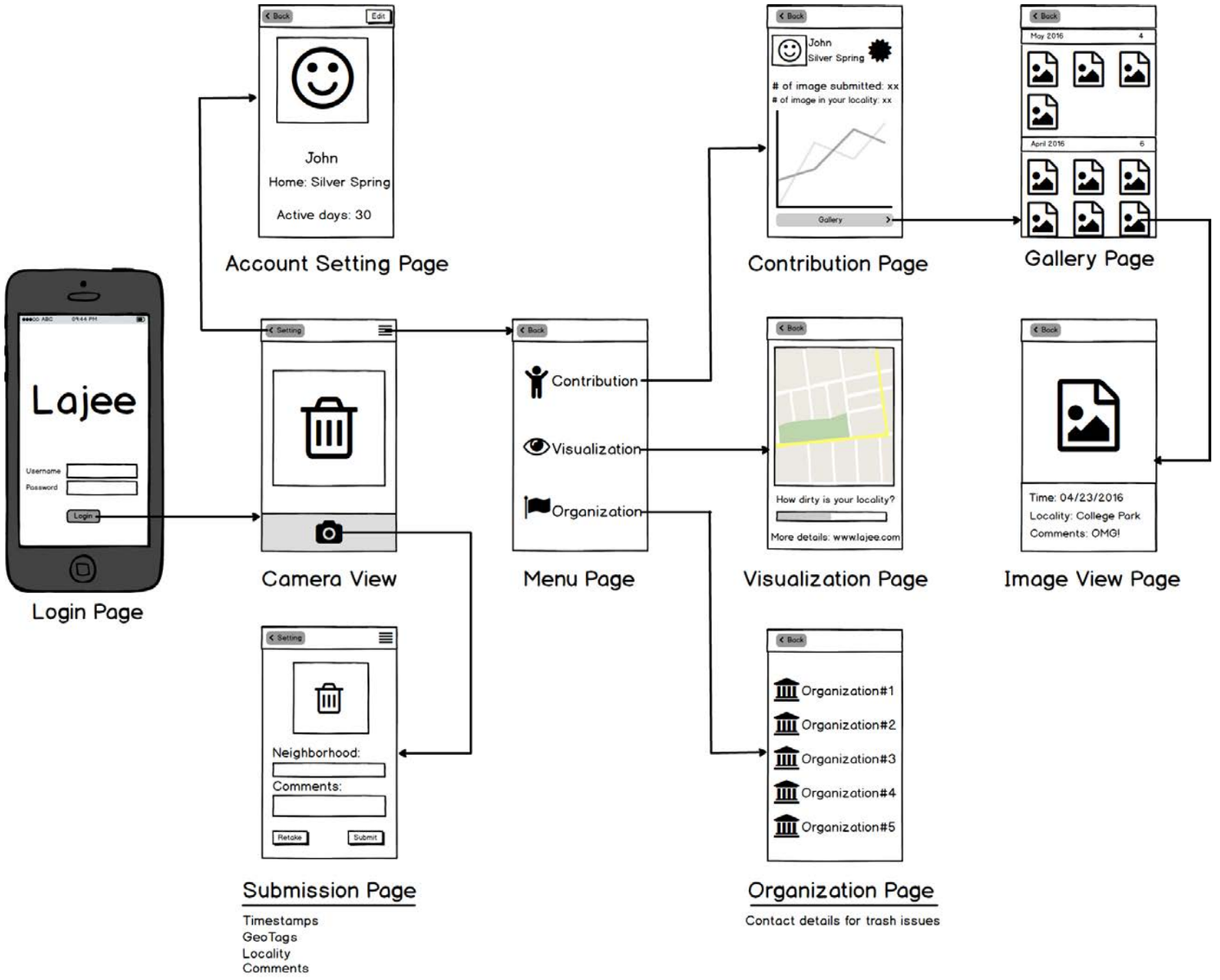




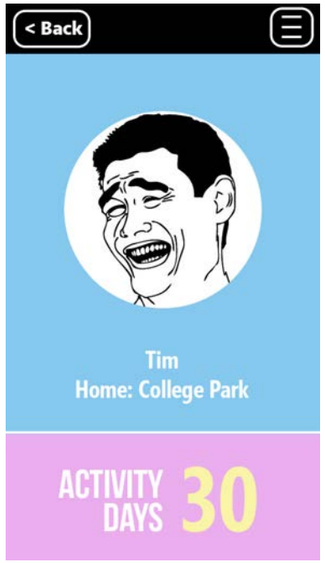
Interactive Prototypes

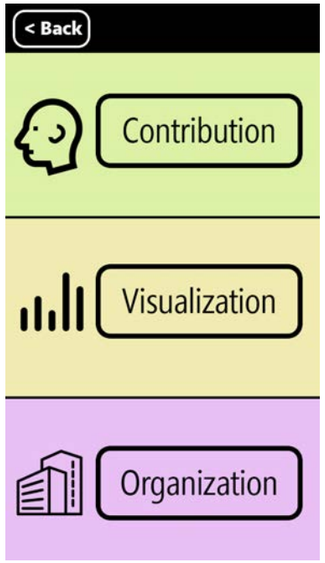
Example of an interactive application using InVision:

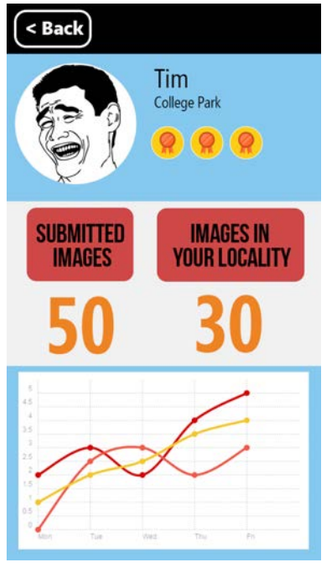
1. Sketching on Balsamiq
2. Refining in Photoshop
3. Adding interactivity in InVision



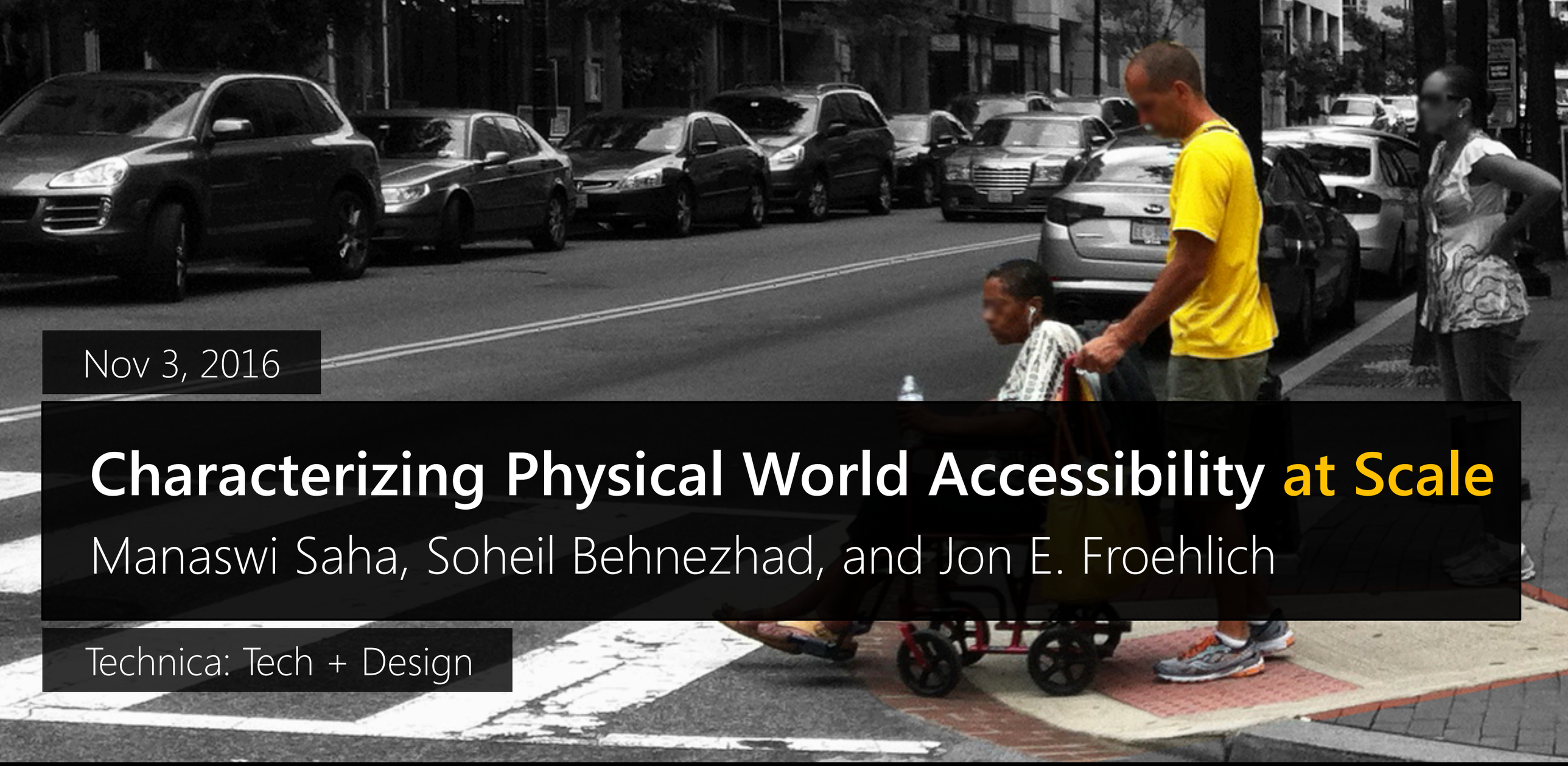
Interactive Prototypes







InVision Demo
https://invis.io/AM97AK246



Nov 3, 2016

Characterizing Physical World Accessibility at Scale

Manaswi Saha, Soheil Behnezhad, and Jon E. Froehlich

Technica: Tech + Design

UNIVERSITY OF MARYLAND

COMPUTER SCIENCE
UNIVERSITY OF MARYLAND

HCIL

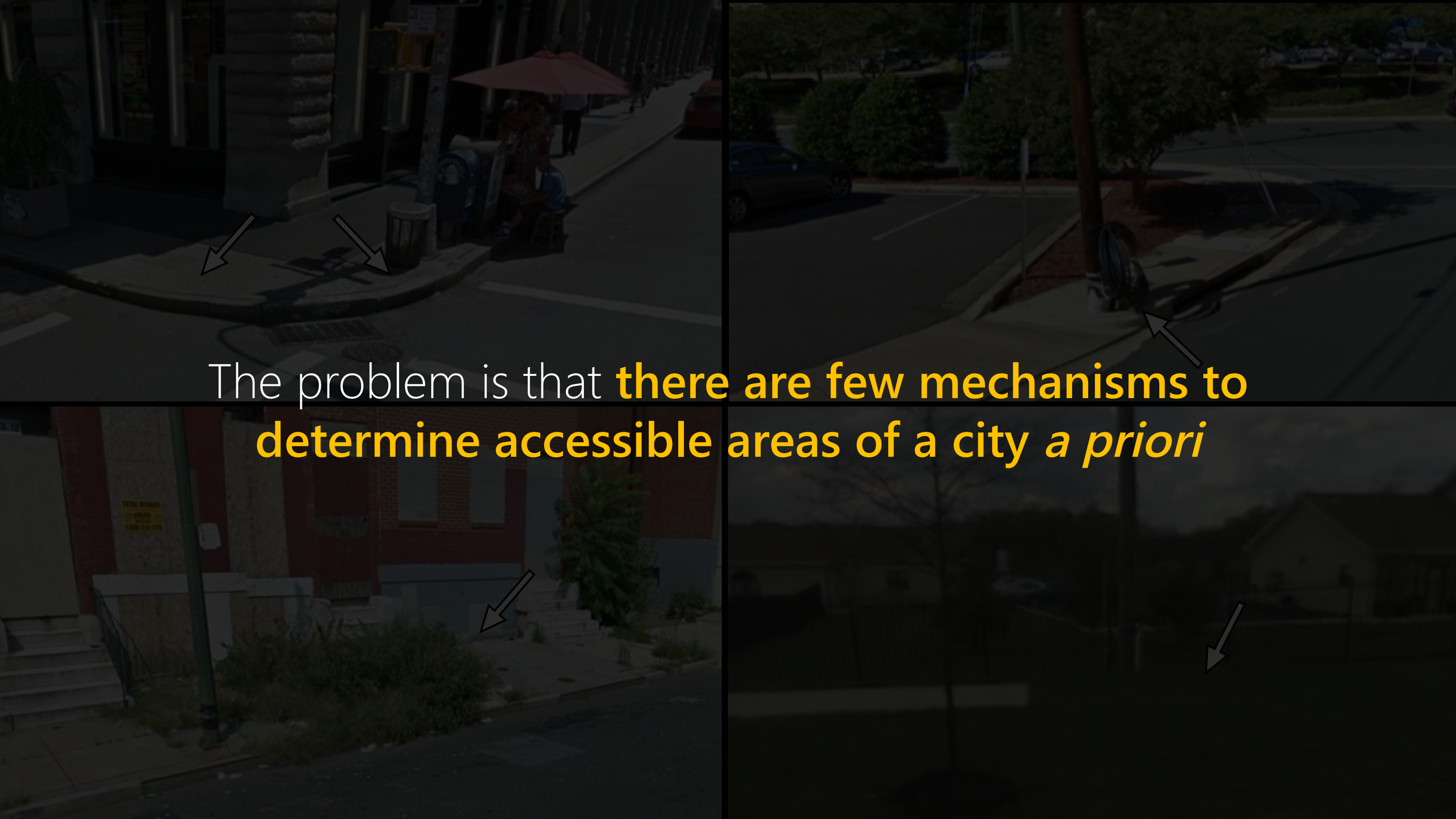
makeability lab


30.6
million U.S. adults with mobility impairment


15.2
million use an assistive aid


Incomplete Sidewalks
Physical Obstacles
Surface Problems
No Curb Ramps
Stairs/Businesses
HESS
DO NOT ENTER

cf. Nuernberger, 2008; Thapar *et al.*, 2004



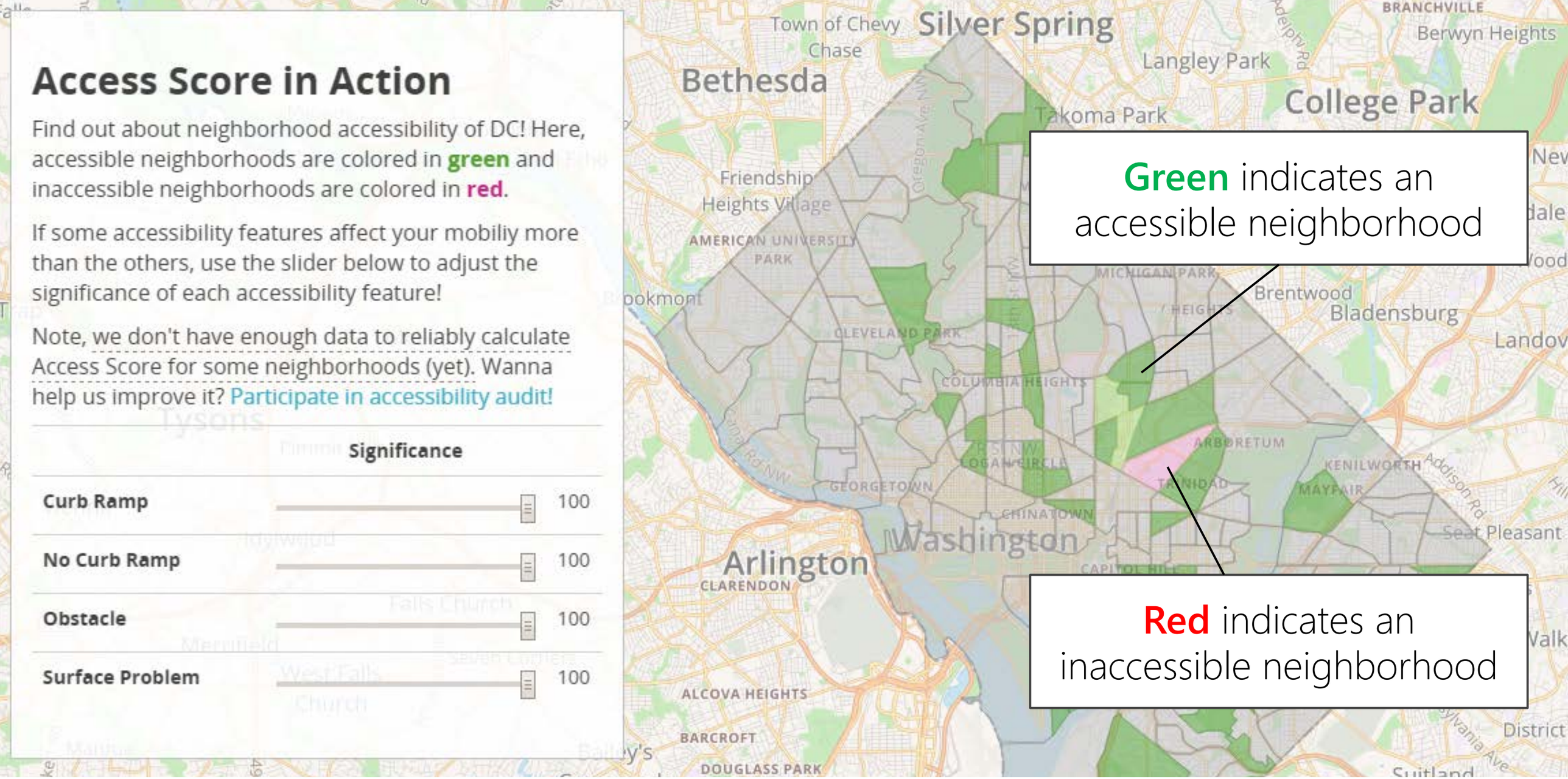
The problem is that **there are few mechanisms to determine accessible areas of a city** ***a priori***

The National Council on Disability noted that there is **no comprehensive information** on “the degree to which sidewalks are accessible” in cities.

National Council on Disability, 2007
The impact of the Americans with Disabilities Act: Assessing the progress toward achieving the goals of the ADA

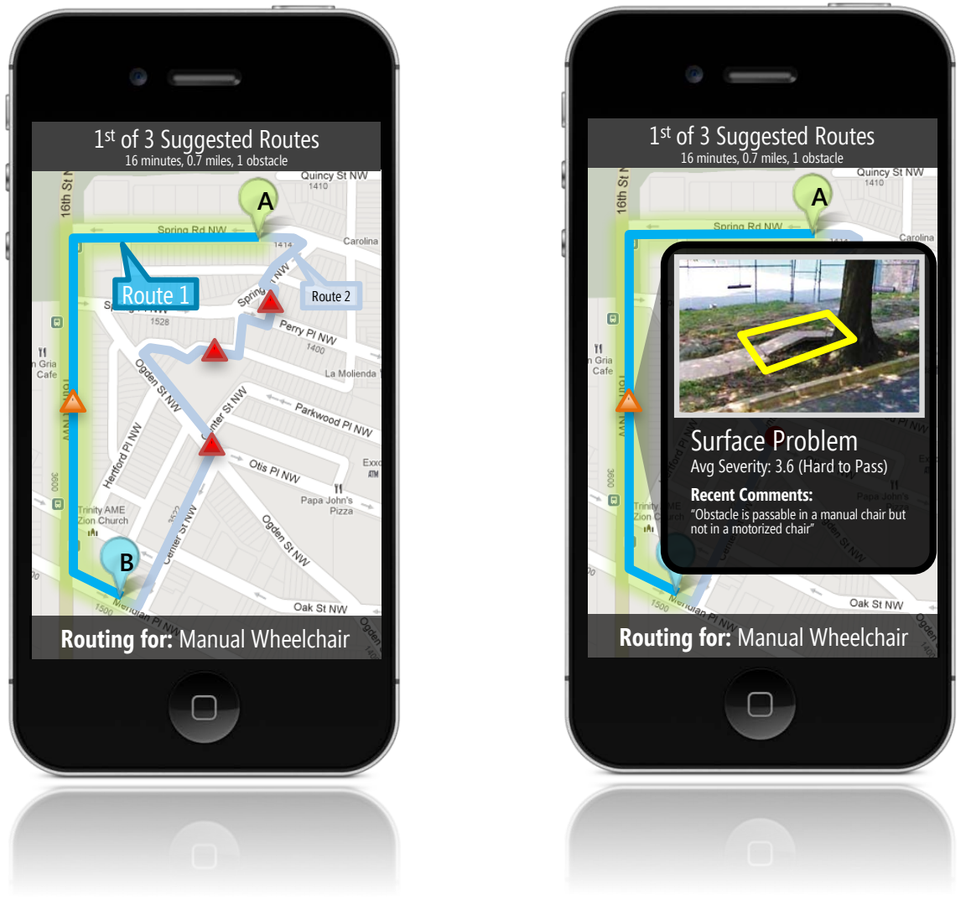
OUR VISION

Design systems that transform the way accessibility information is **collected** and **used**.



Proof-of-Concept Application of Accessibility Data

Accessibility-aware Navigation



THESE APPLICATIONS HAVE

HUGE DATA

REQUIREMENTS

THESE APPLICATIONS HAVE

HUGE DATA

REQUIREMENTS

Where is this data going to come from?

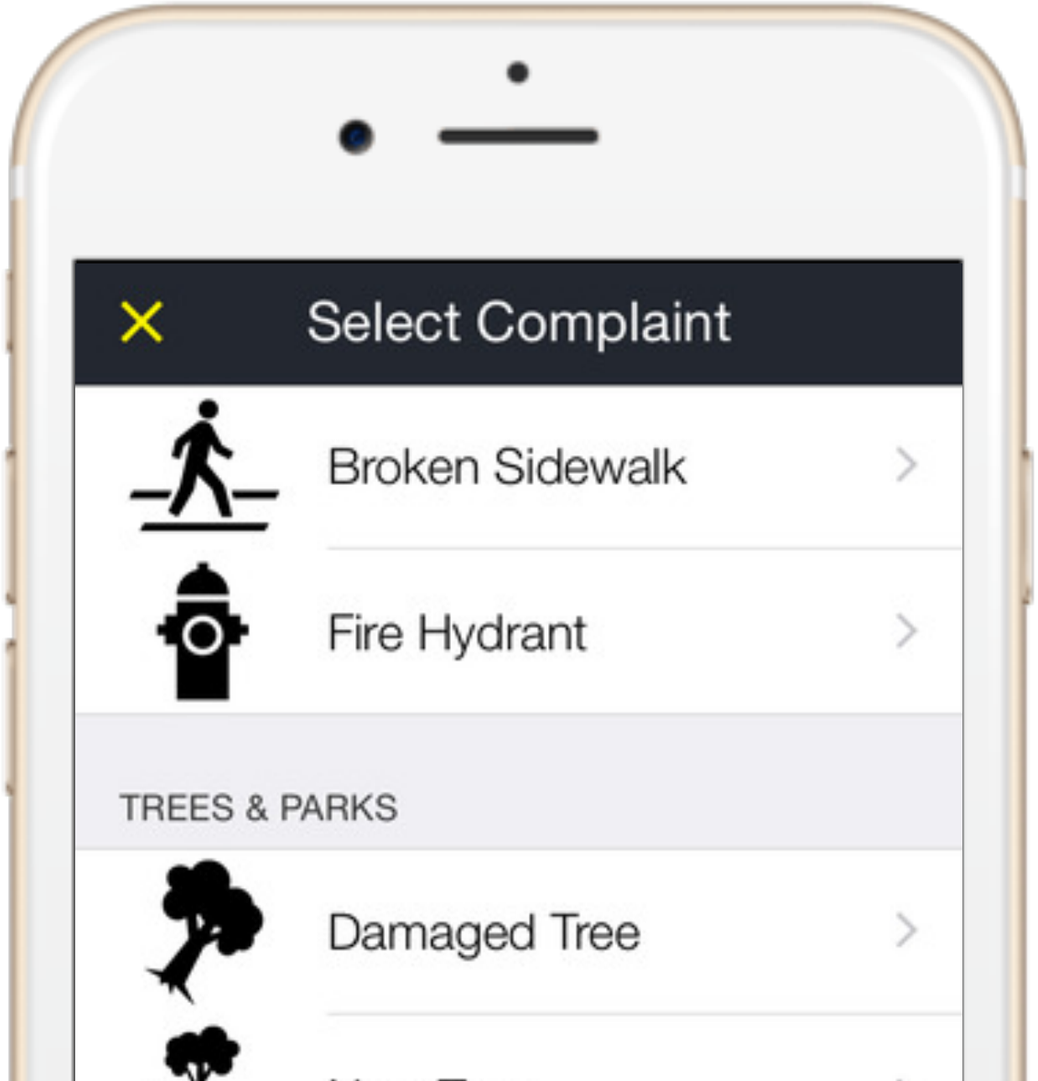
Traditional Walkability Audits

Walkability Audit
Wake County, North Carolina

Walkability Audit
Wake County, North Carolina

Safe Routes to School Walkability Audit
Rock Hill, South Carolina

Mobile Reporting Solutions



http://www1.nyc.gov/311/index.page

Crowdsourced
Data Collection

Accessibility-aware
Application Design

Crowdsourced
Data Collection

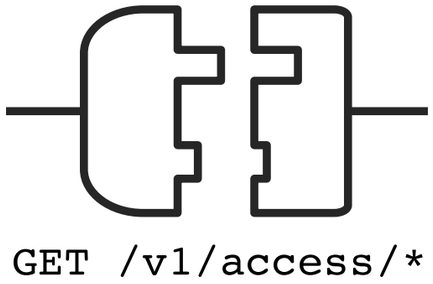
Accessibility-aware
Application Design

How do we collect accurate street-level accessibility data?

Our Approach: Remotely collect street-level accessibility information from Google Street View (GSV) using crowdsourcing and computation

http://sidewalk.umiacs.umd.edu

Volunteered Accessibility Data Collection



Accessibility Data Serving APIs

Proof-of-Concept Applications

Chrome File Edit View History Bookmarks People Window Help

Aug 14 3:44 PM

Project Sidewalk

Kotaro Hara

localhost:9000

Apps Gmail Calendar Google Maps Drive Scholar YouTube Chase GitHub Makeability Proxy SVG Crowbar Other Bookmarks

Project Sidewalk beta

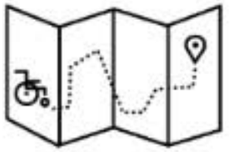
Demo FAQ **Start Auditing** Sign in

Help us make sidewalks more accessible for everyone

Participate

Use our tool to label accessibility attributes in

The collected data is stored on our server and



The data will be used to enable new accessibility-

Chrome File Edit View History Bookmarks People Window Help

Aug 14 3:44 PM

Project Sidewalk

Kotaro Hara

localhost:9000

Apps Gmail Calendar Google Maps Drive Scholar YouTube Chase GitHub Makeability Proxy SVG Crowbar Other Bookmarks

Project Sidewalk beta

Demo FAQ **Start Auditing** Sign in

Help us make sidewalks more accessible for everyone

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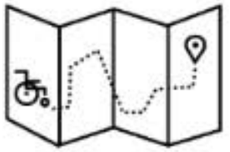


The data will be used to enable new accessibility-

Crowdsourced
Data Collection

Accessibility-aware
Application Design

How can we leverage this unprecedented level of accessibility data in new interactive GIS tools?

Interview Studies with Mobility Impaired People

Hara, K., Le, V., Froehlich, J.E. CHI2013; **Hara, K.,** Chan, C., Froehlich, J.E. *CHI 2016*

Participatory Design Process

Recruited 20 people with varying levels of mobility from Washington, D.C. area

- Electric wheelchair/scooter users
- Manual wheelchair users
- Manual mobility aids (e.g., cane) users

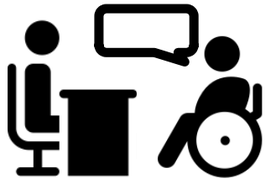
Recruited participants via local accessibility organizations, word-of-mouth, and email listserv on a rolling basis

Age ranged between 19-71

The study was split into three parts

Study Method: Three-Part Study

Scenario-based Design



Semi-structured Interview

Design Probe

Part 1: Semi-Structured Interview

What are their needs?

Part 1: Semi-Structured Interview

To better understand how people with mobility impairments plan their trips, we asked:

- How the accessibility problems in the built-environment affect their decisions to travel
- What tools and methods do they use to assess the accessibility before they travel

Study Method: Three-Part Study

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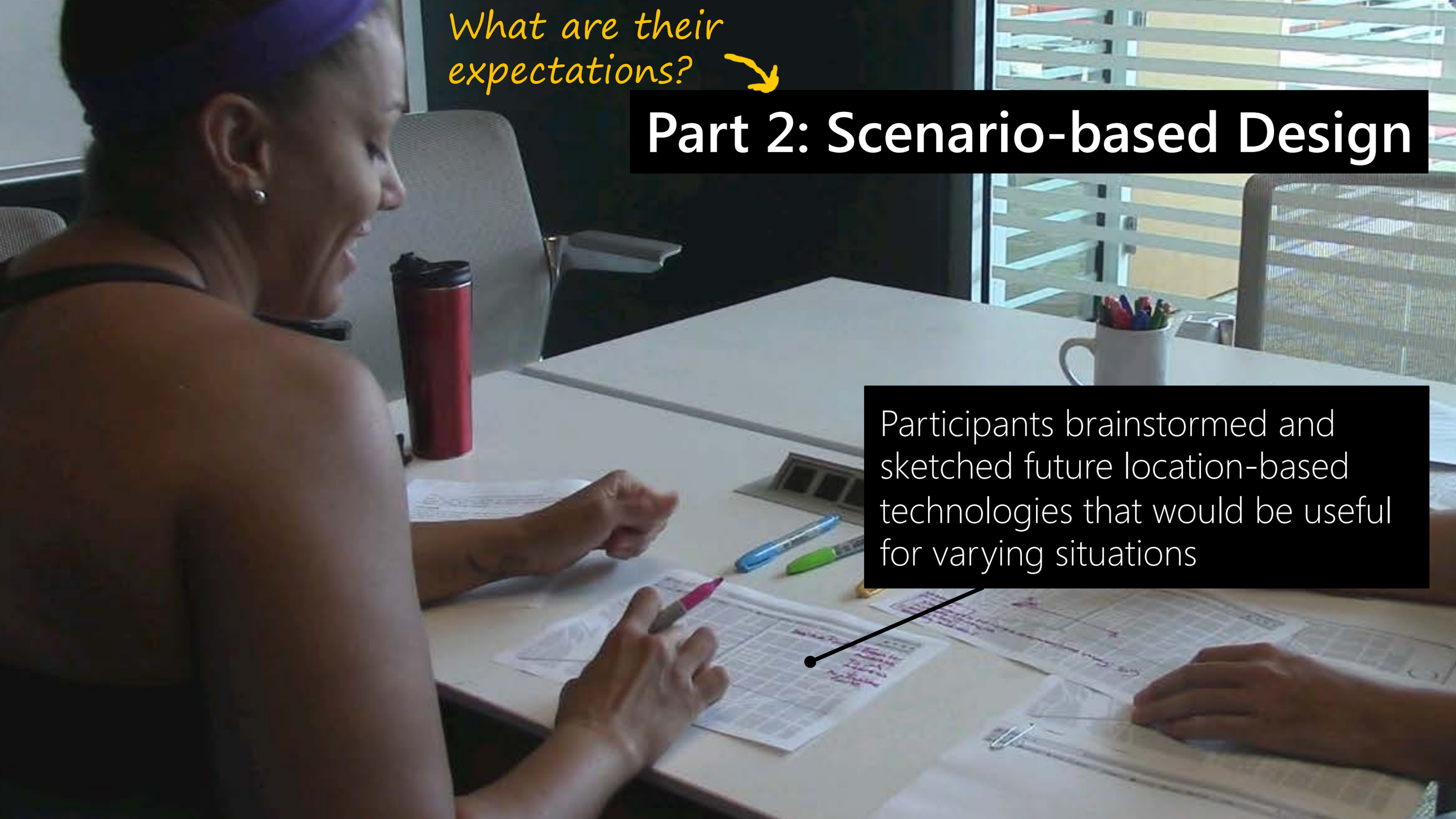
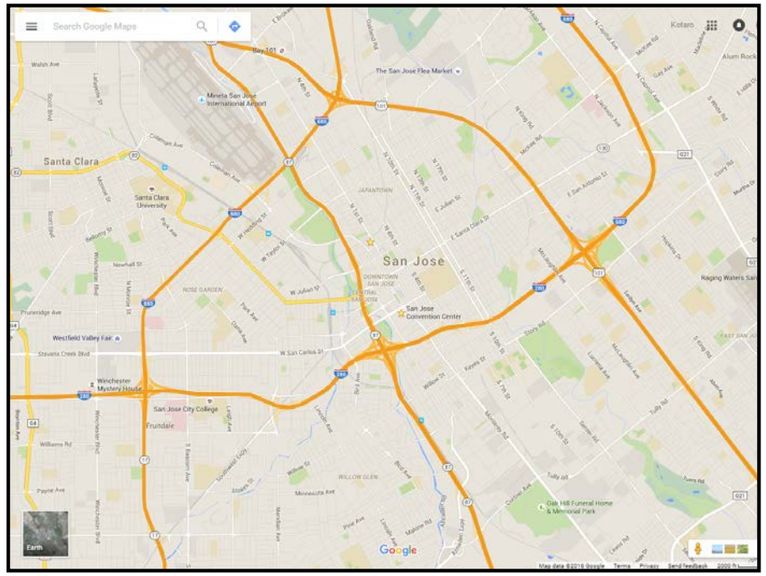


Part 2: Scenario-based Design

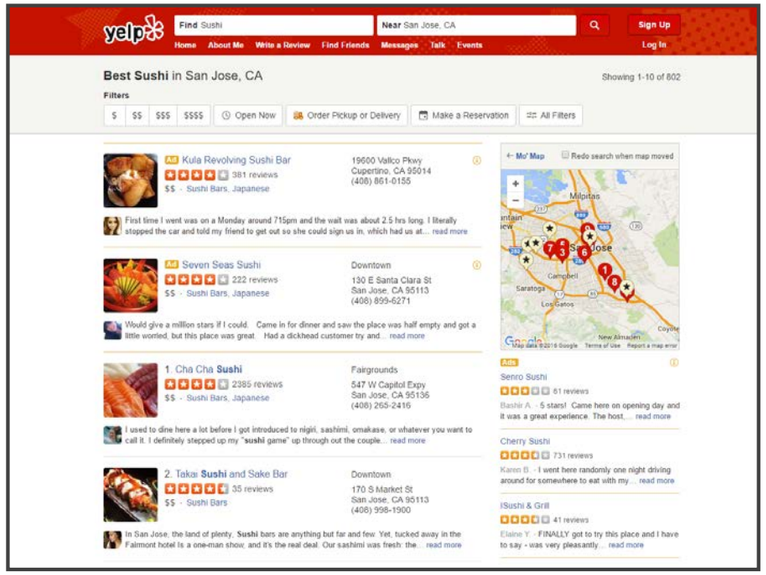
Participants brainstormed and sketched future location-based technologies that would be useful for varying situations

Scenarios

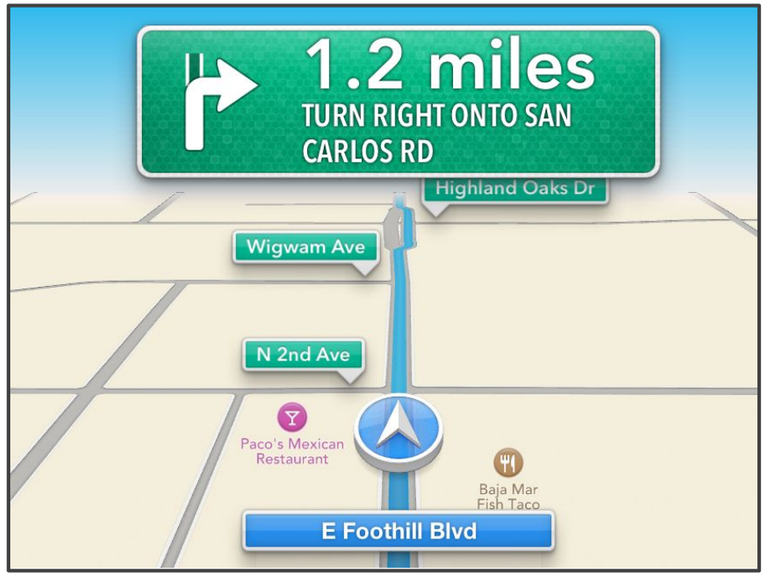
To help guide the design activity, we used three realistic scenarios



Scenario 1
Accessibility Exploration



Scenario 2
Accessible Location Search



Scenario 3
Accessibility-Aware Navigation

Scenario: Citywide Accessibility Exploration

You are planning to rent a room in an unfamiliar city that you will move to in a few months.

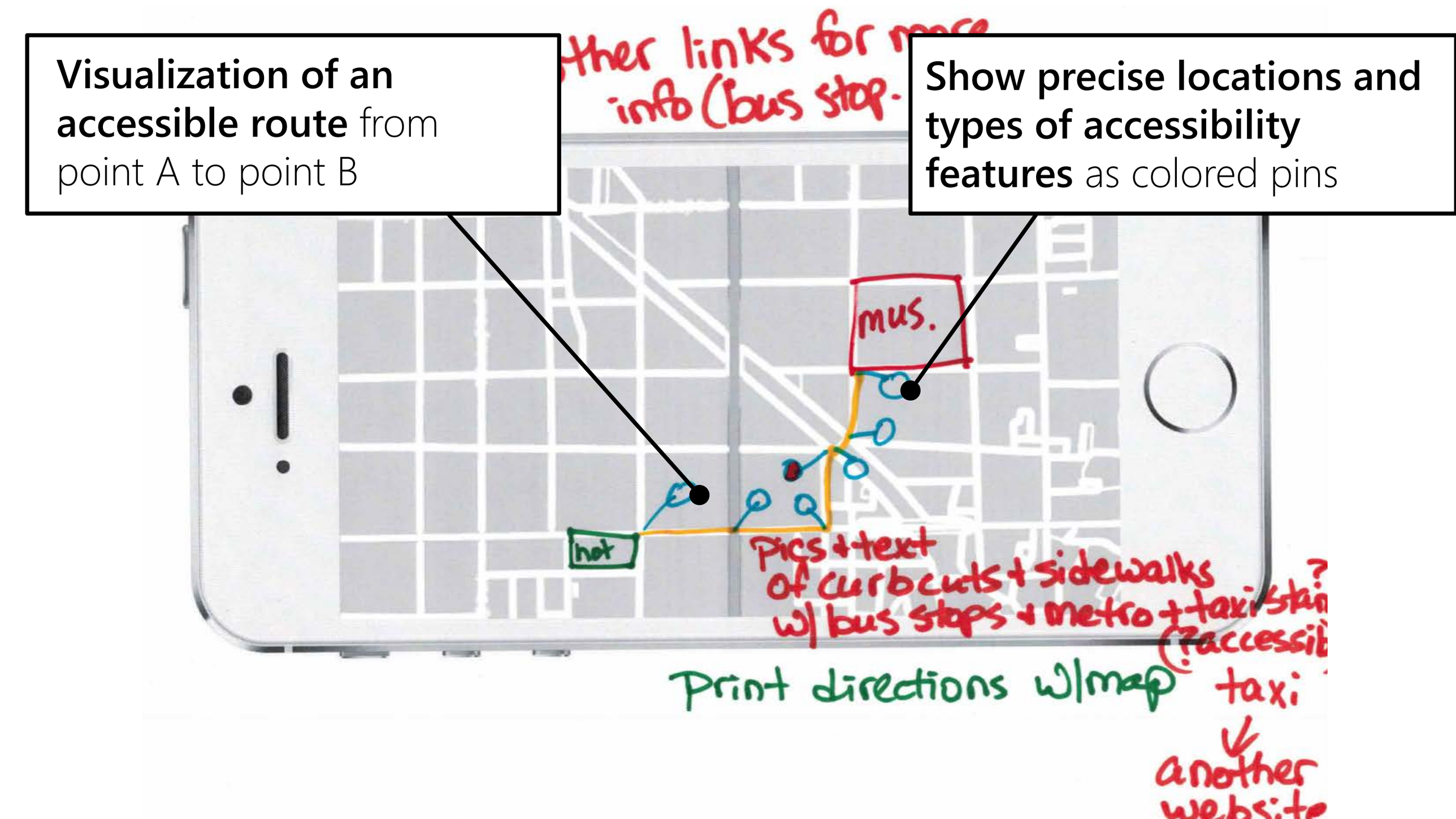
Scenario: Citywide Accessibility Exploration

You are planning to rent a room in an unfamiliar city that you will move to in a few months.

Imagine that there is a website that provides accessibility information about the city. What should that website look like?

Pictures of the building proximity and a video that walks you through the interior enable you to **visually inspect accessibility** of the place and assess whether it is **accessible for you**

P9, Muscular Dystrophy, Electric Wheelchair User


Visualization of an accessible route from point A to point B
Show precise locations and types of accessibility features as colored pins
mus.
hot
Pics + text of curbcuts + sidewalks w/ bus stops + metro + taxi
Print directions w/ map
taxi
another website

Study Method: Three-Part Study

Scenario-based Design

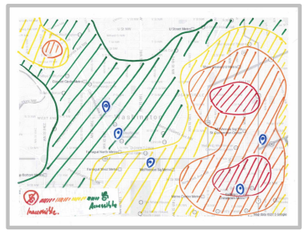
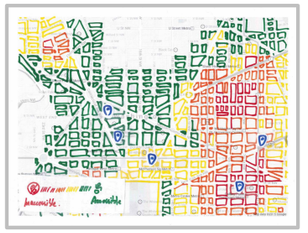
Semi-structured Interview

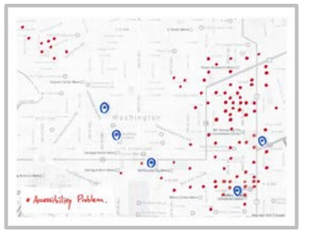
Design Probe

Part 3: Design Probe

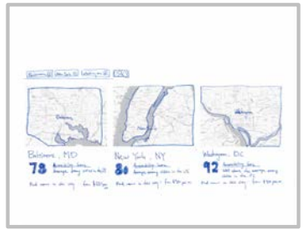
Participants critiqued researcher-prepared design mockups

Accessibility Score Visualizations
Map-based at-glance accessibility visualizations



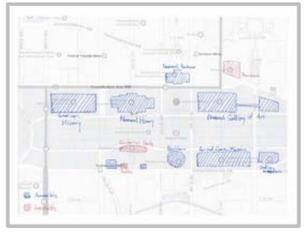
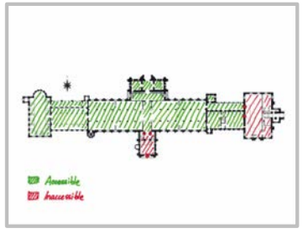
Accessibility Score Comparison
Compare accessibility levels between cities

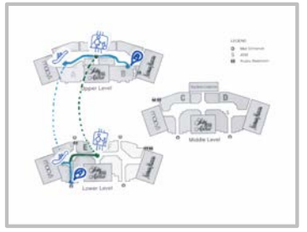


Accessibility-aware Location Search
Location search augmented with accessibility data

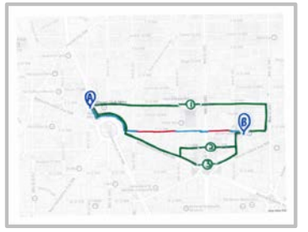
Accessible Bus Stop Finder
View proximal bus stops that are accessible

Indoor Accessibility Visualization
Indoor at-glance accessibility visualizations

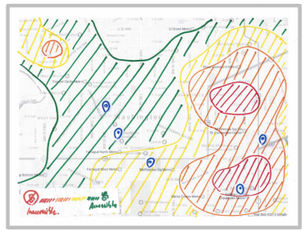


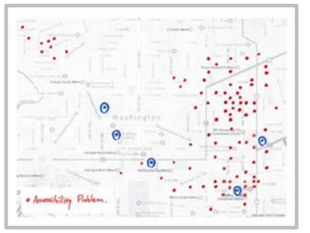
Outdoor Accessibility Navigation
Accessibility-aware pedestrian routing

Accessibility Score Visualizations

Map-based at-glance accessibility visualizations





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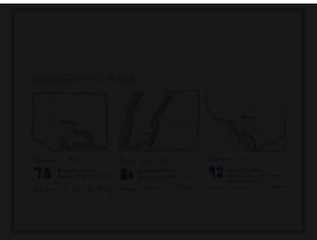

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Location search augmented with accessibility data

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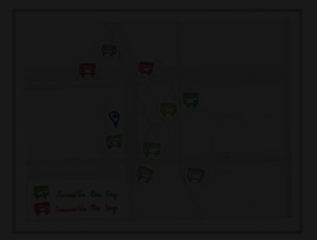
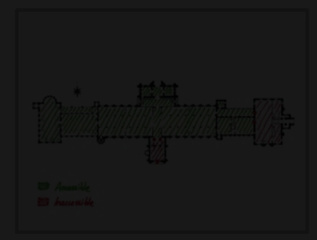
View proximal bus stops that are accessible



Building Accessibility Visualization

Indoor at-glance accessibility visualizations



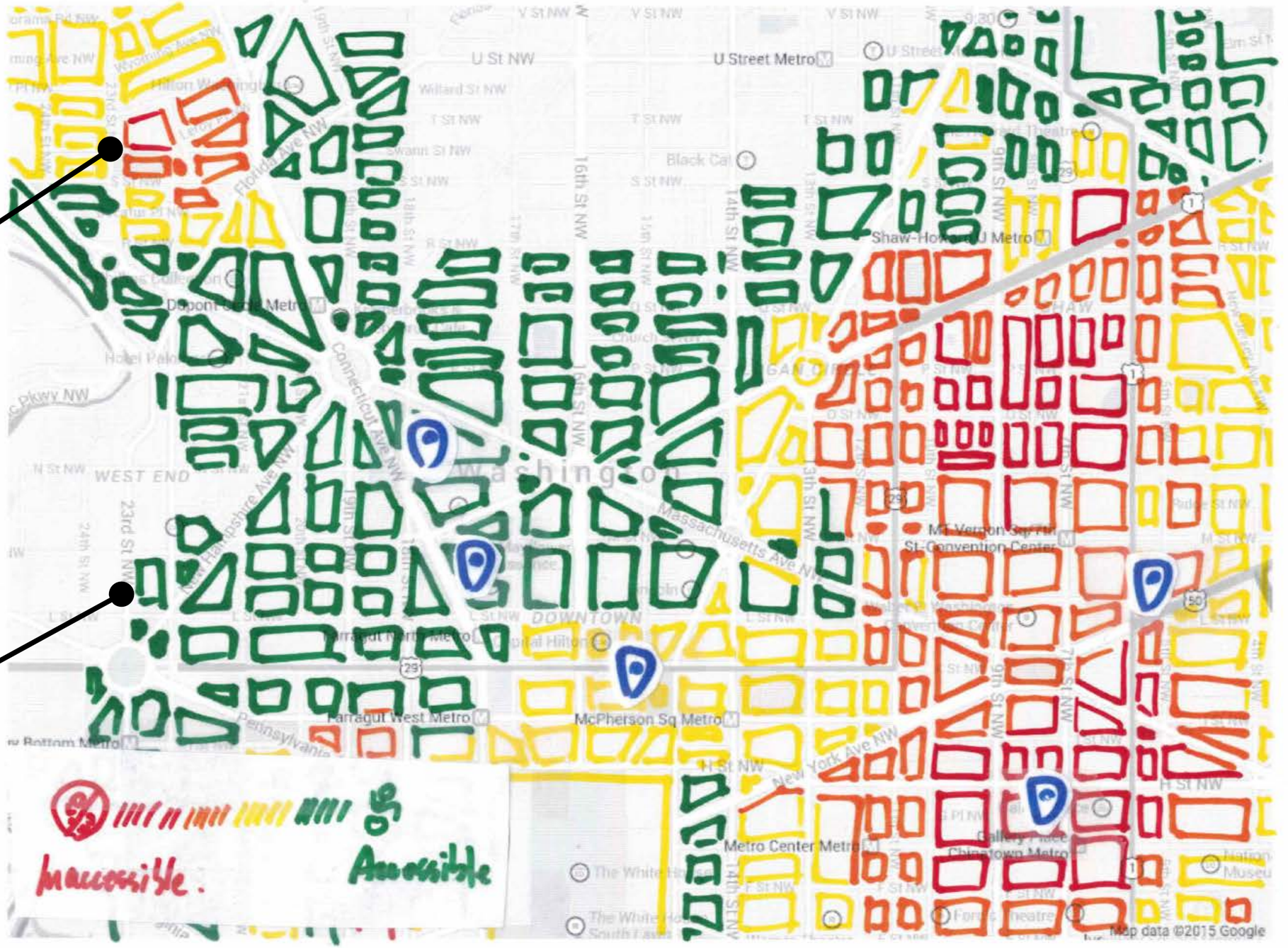
Outdoor Accessibility Navigation

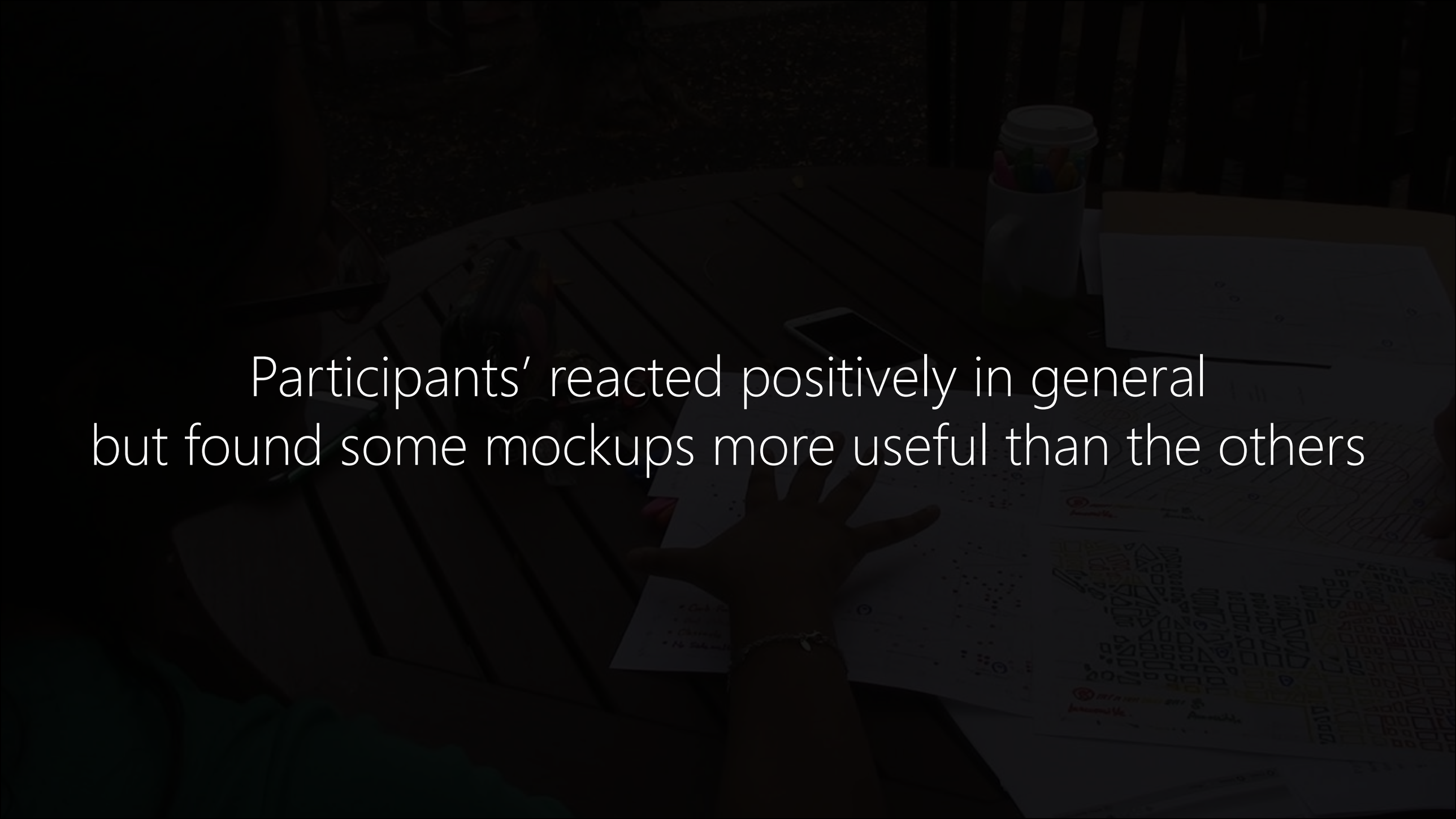
Accessibility-aware pedestrian routing

Sidewalk-level accessibility Visualization

Inaccessible sidewalks are colored in red

Accessible sidewalks are colored in green

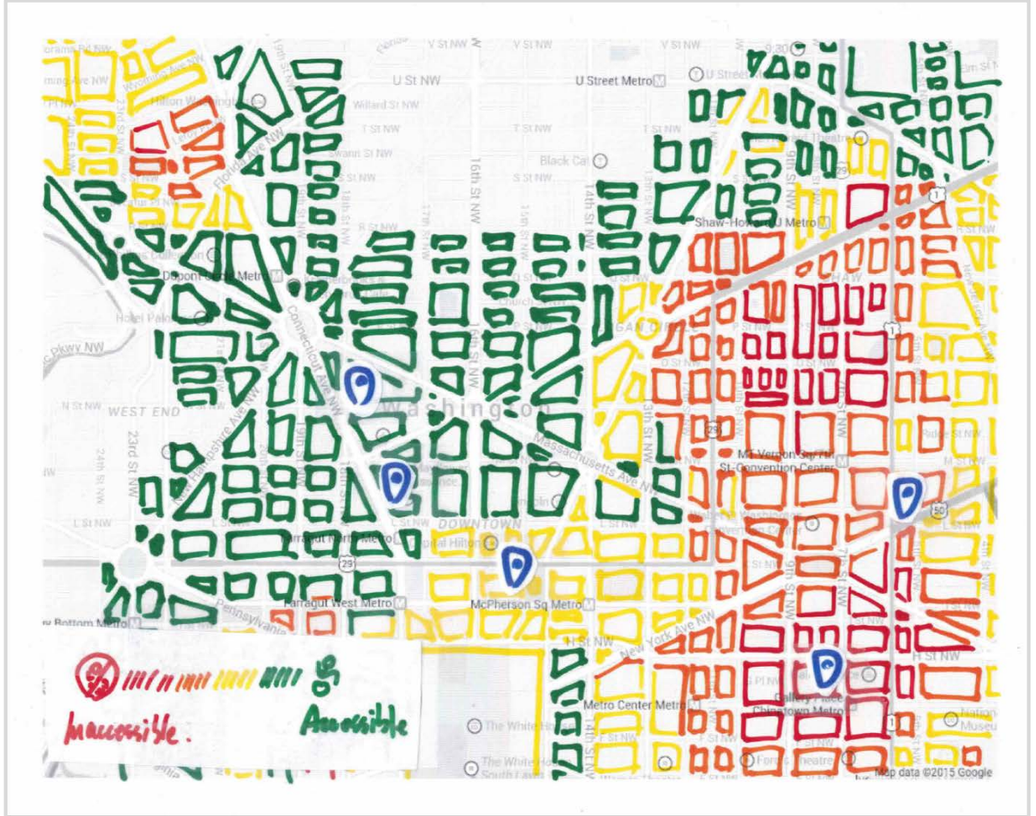




Participants’ reacted positively in general
but found some mockups more useful than the others

Neighborhood-level Accessibility Visualization

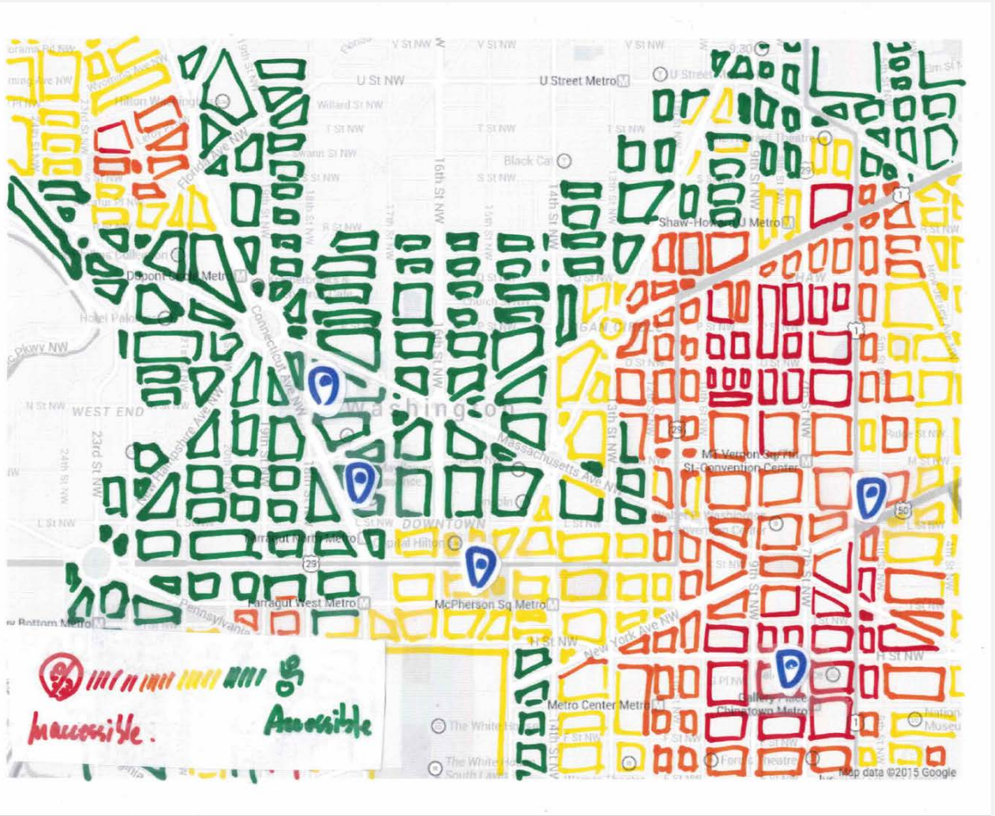
Sidewalk-level Accessibility Visualization



Two top-down map-based visualizations that show accessibility levels of city neighborhoods

Neighborhood-level Accessibility Visualization

Sidewalk-level Accessibility Visualization



The sidewalk-level visualization was preferred because it provided more **precise location information**

Summary

Ten Desired Features

Street-level Visualization

POI Accessibility Rating

Detailed Description

Floor Plan

Visual Inspection

Discussion and Review

Search and Filter

Routing

Transportation

Universal Design

Six Data Qualities

Granularity

Relevance

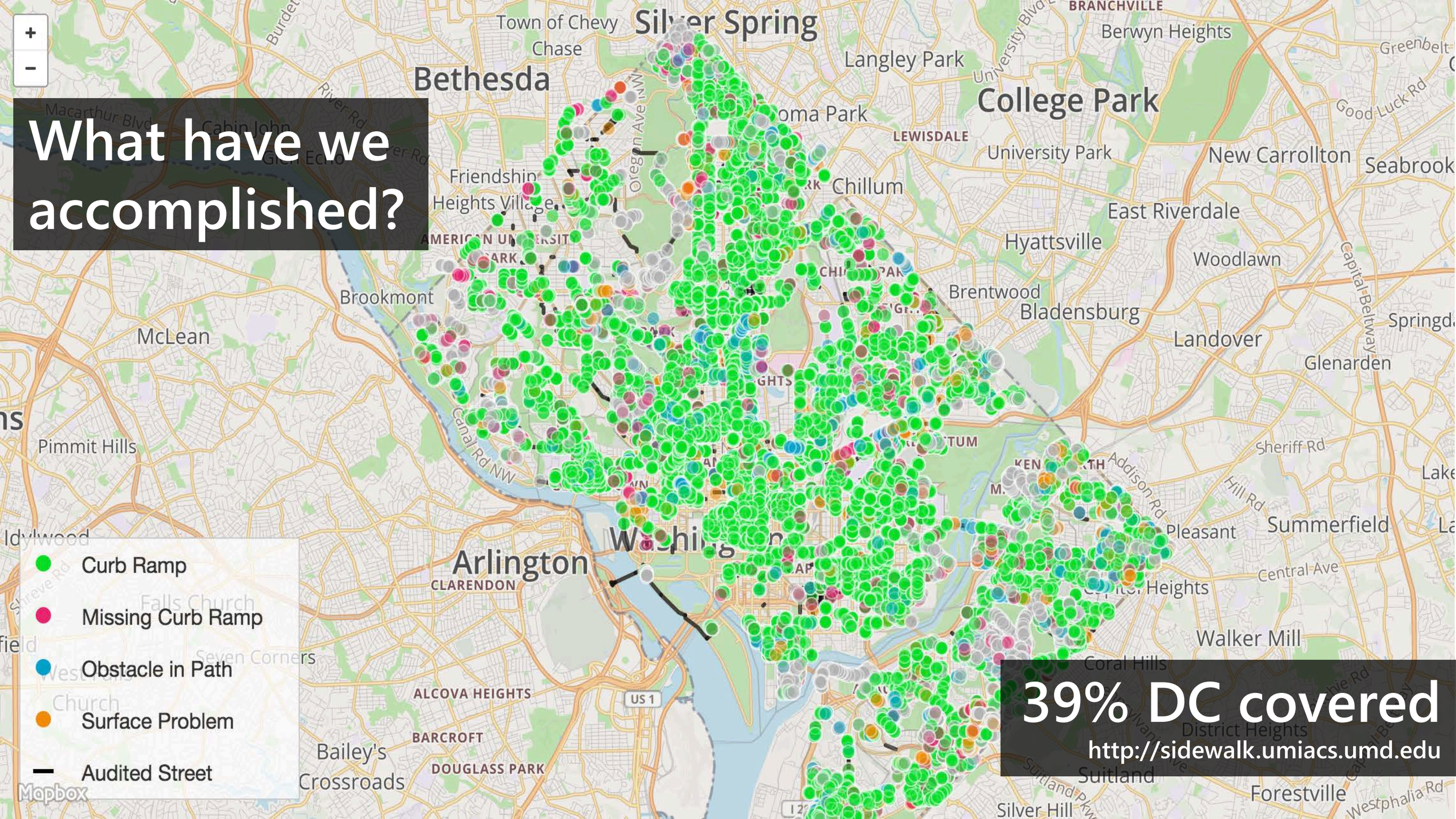
Credibility

Recency of Information

Coverage

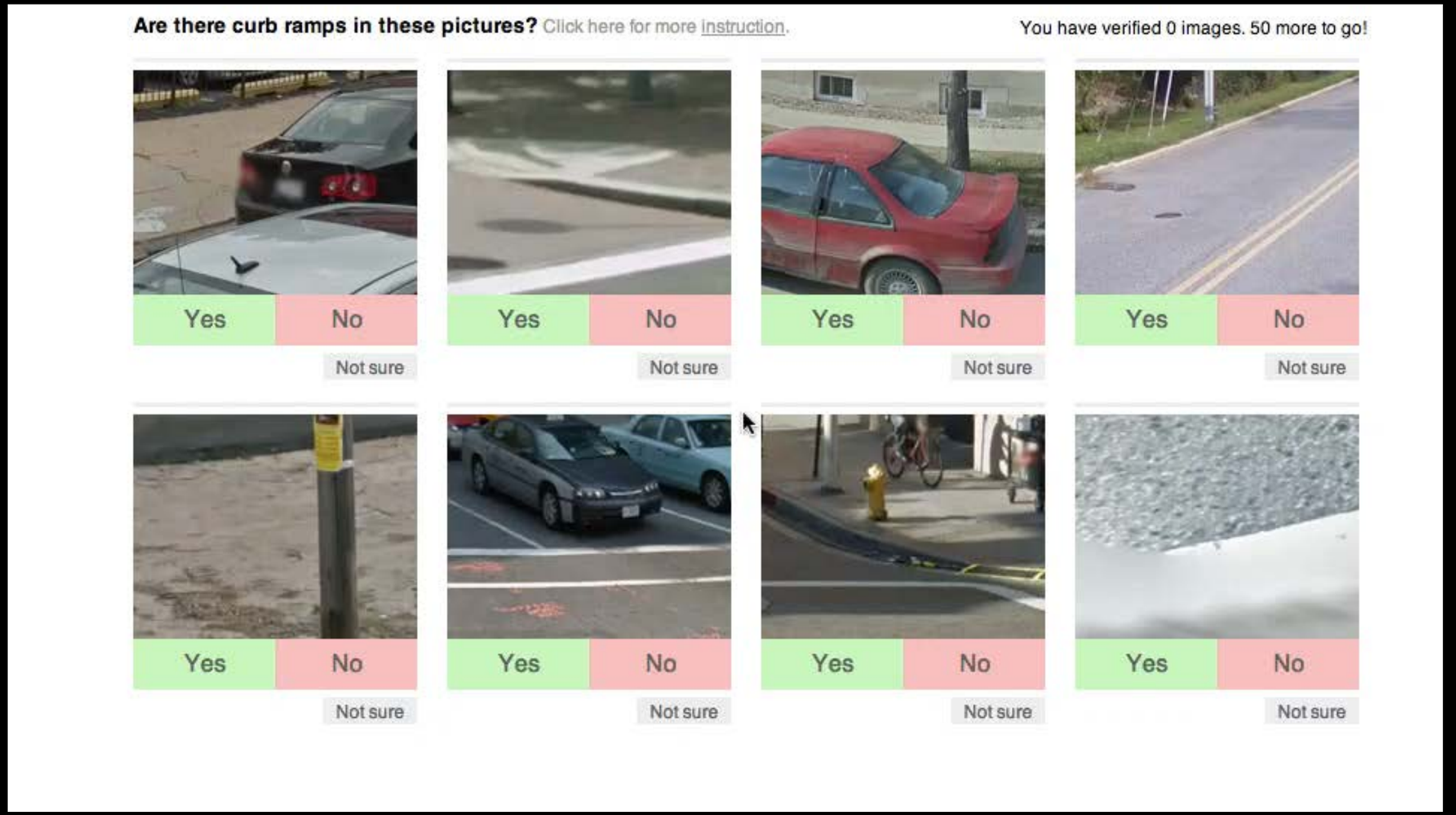
Location Precision

The result **guides the design of accessibility data collection methods and applications** enabled by the data

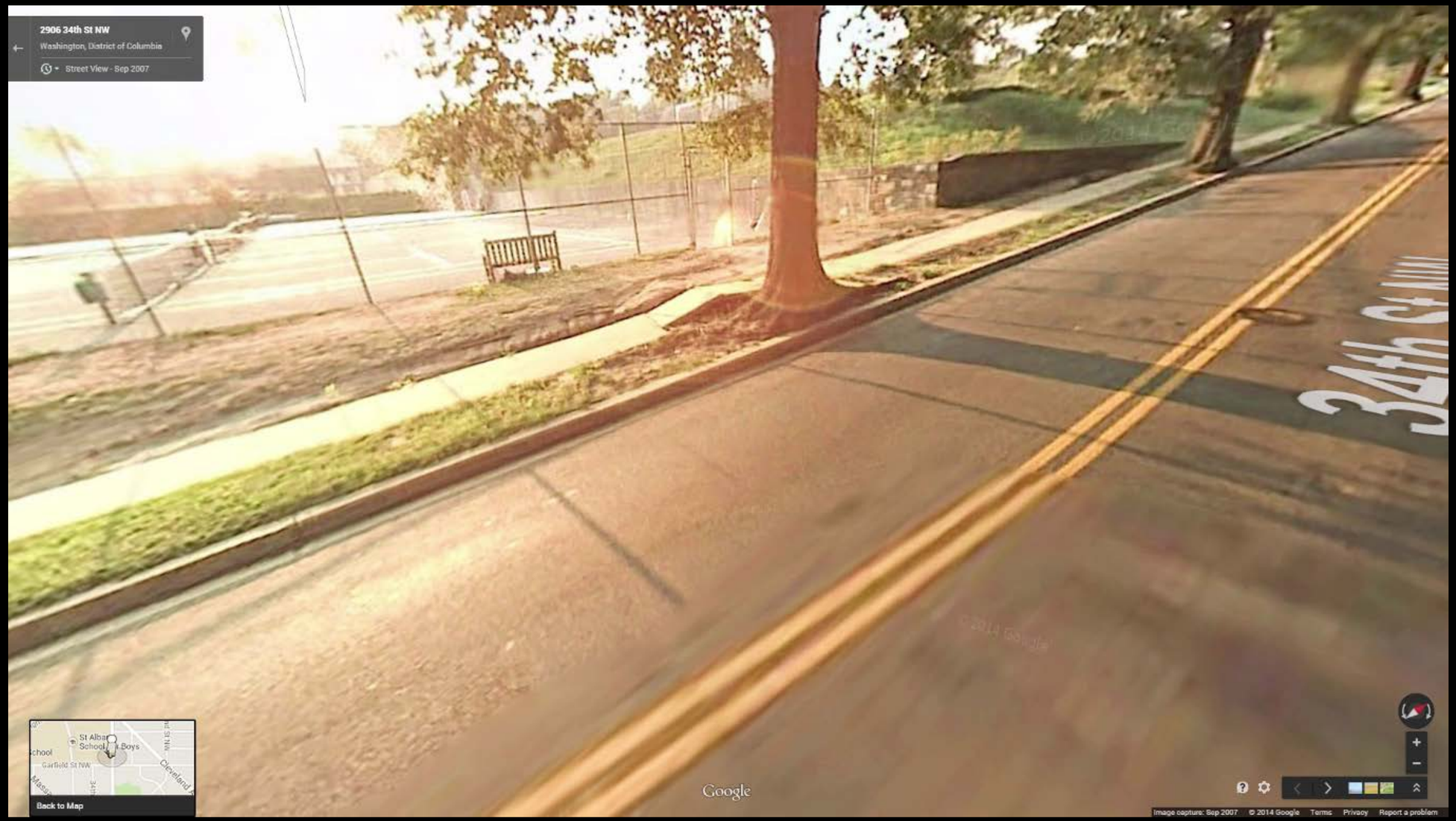

What have we accomplished?
Curb Ramp
Missing Curb Ramp
Obstacle in Path
Surface Problem
Audited Street
39% DC covered
http://sidewalk.umiacs.umd.edu
Silver Spring
Bethesda
College Park
Arlington
Chillum
Hyattsville
Brookmont
McLean
Pimmit Hills
Brentwood
Bladensburg
Landover
Glenarden
Woodlawn
East Riverdale
University Park
New Carrollton
Seabrook
Berwyn Heights
Langley Park
Town of Chevy Chase
Friendship Heights Village
Takoma Park
Pleasant
Summerfield
Capitol Heights
Walker Mill
Coral Hills
District Heights
Suitland
Forestville
Silver Hill
Falls Church
Seven Corners
Bailey's Crossroads
ALCOVA HEIGHTS
BARCROFT
DOUGLASS PARK
CLARENDON
Idylwood
Mapbox

What next?

Future Work: Faster Labeling & Verification Interfaces

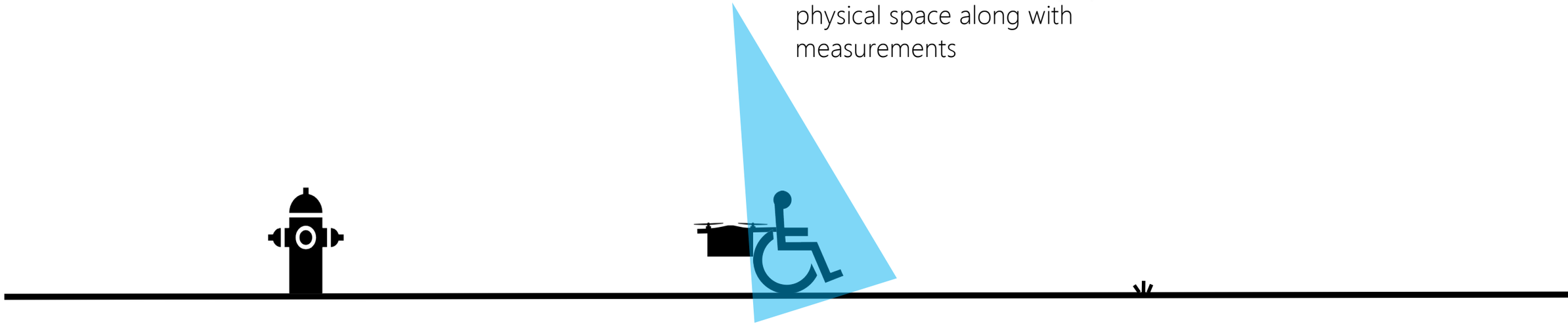


Future Work: Track Physical Accessibility Changes Over Time



Future Work: Additional Surveying Techniques

Transmits real-time imagery of physical space along with measurements



Collaborators

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makeeability
lab

Questions?

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Nov 3, 2016

Characterizing Physical World Accessibility at Scale

Manaswi Saha, Soheil Behnezhad, and Jon E. Froehlich

Technica: Tech + Design

UNIVERSITY OF MARYLAND
COMPUTER SCIENCE UNIVERSITY OF MARYLAND
HCIL
makeability lab

SQUEEZAPULSE

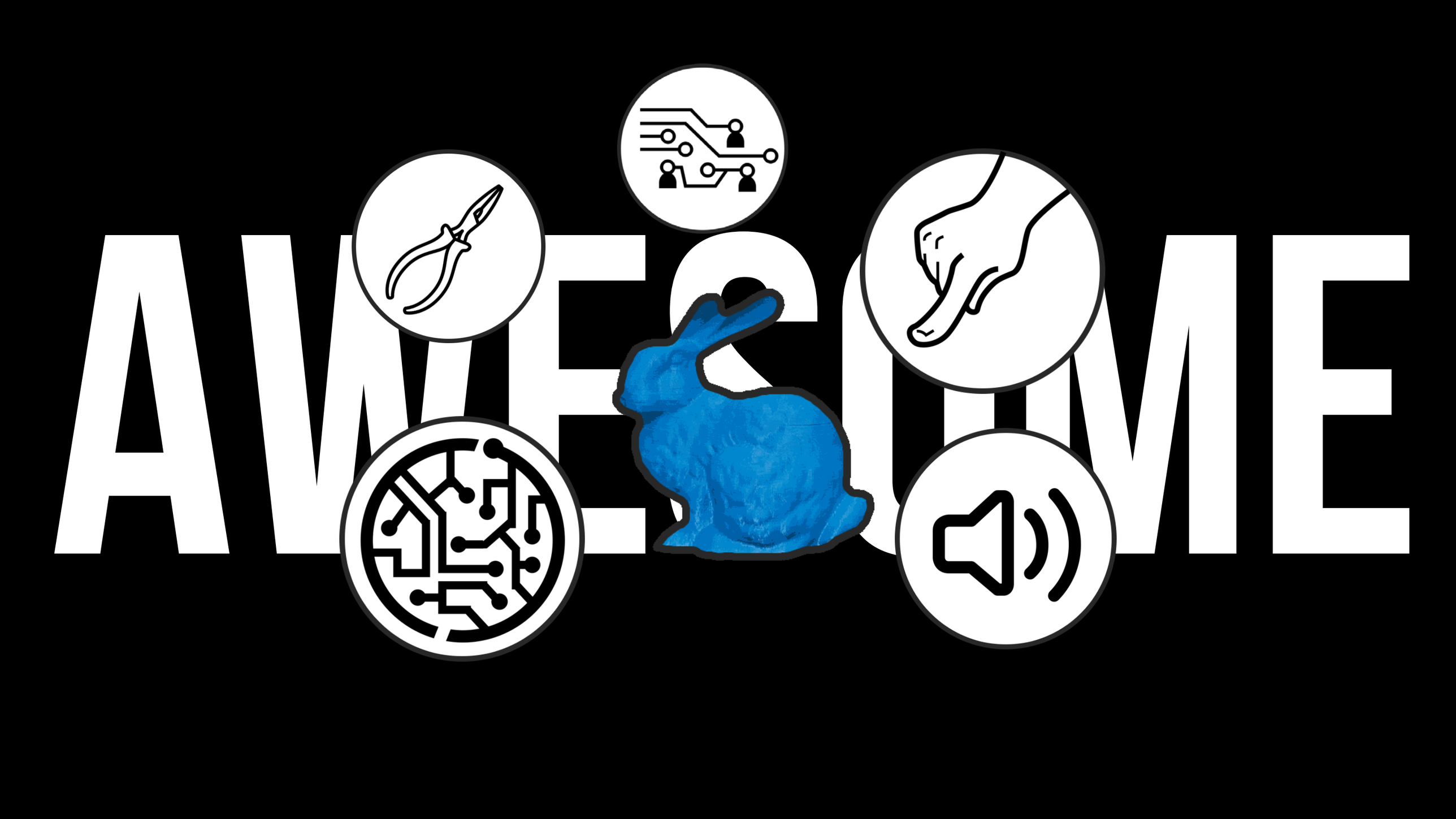
Adding Interactive Input to Fabricated Objects Using Passive Pulses of Air

Liang He
Gierad Laput, Eric Brockmeyer, and Jon Froehlich

HCIL UNIVERSITY OF MARYLAND
HCII Carnegie Mellon University
Disney Research Pittsburgh


3D PRINTING
LASER CUTTING


NOT
INTERACTIVE

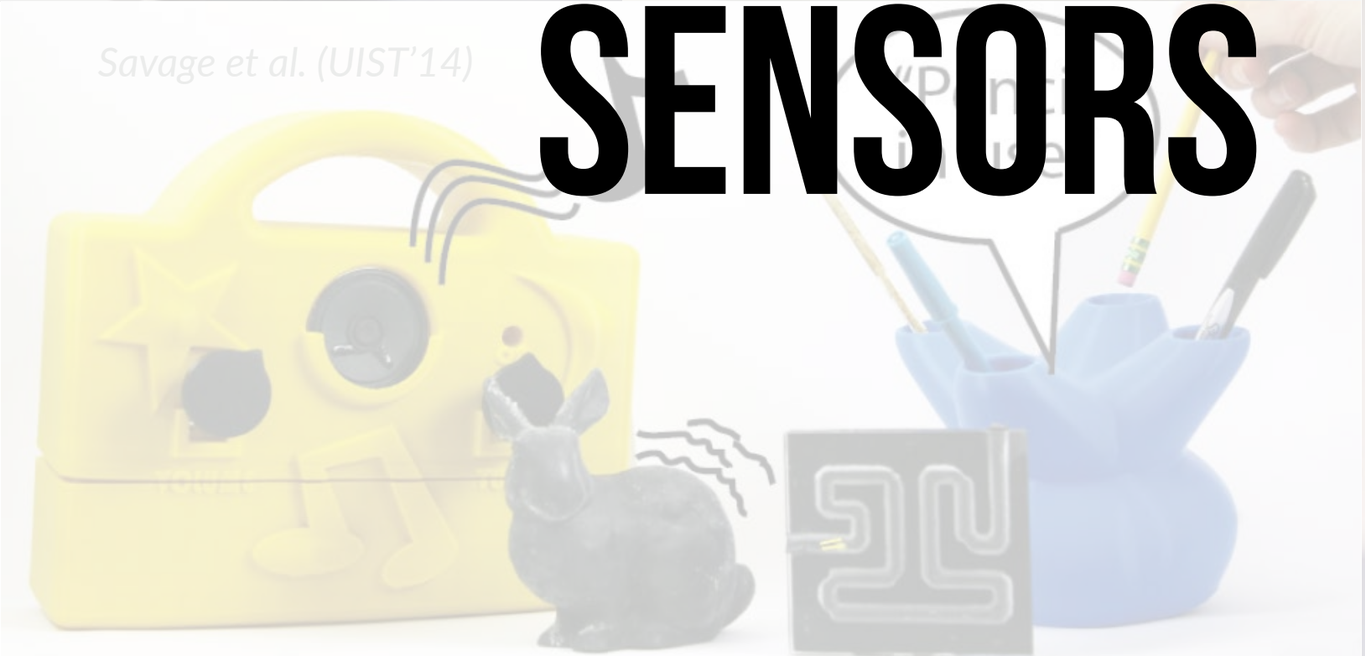

AWESOME

So, what are the options?

Willis et al. (UIST'12)

Brockmeyer et al. (UIST'13)

EMBEDDING SENSORS



Savage et al. (UIST'14)

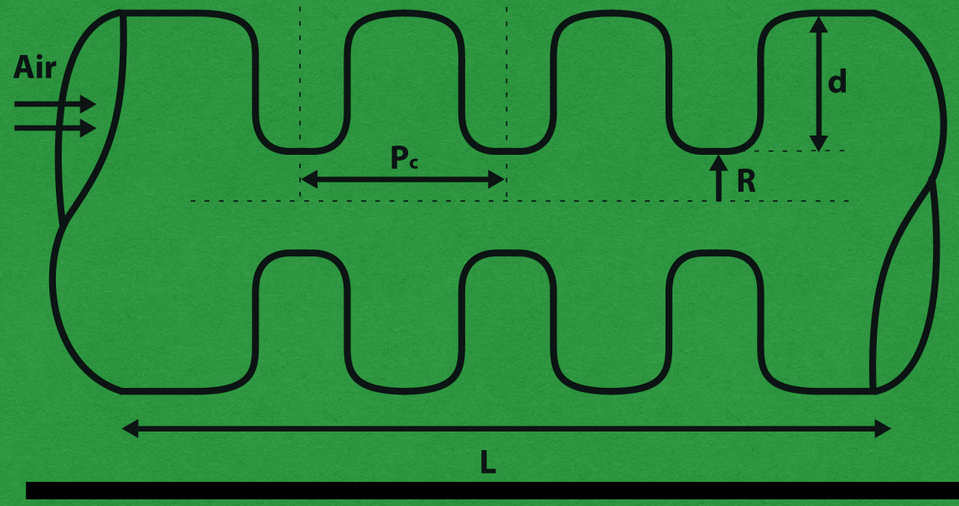
Savage et al. (UIST'13)

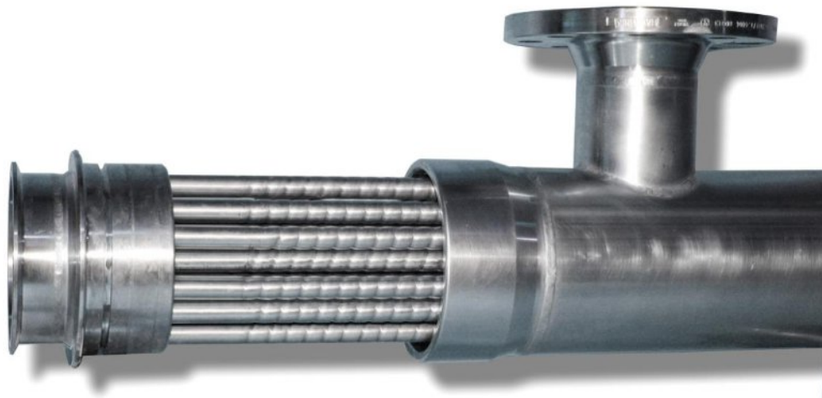
EMBEDDING STRUCTURES

SqueezaPulse

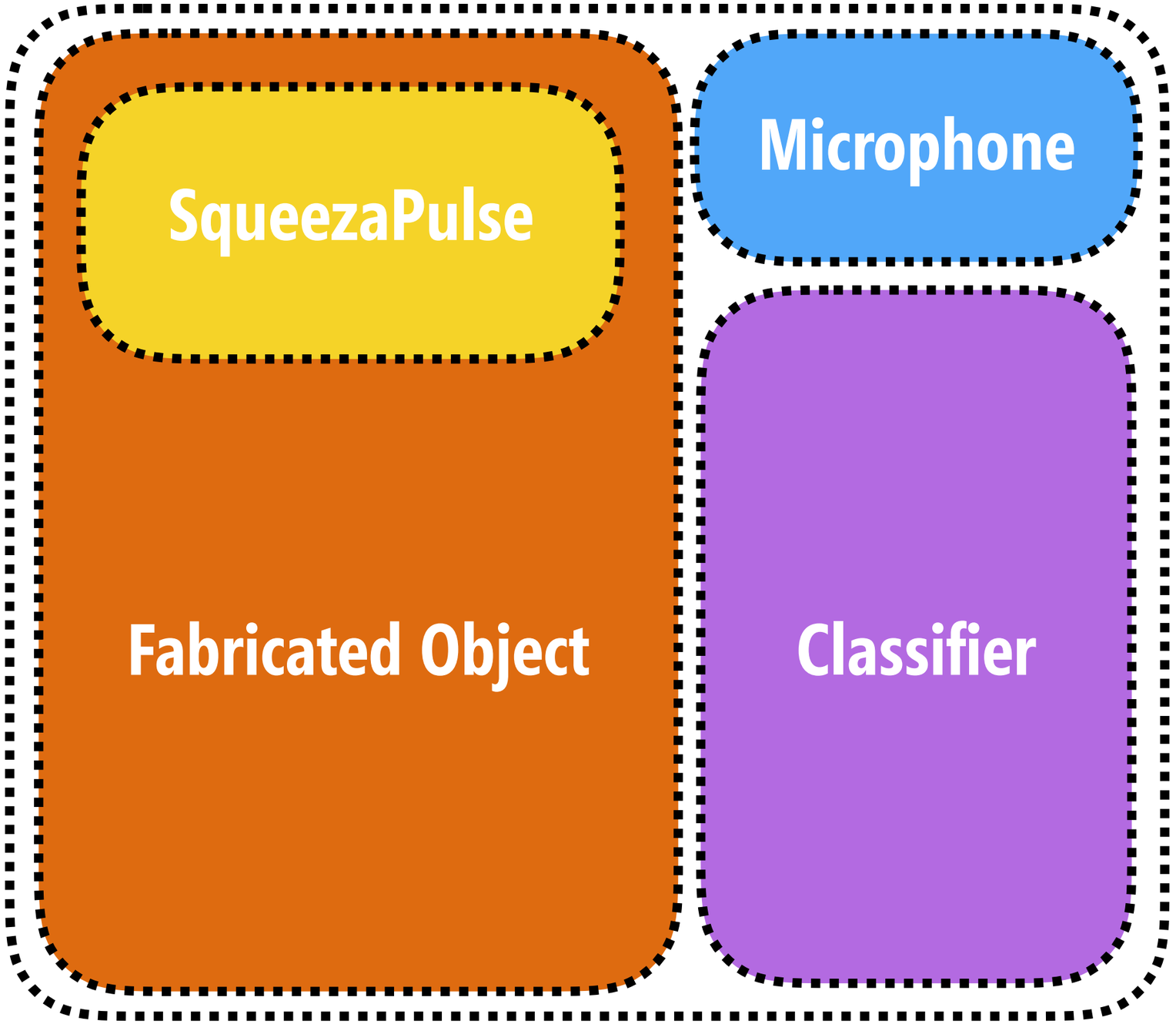
INSPIRATION

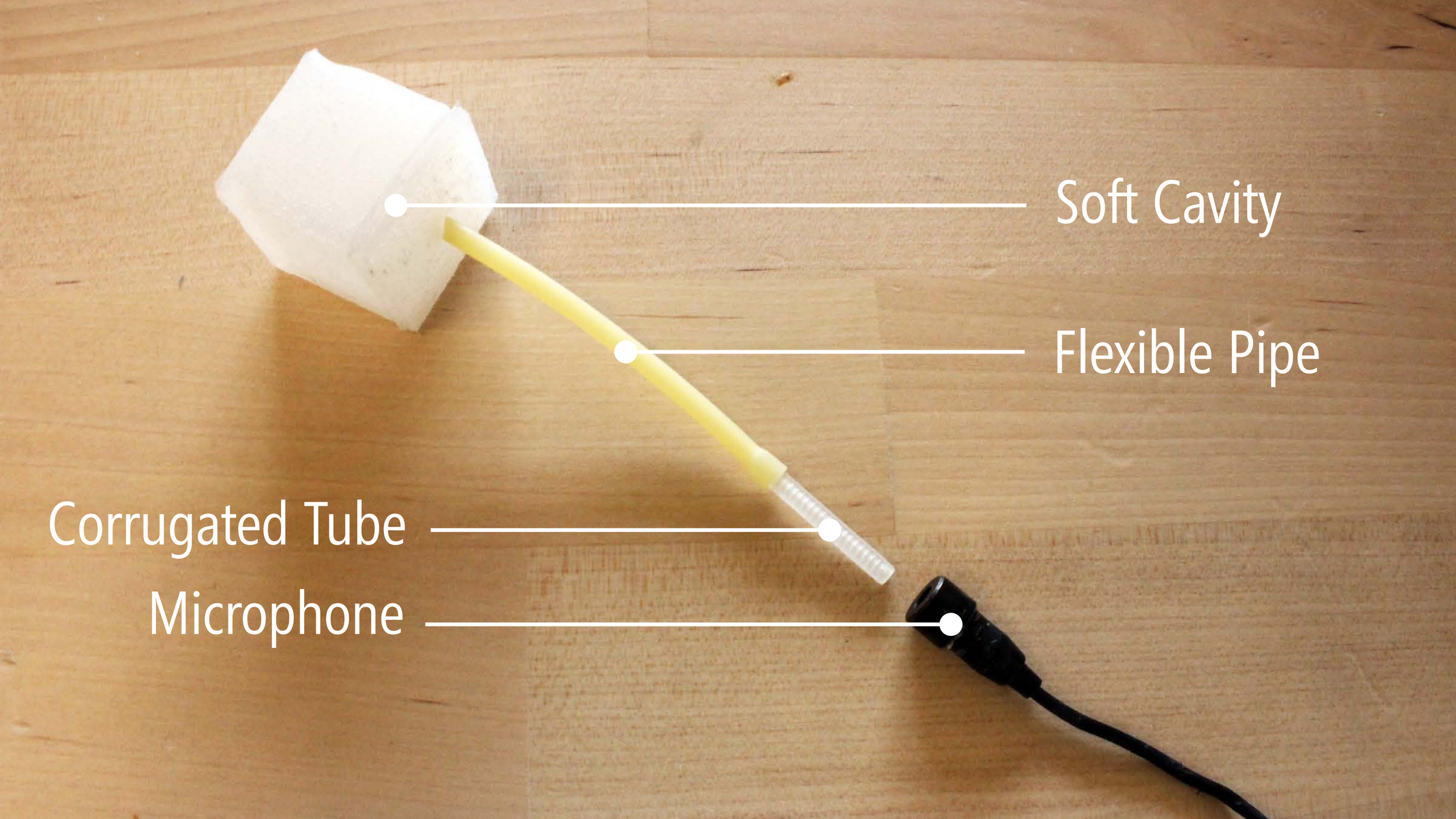
CORRUGATED ACOUSTICS

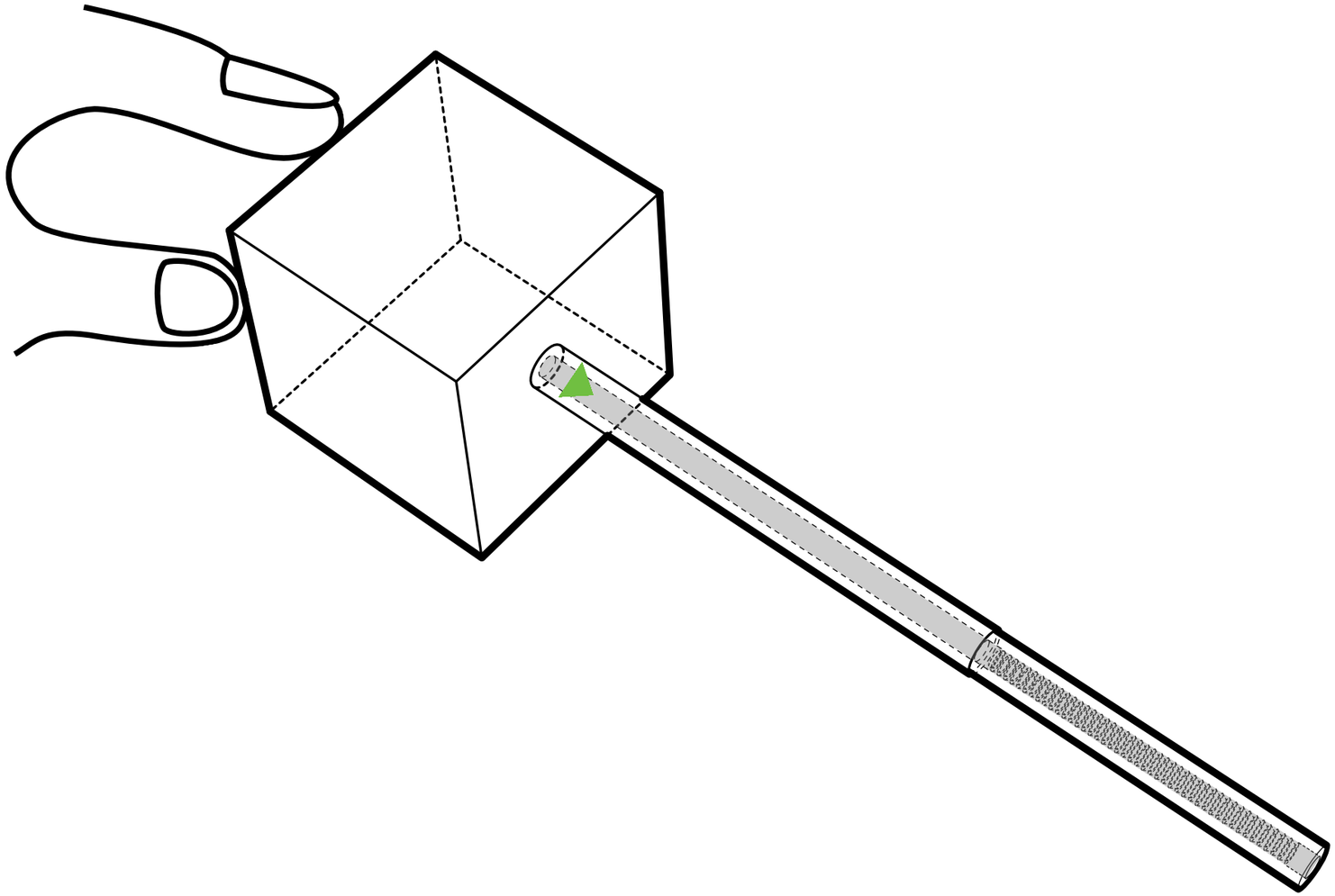




OVERVIEW




Soft Cavity
Flexible Pipe
Corrugated Tube
Microphone



Microphone

Microphone

SqueezaPulse Engine

Classifier

Interactive Object

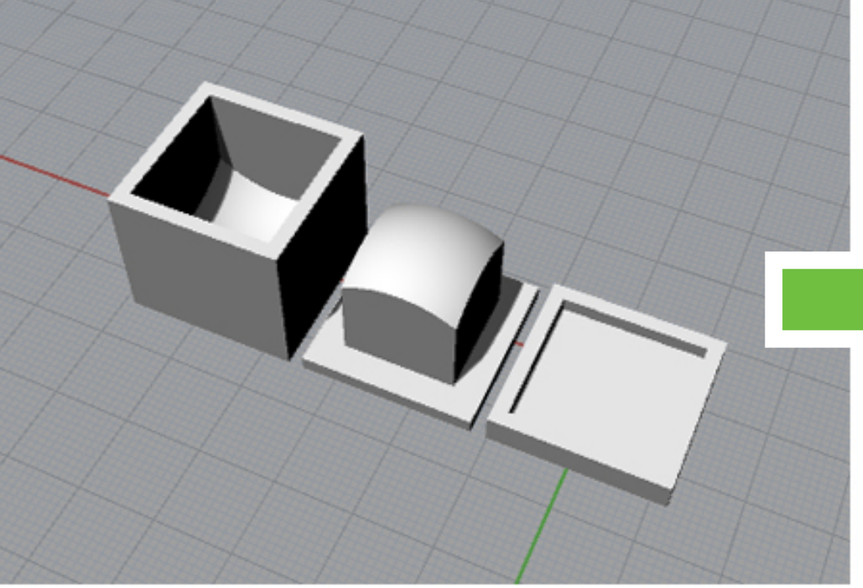
Hardware

Software

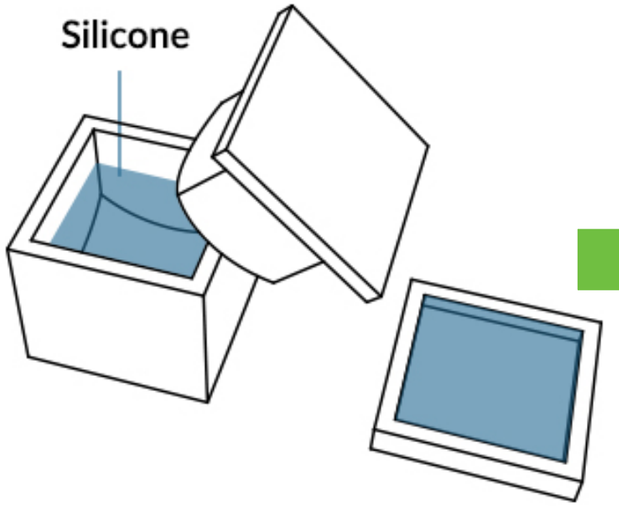
Database

Fabrication

SOFT CAVITY



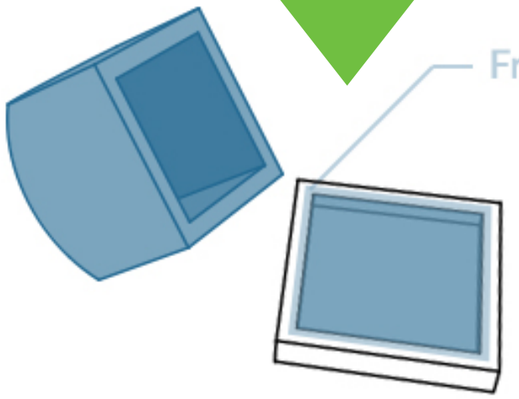
A. 3D modelling in CAD software



B. Filling silicone rubber compounds

3 Hours

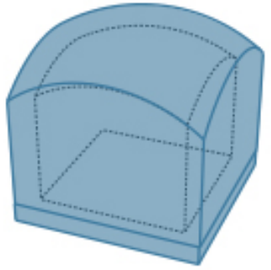
C. Casting



D. Adding one more layer of fresh silicone to bond two parts

3 Hours

E. Casting again

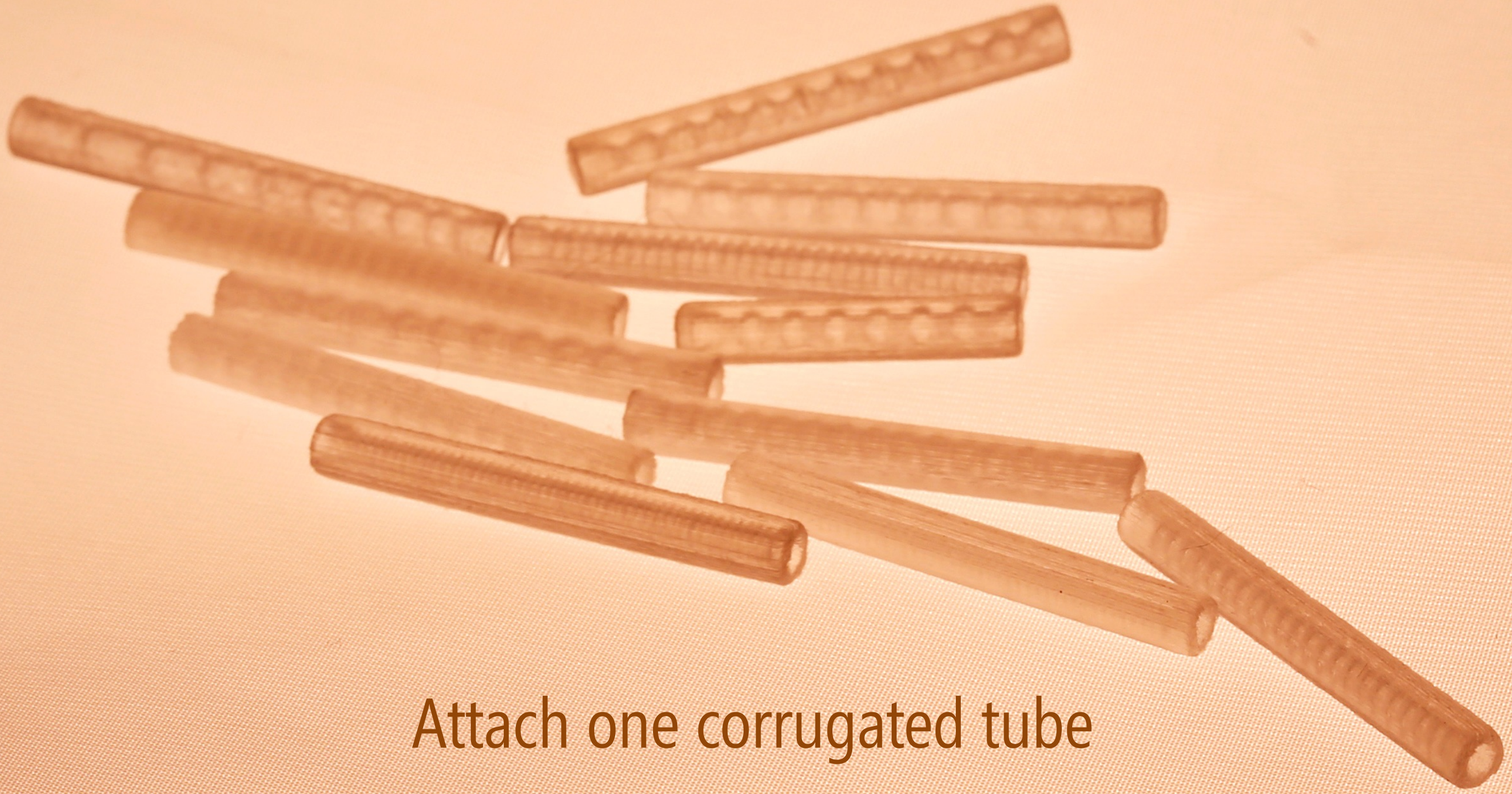


F. Soft cavity

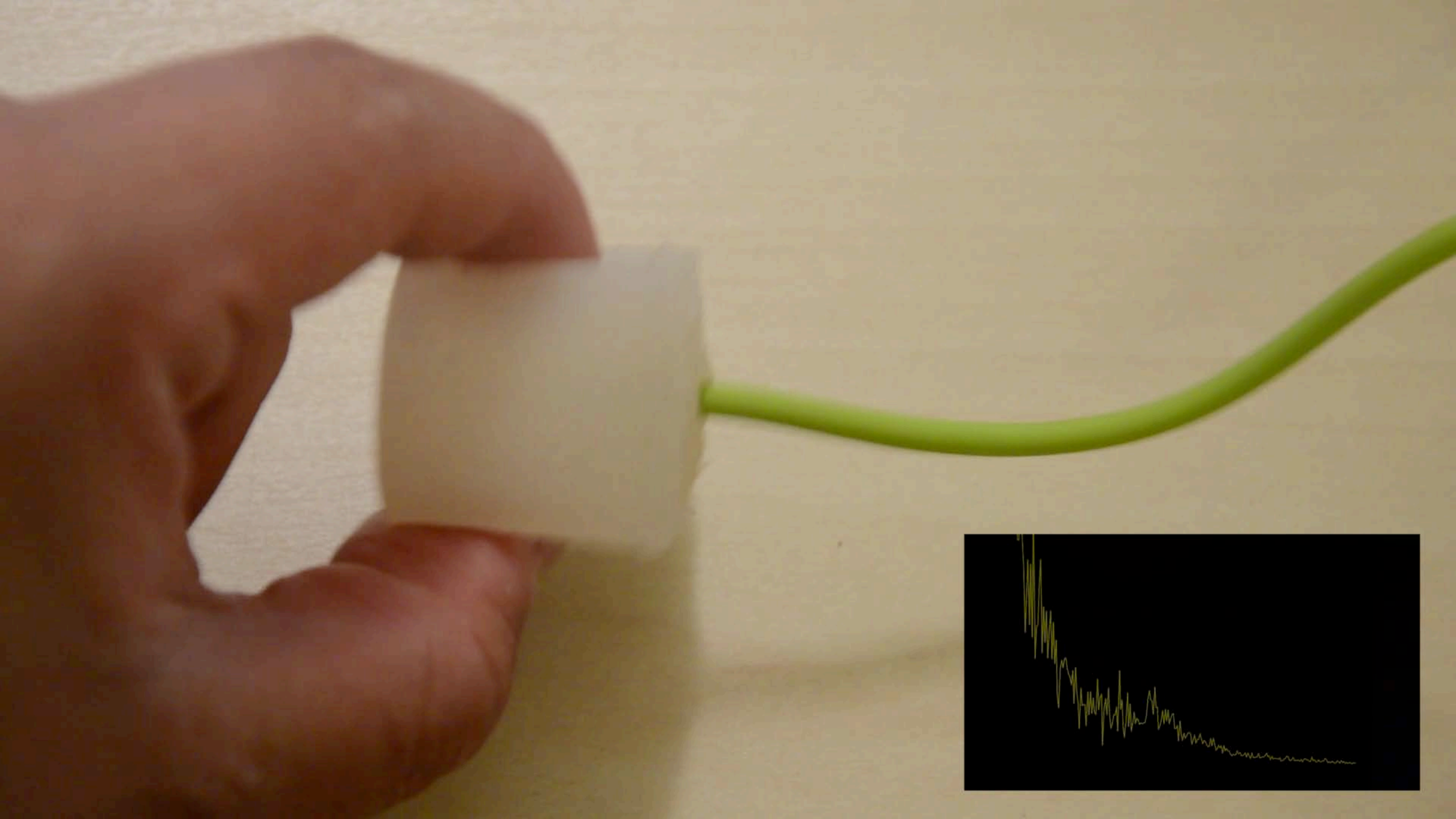

FLEXIBLE LATEX PIPE

Insert latex pipe in the soft cavity

CORRUGATED TUBE



Attach one corrugated tube

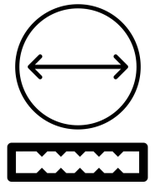


Form Factor Design

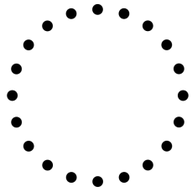
SUMMARY OF FORM FACTORS

Pipe Length

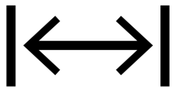
Tube Length



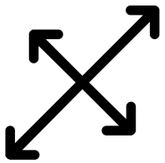
Tube Diameter



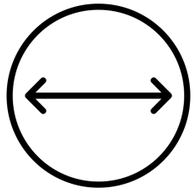
Corrugation Shape



Baffle Gap



Baffle Distribution



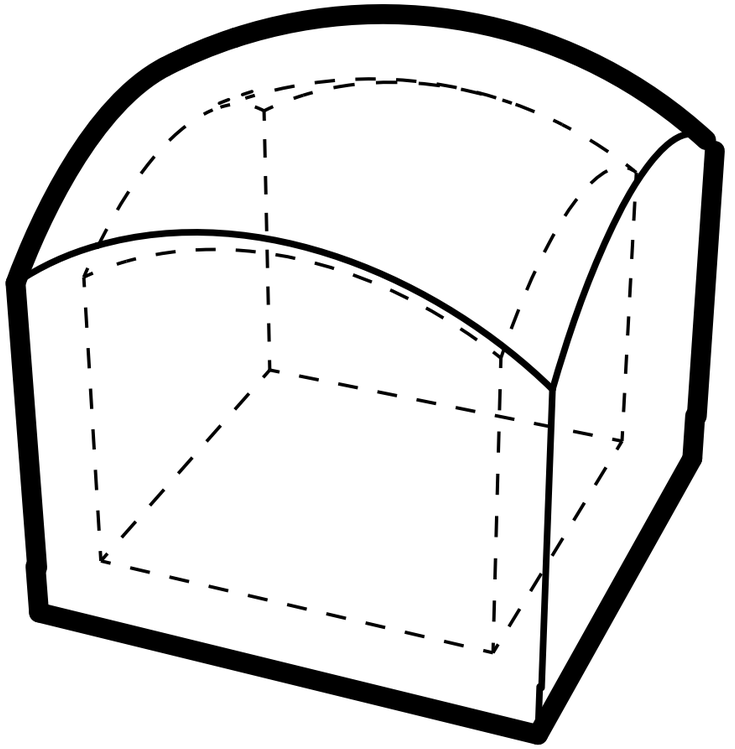
Pipe Diameter

Curved Surface

PIPE DIAMETER

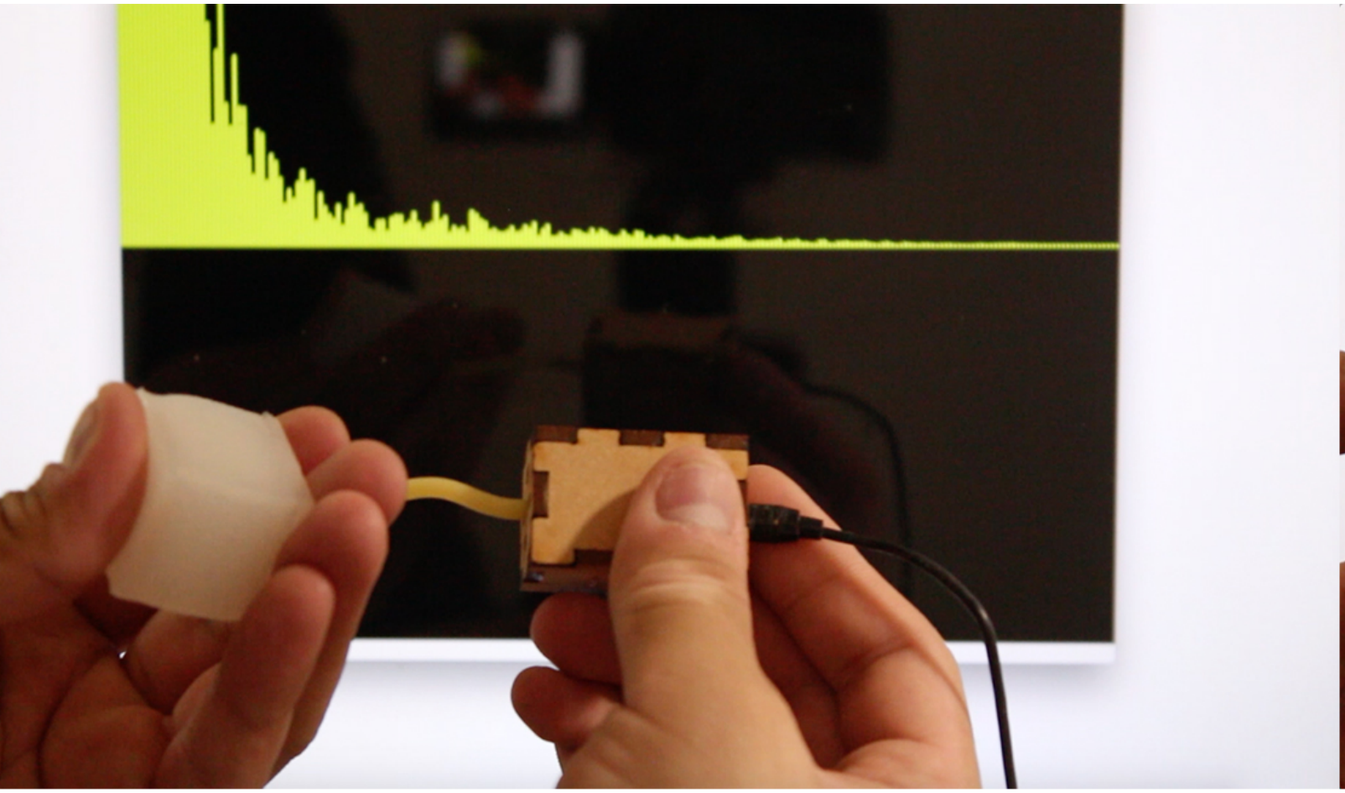
1/16 inch: bigger one causes weaker pulses and smaller one blocks the air flow

CURVED SURFACE

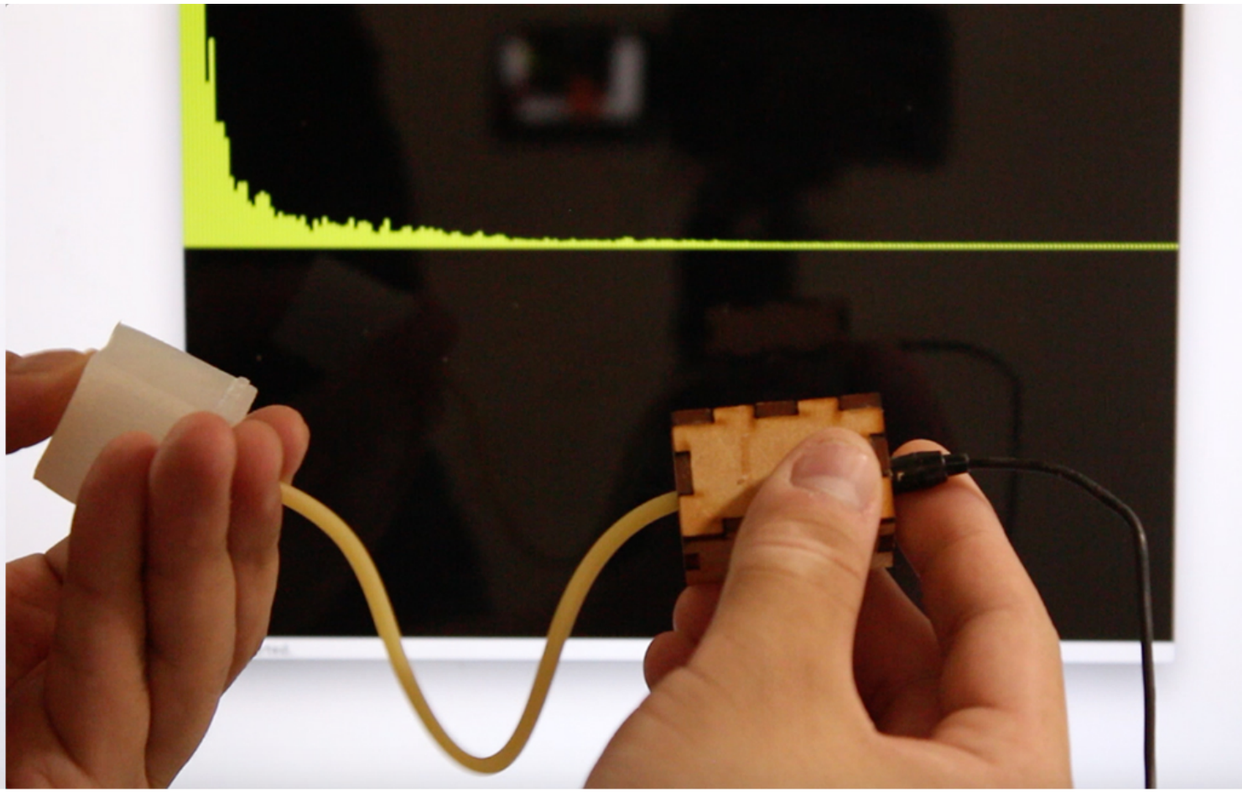


Curved contact is more sensitive

PIPE LENGTH

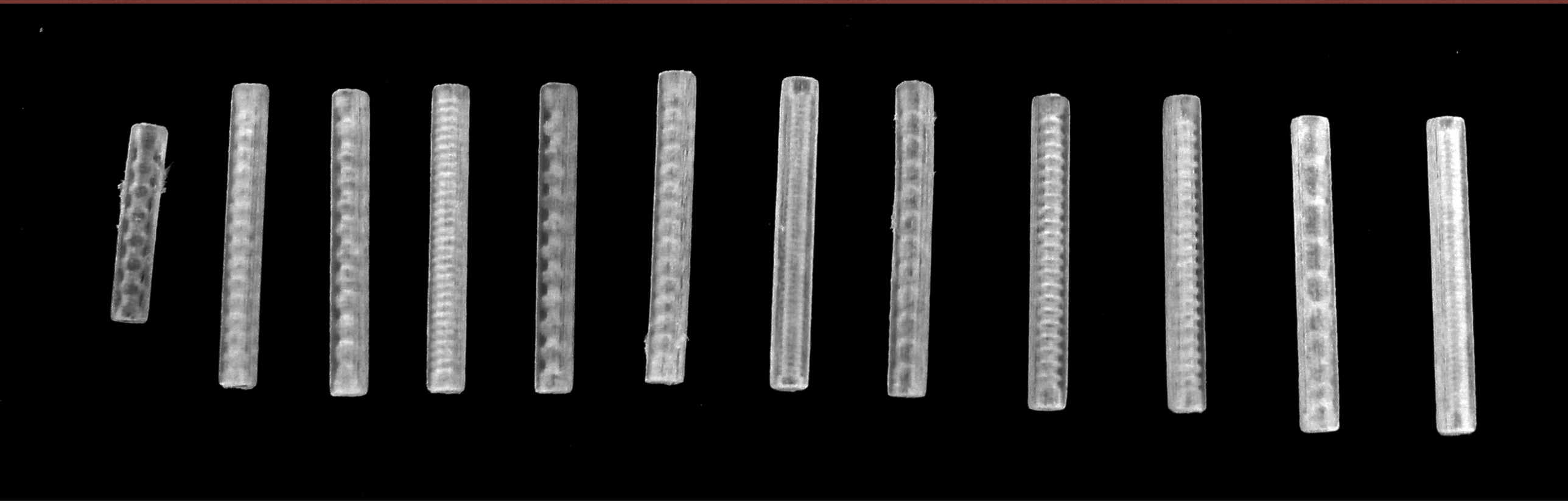


Shorter pipe



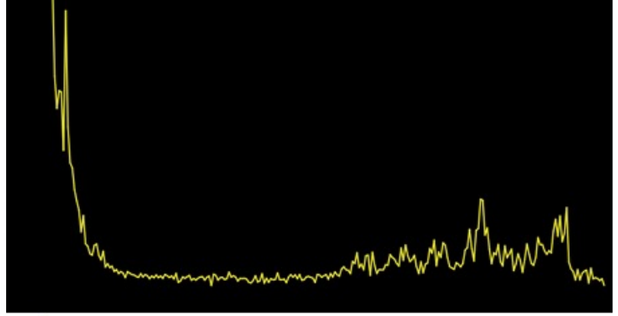
Longer pipe

CORRUGATED TUBE

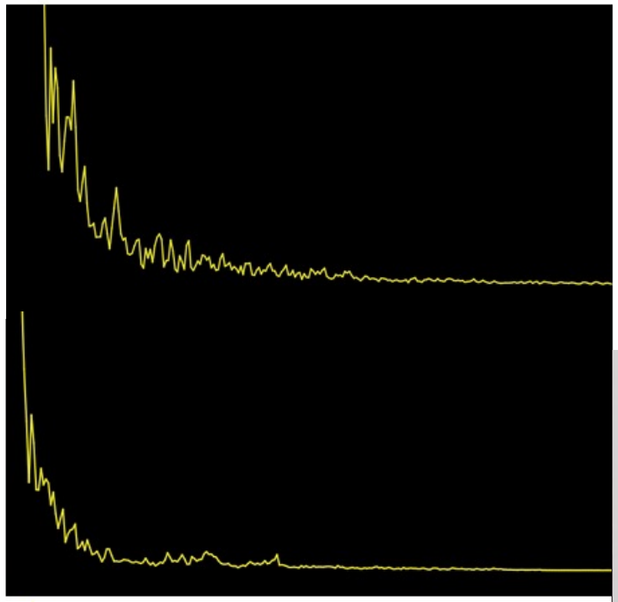


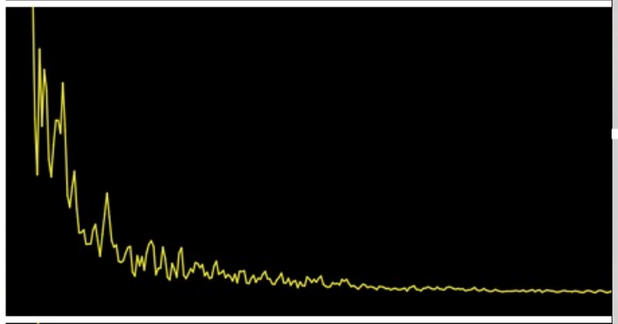
Major factors that contributes the generation of distinct pulses:
Tube length, tube diameter, corrugation shape, corrugation gap, and the geometry of corrugation

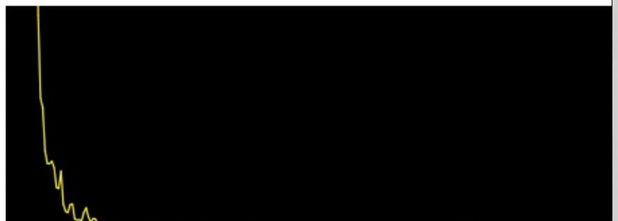
TUBE DIAMETER



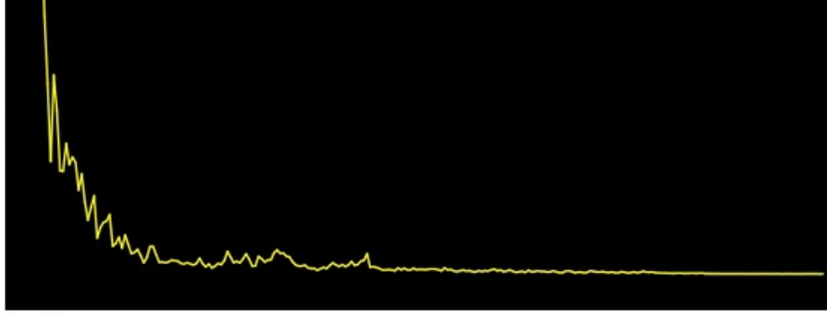
GAP BETWEEN CORRUGATION

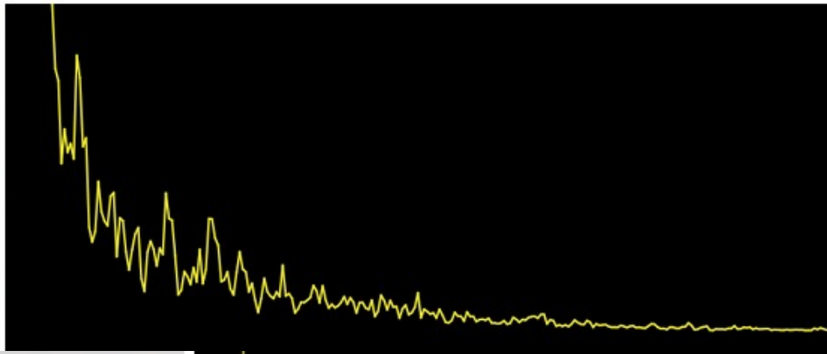




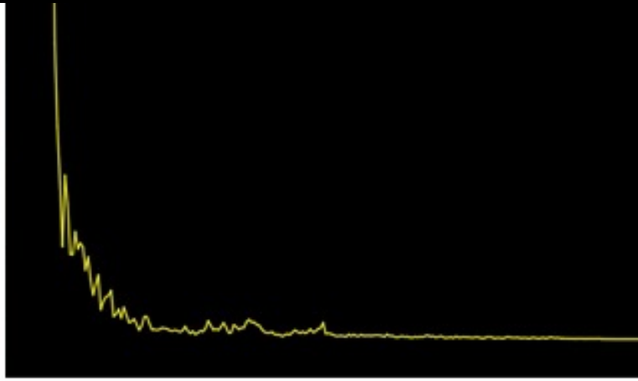


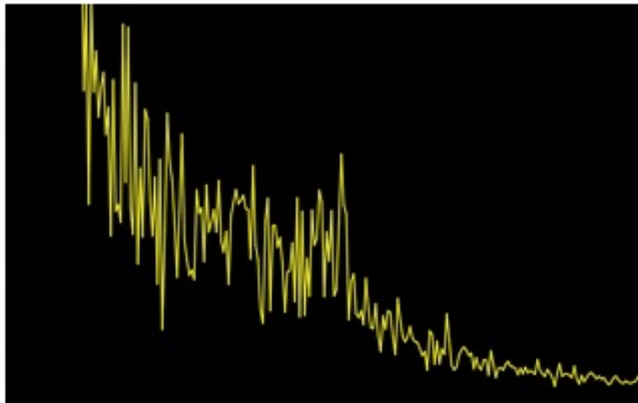
CORRUGATION SHAPE



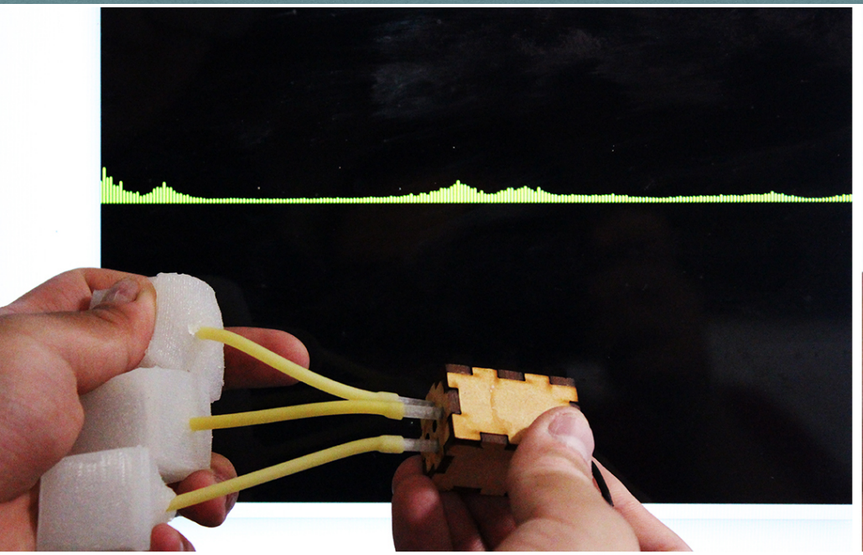


CORRUGATION GEOMETRY DISTRIBUTION

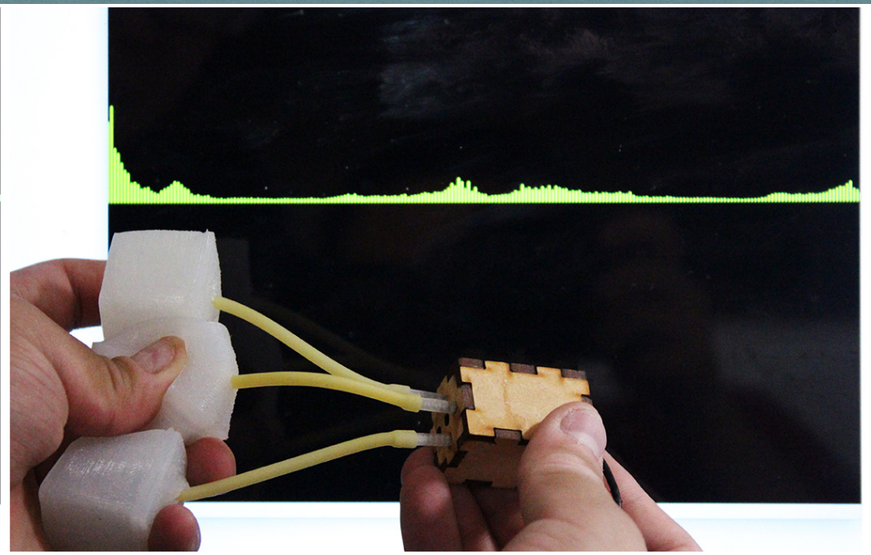




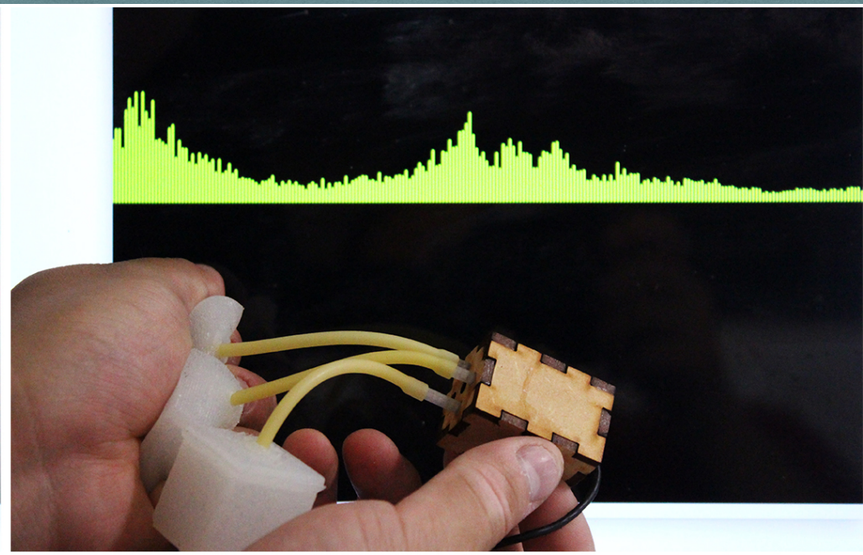
INDIVIDUAL VS. SIMULTANEOUS



The Upper One

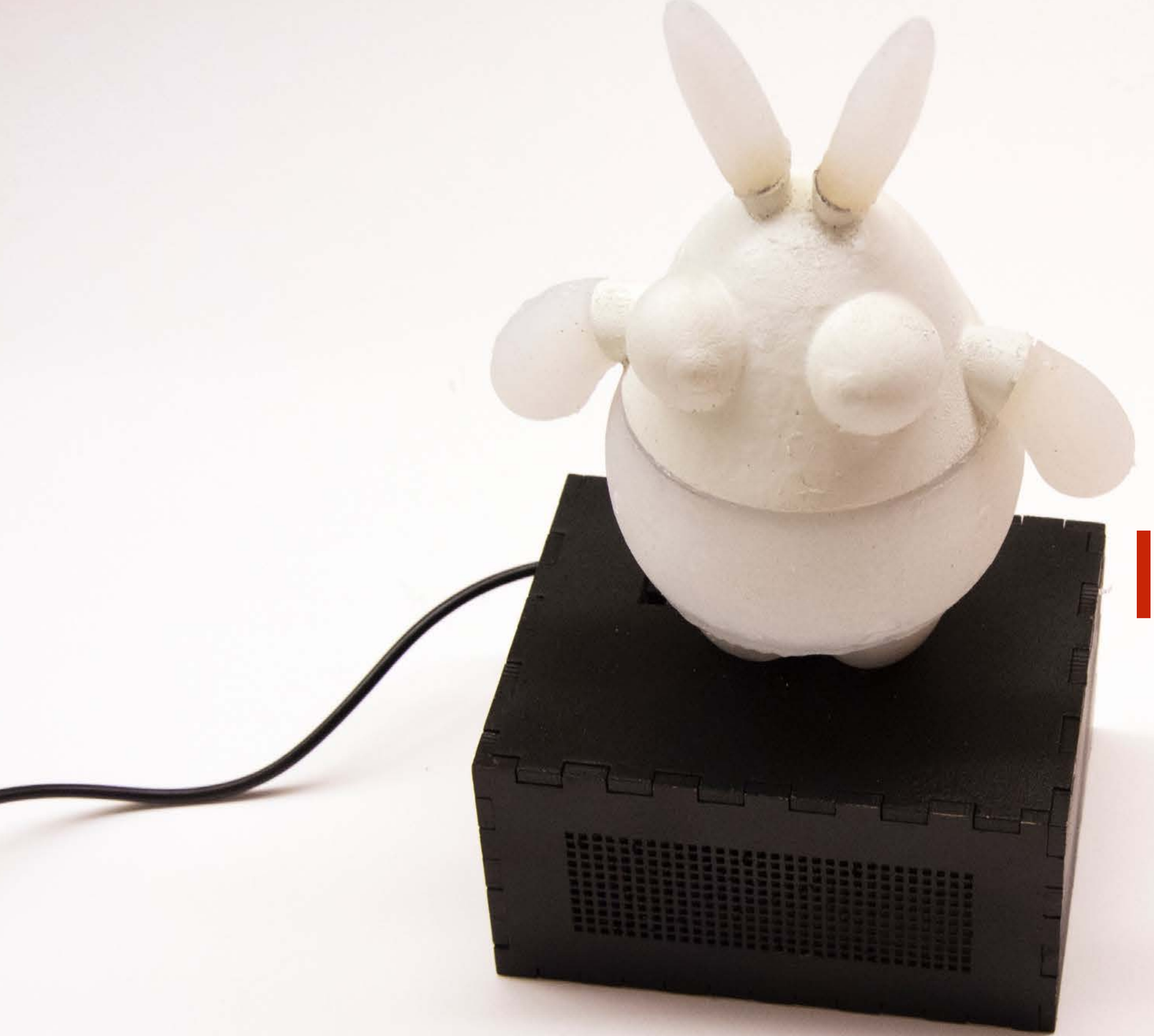


The Middle One

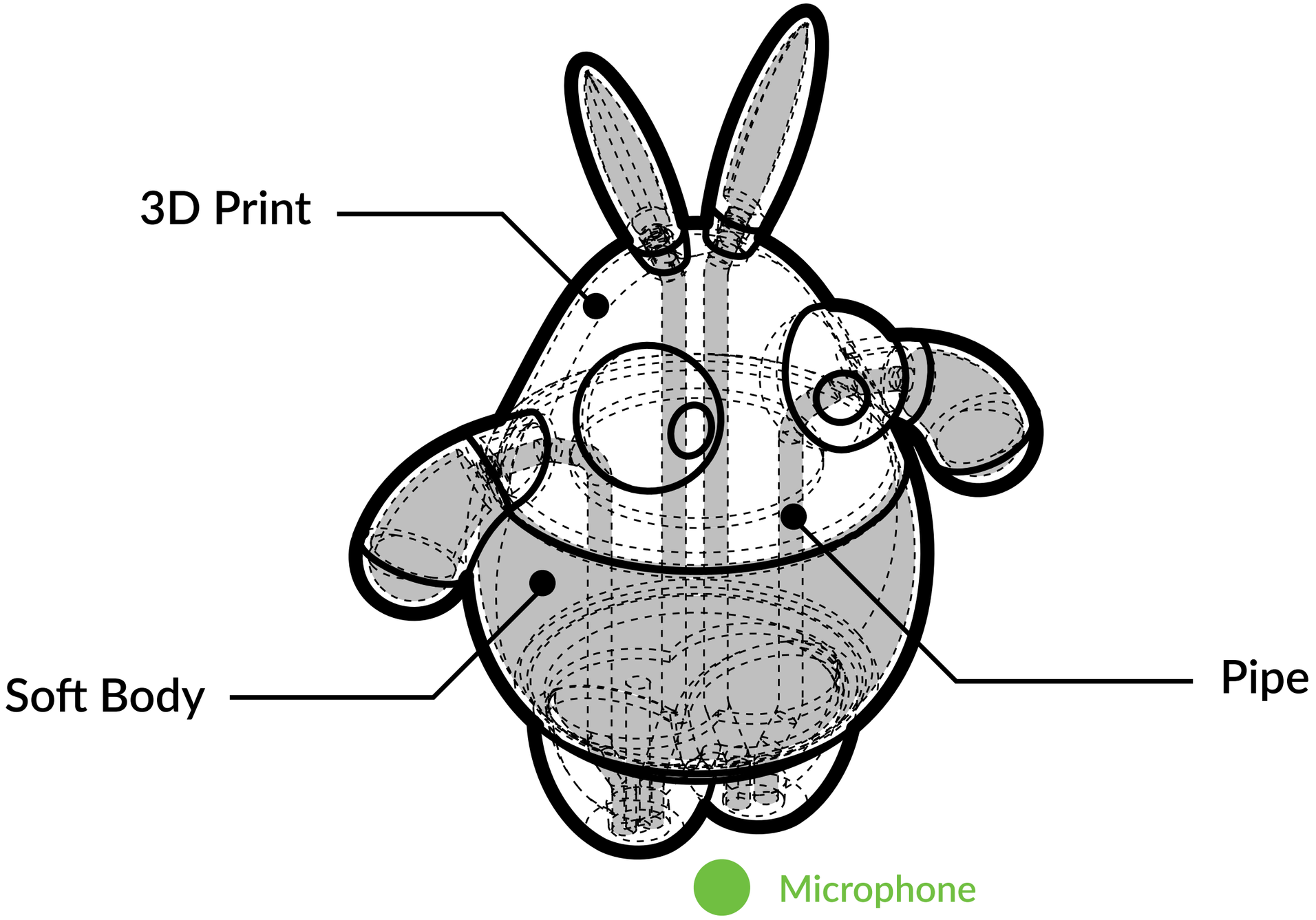


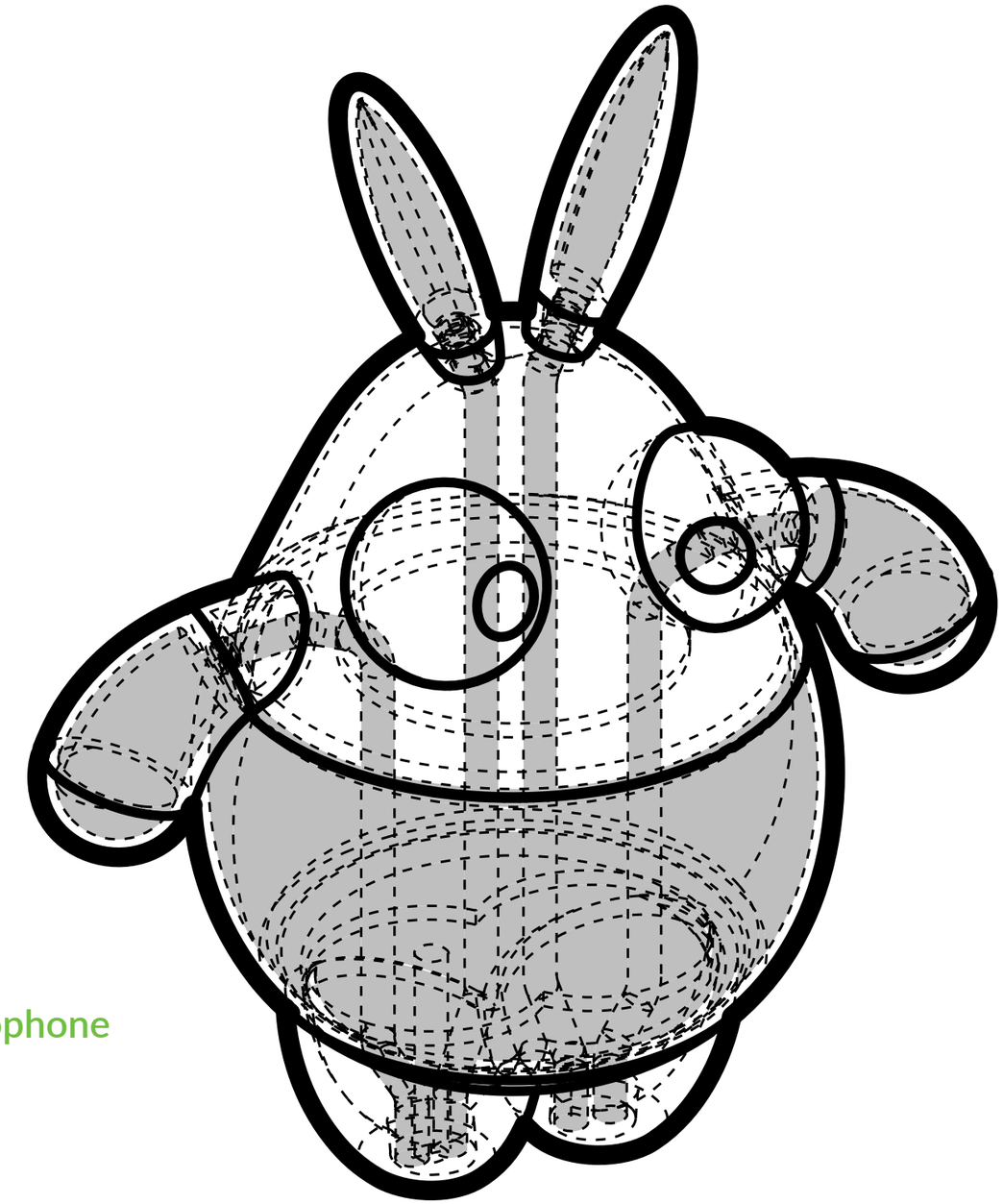
The Upper & The Middle

Applications

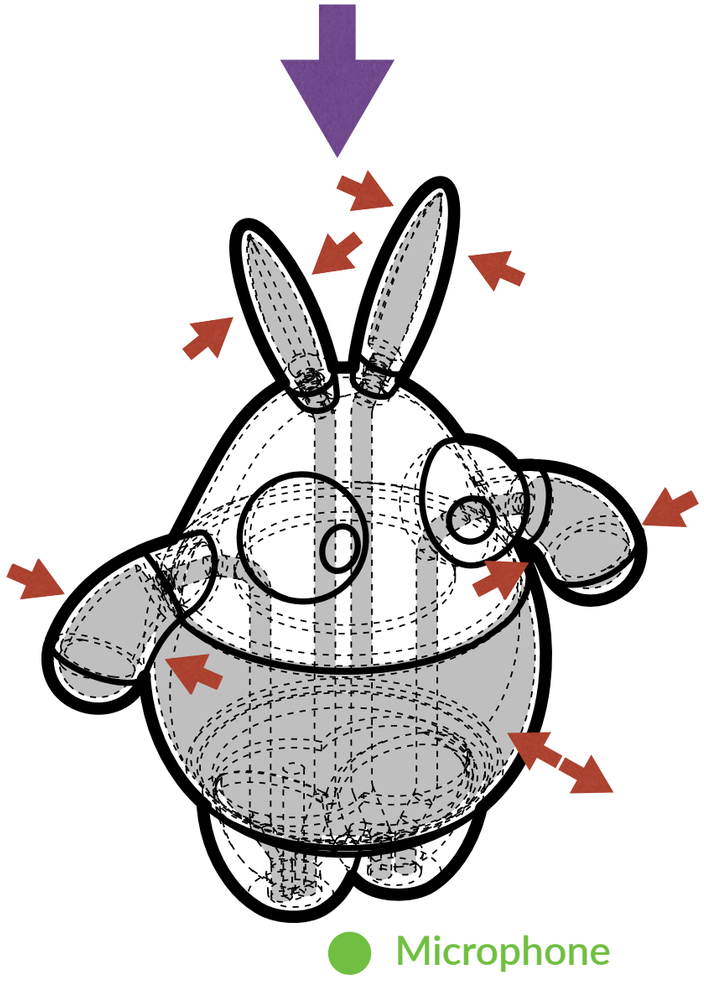


INTERACTIVE DOLL


3D Print
Soft Body
Pipe
Microphone



Microphone

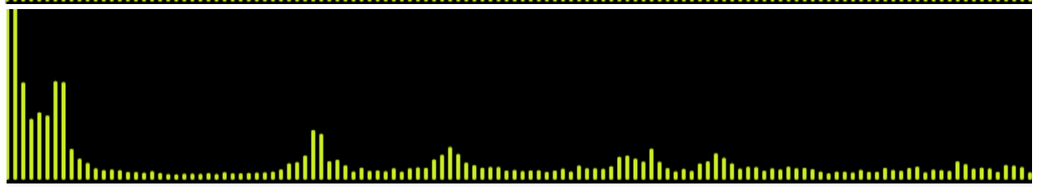


Squeeze right ear

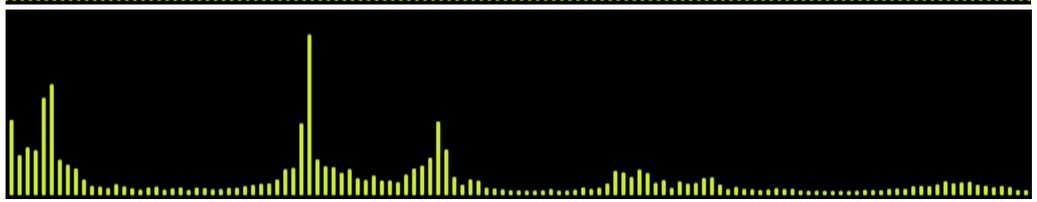
Squeeze left ear

Squeeze both ears

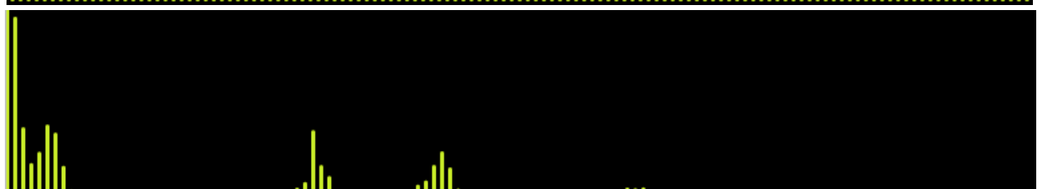
Squeeze right hand



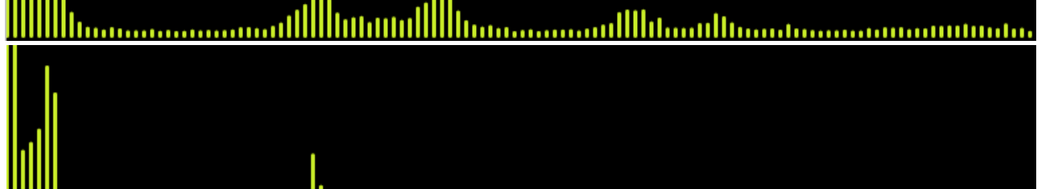
Squeeze left hand



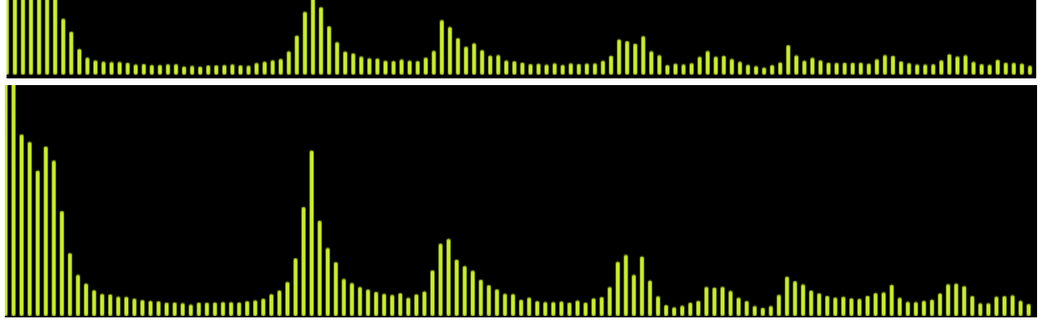
Squeeze both hands



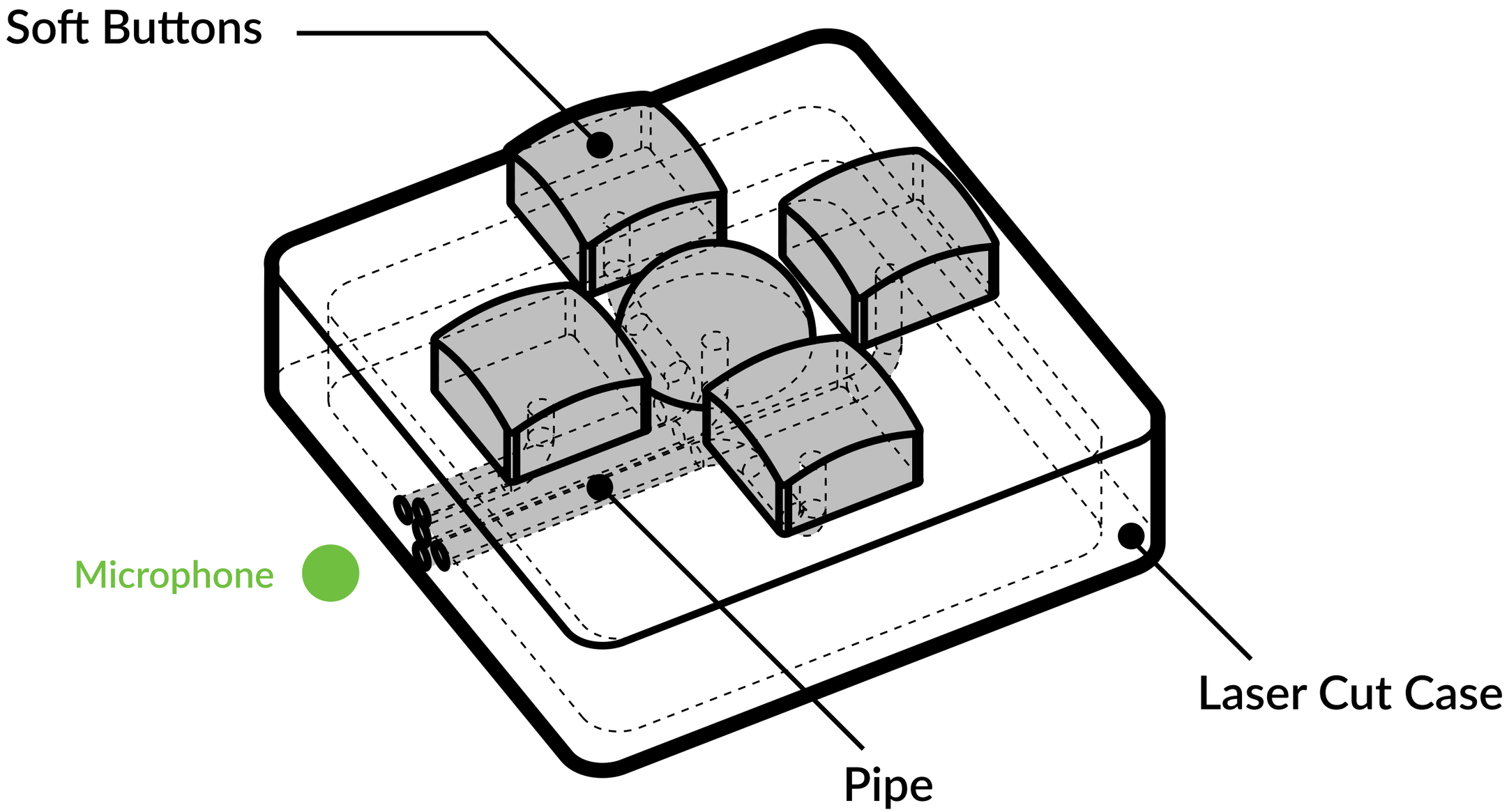
Poke the body



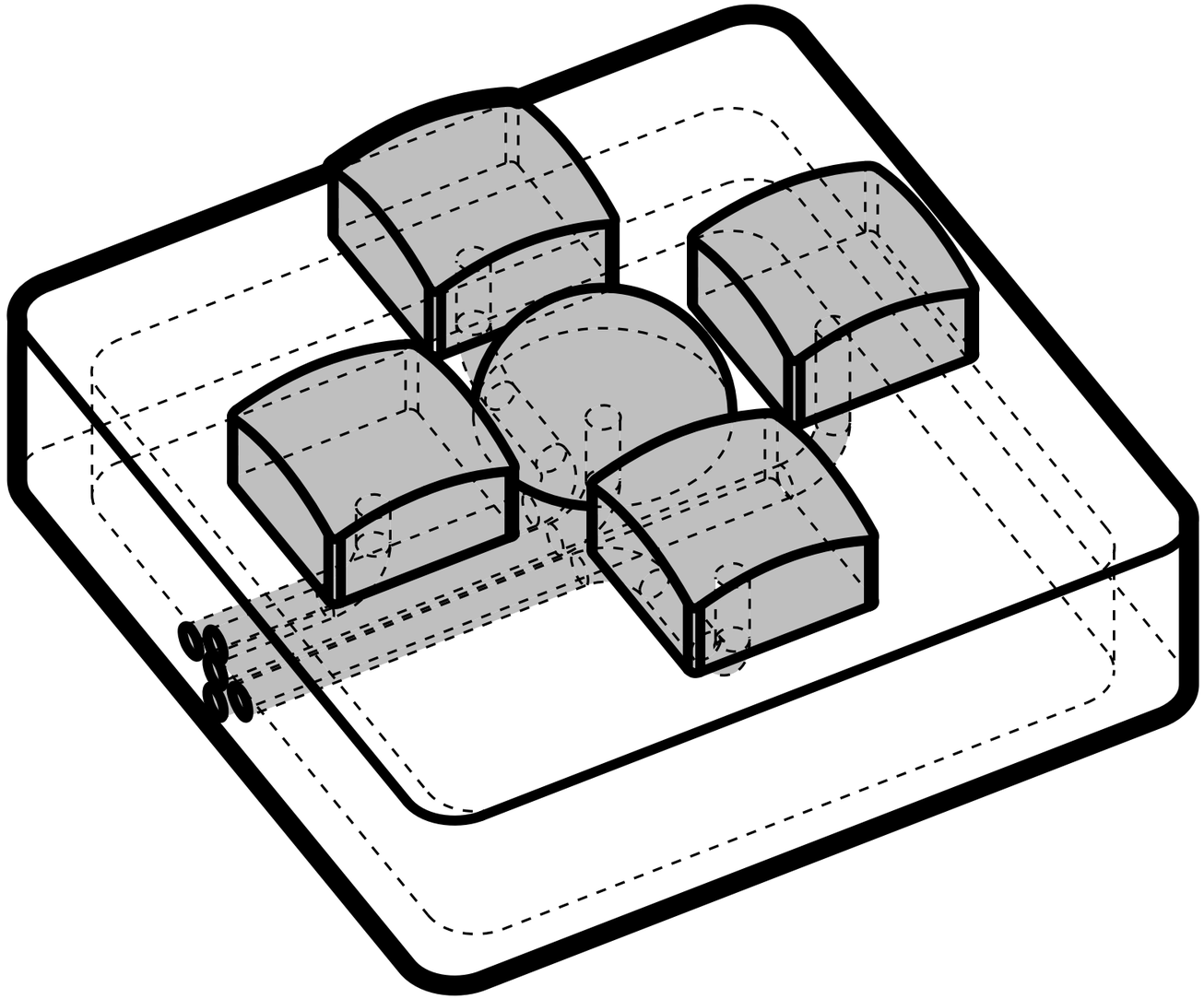
Press the print

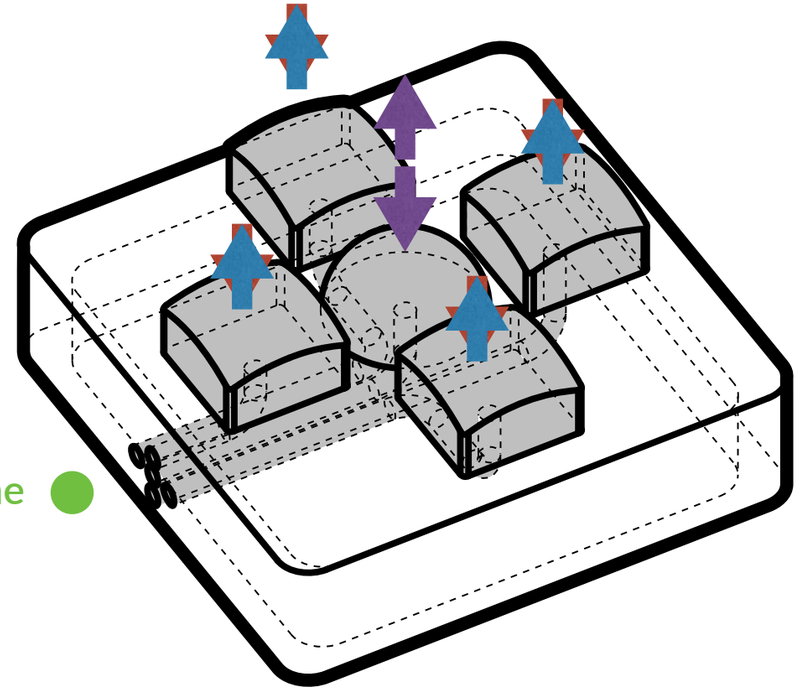


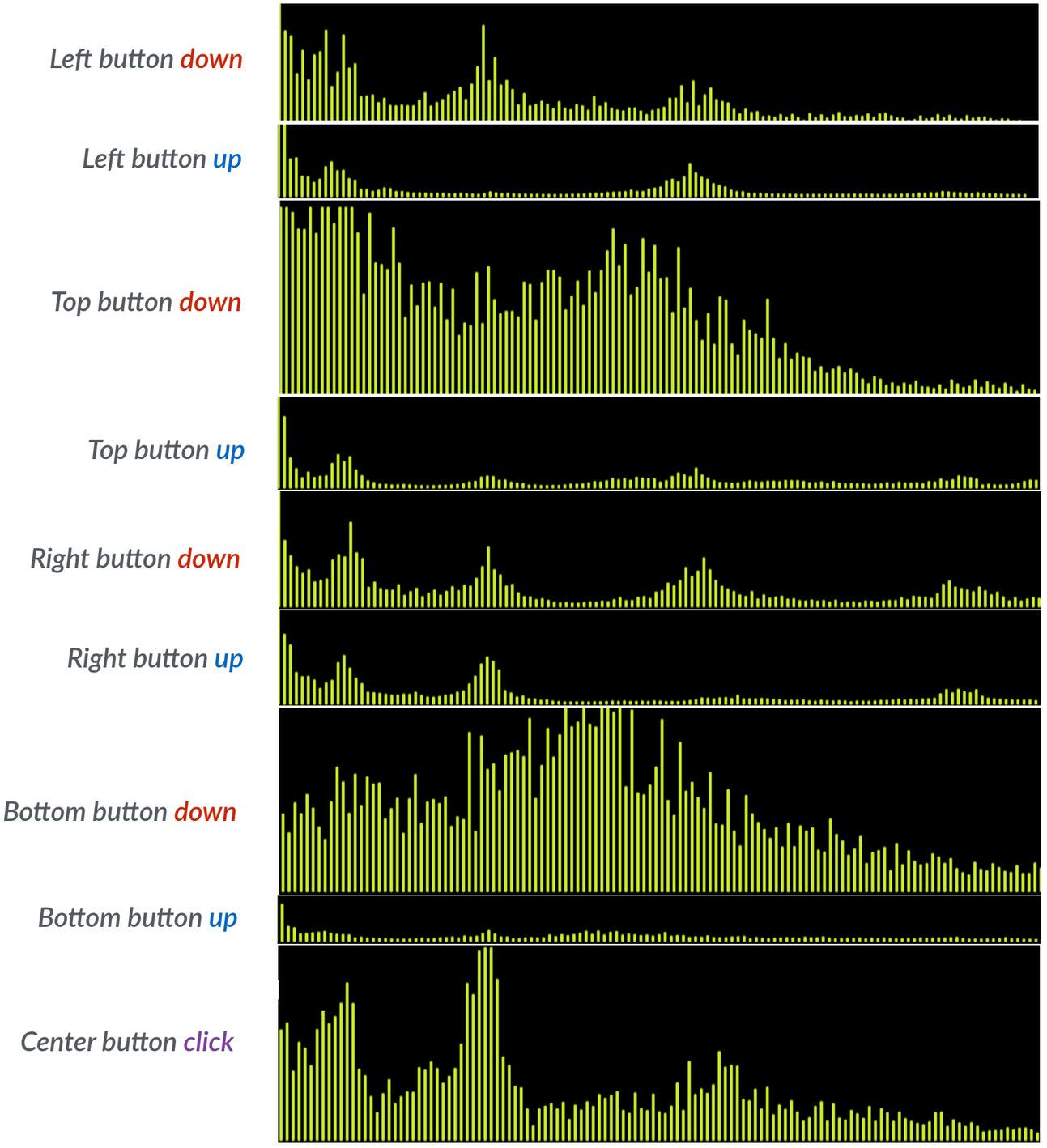

GAME CONTROLLER

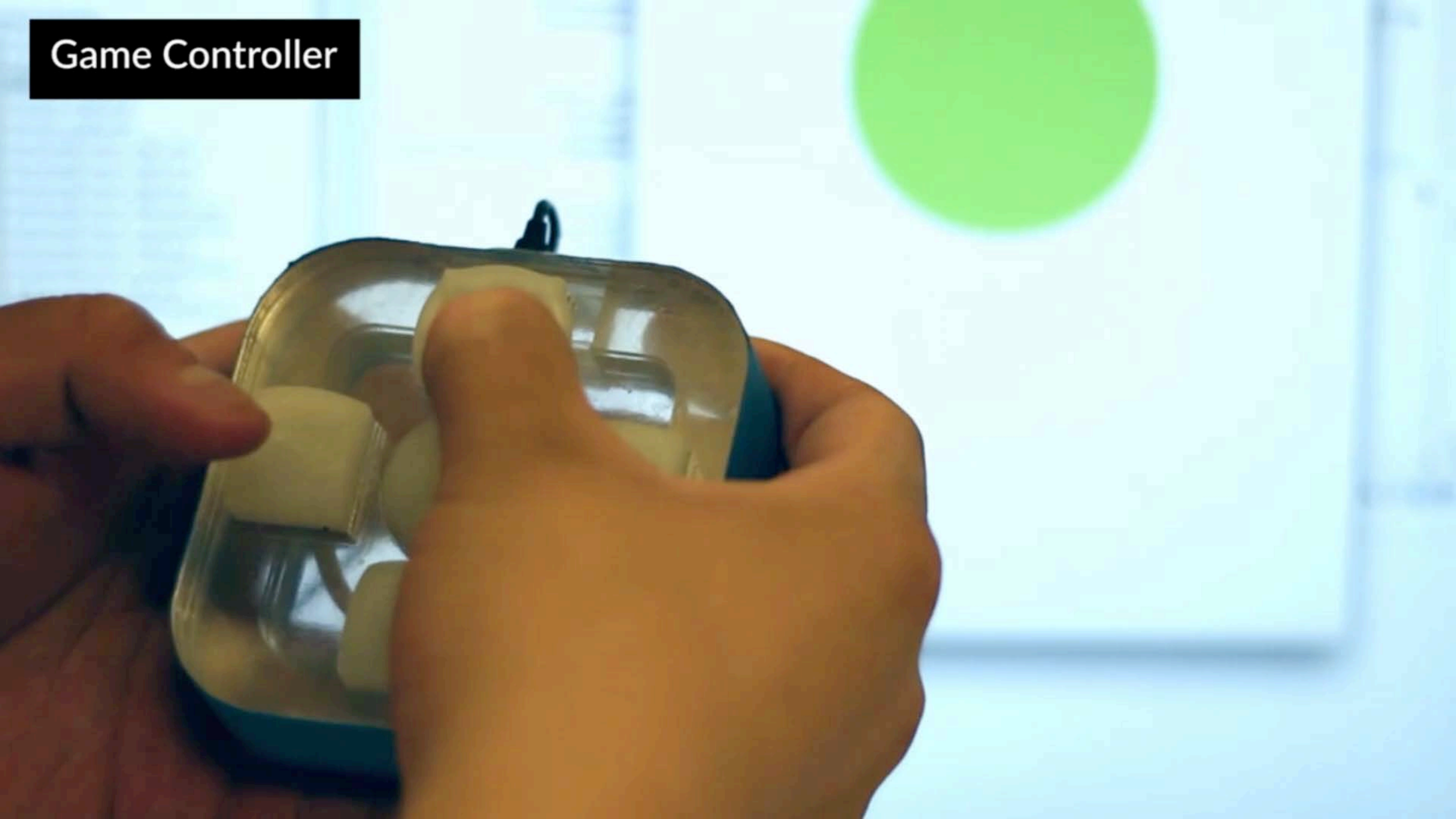

Soft Buttons
Microphone
Pipe
Laser Cut Case

Microphone

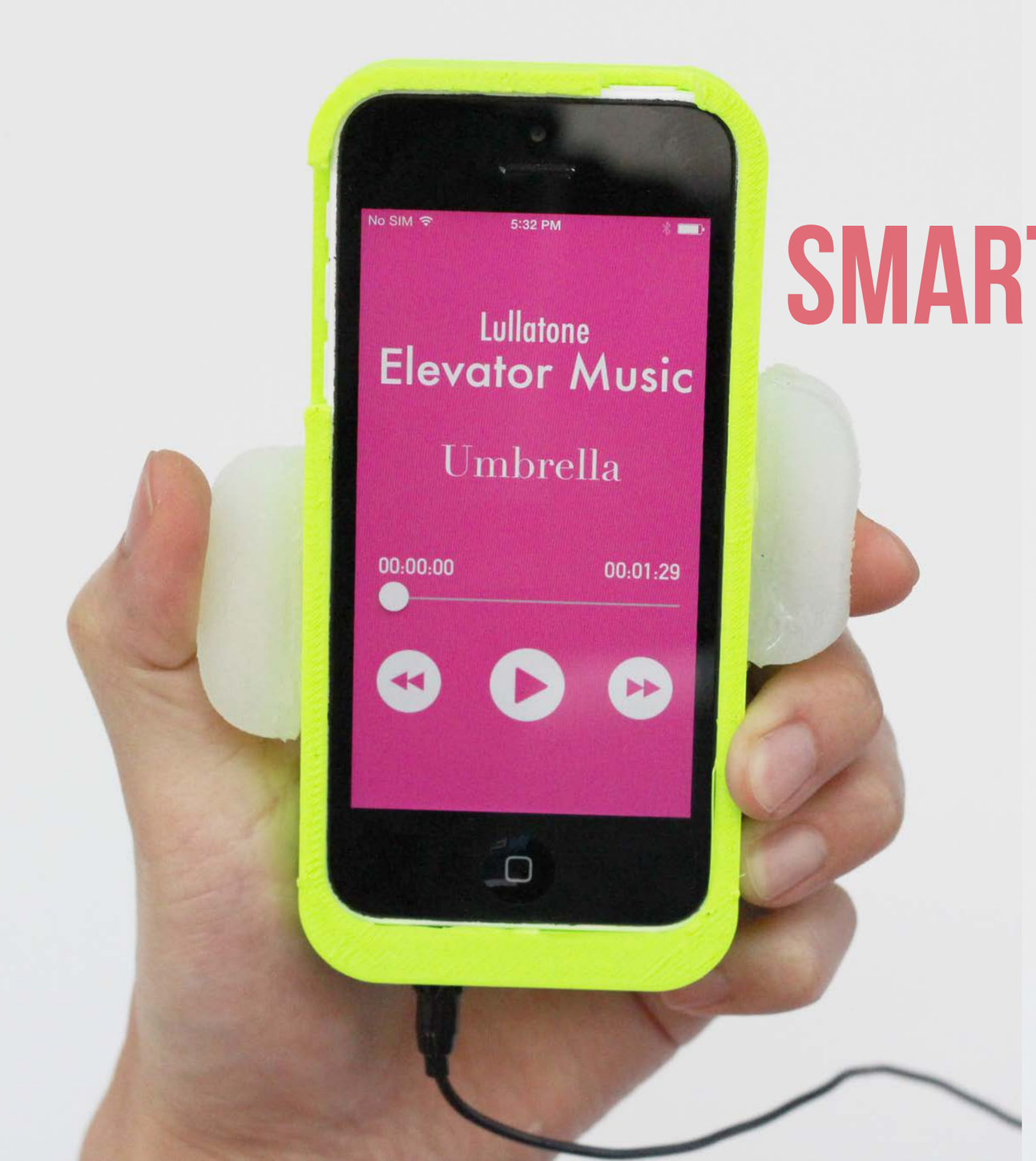



Microphone

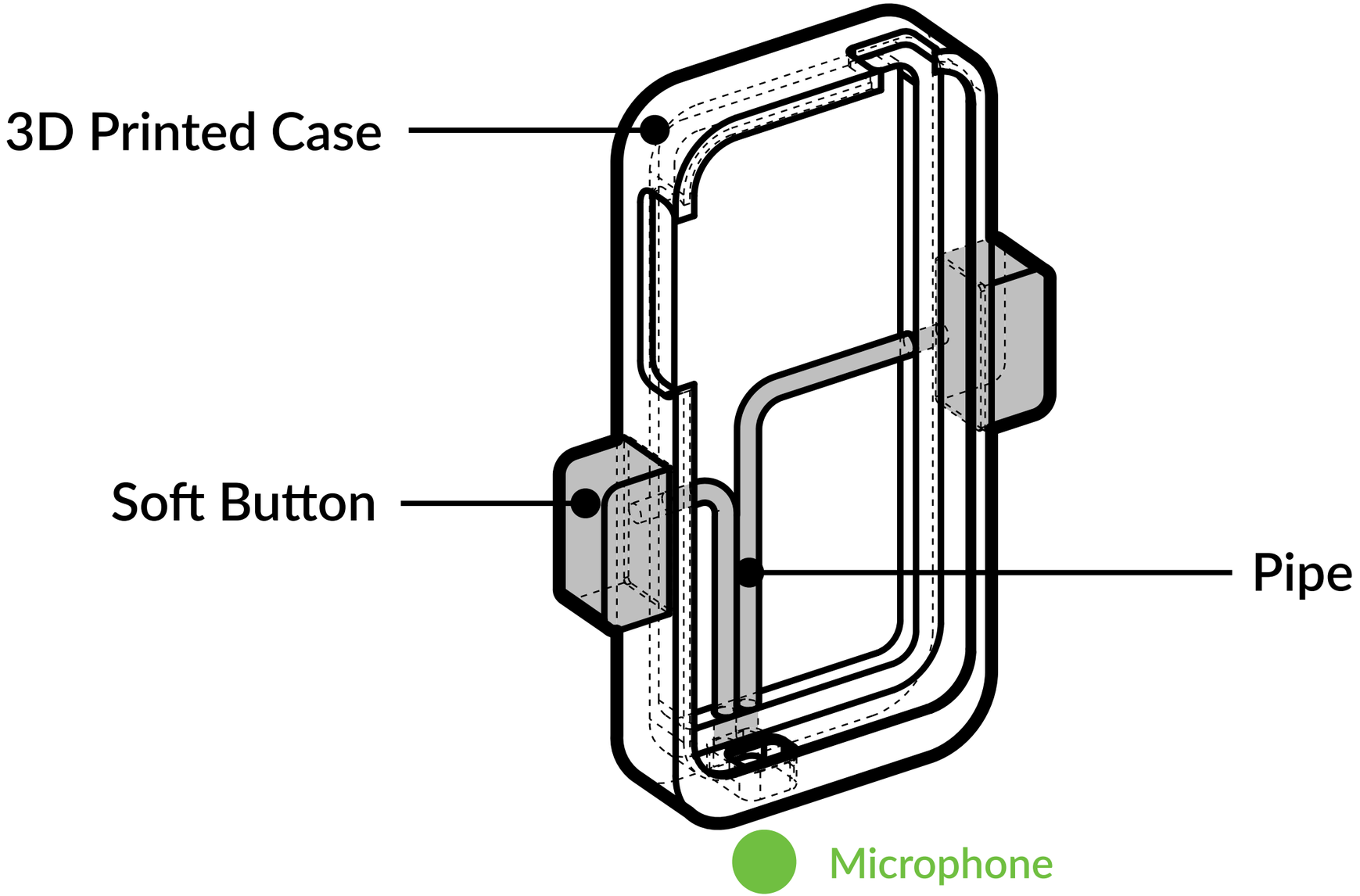

Left button down
Left button up
Top button down
Top button up
Right button down
Right button up
Bottom button down
Bottom button up
Center button click

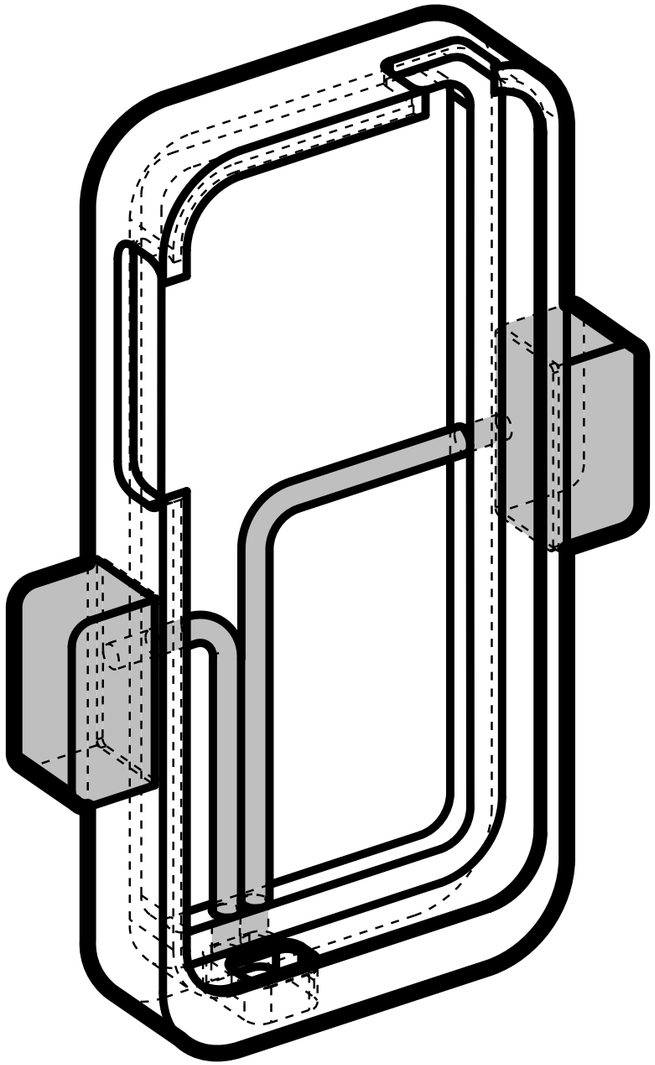

Game Controller

SMART CASE

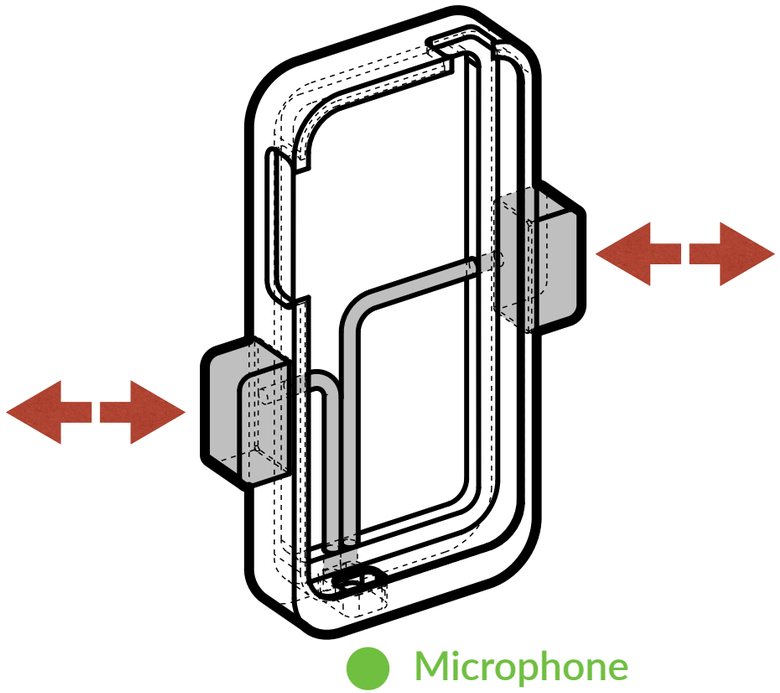

No SIM
5:32 PM
Lullatone
Elevator Music
Umbrella
00:00:00
00:01:29


8:00 AM
Snooze

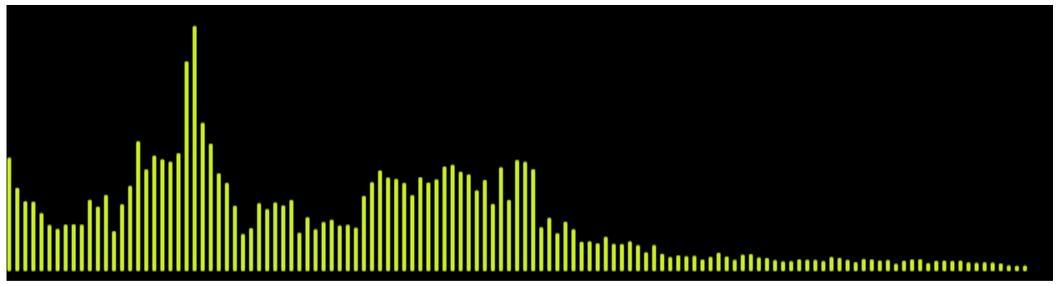

3D Printed Case
Soft Button
Pipe
Microphone



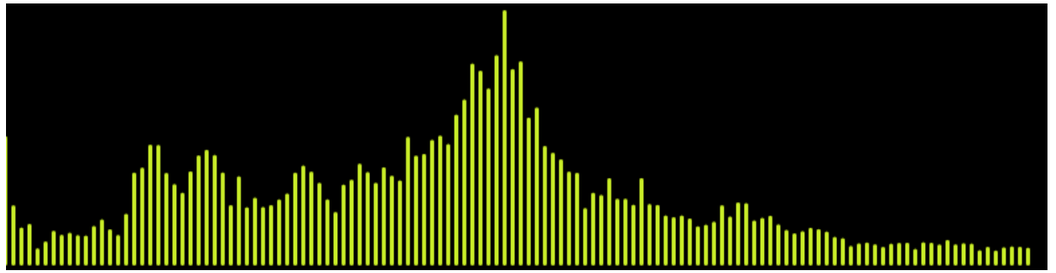
- Microphone



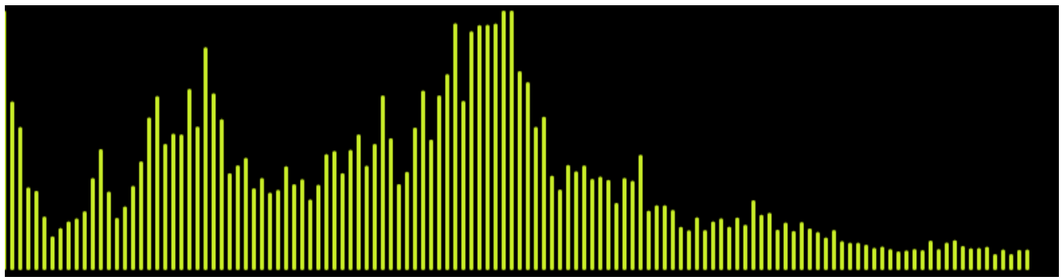
Squeeze left button



Squeeze right button



Squeeze both buttons




Smart Case

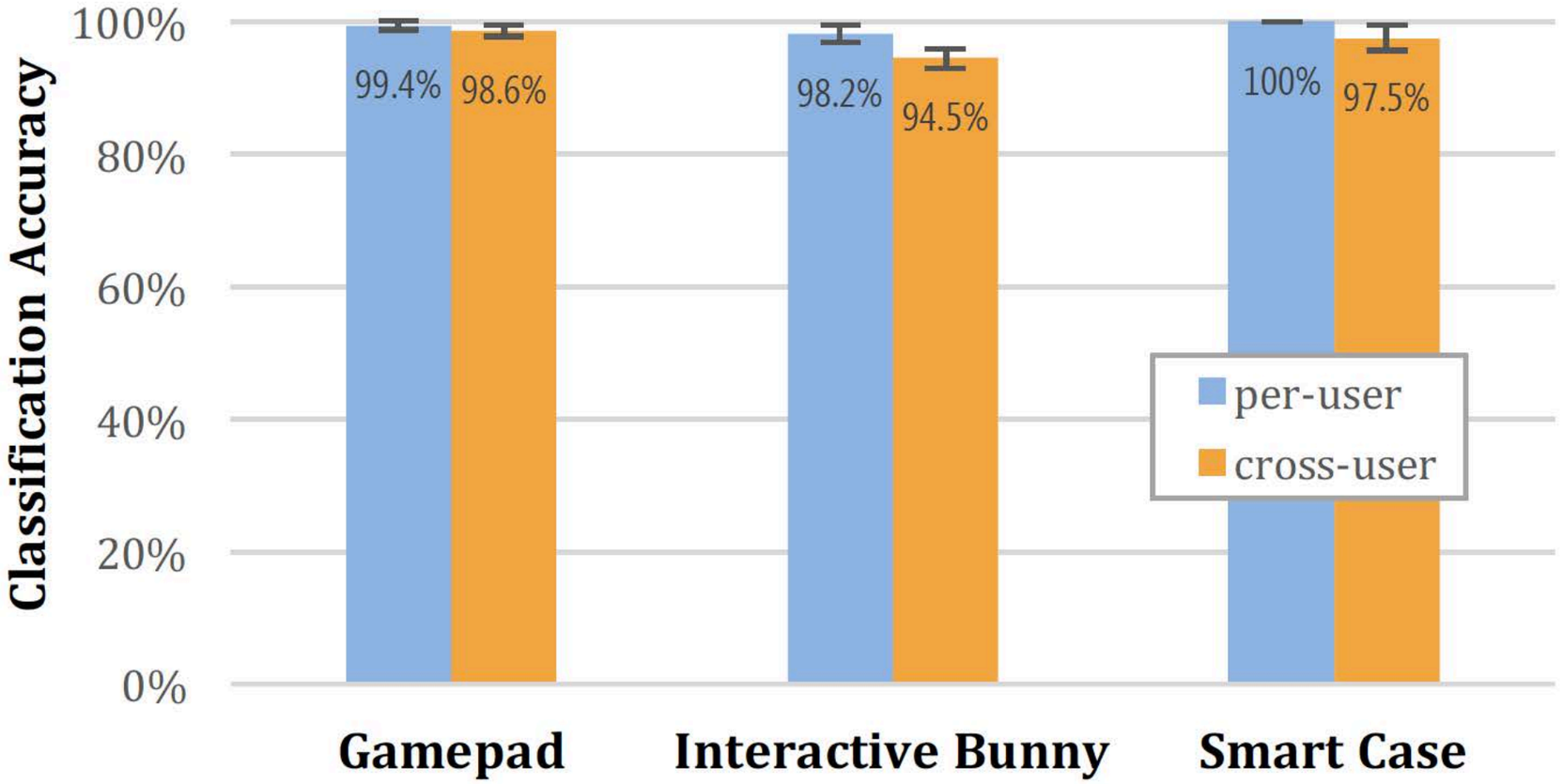

19.7%
FORCE SENSOR


11.6%

Evaluation

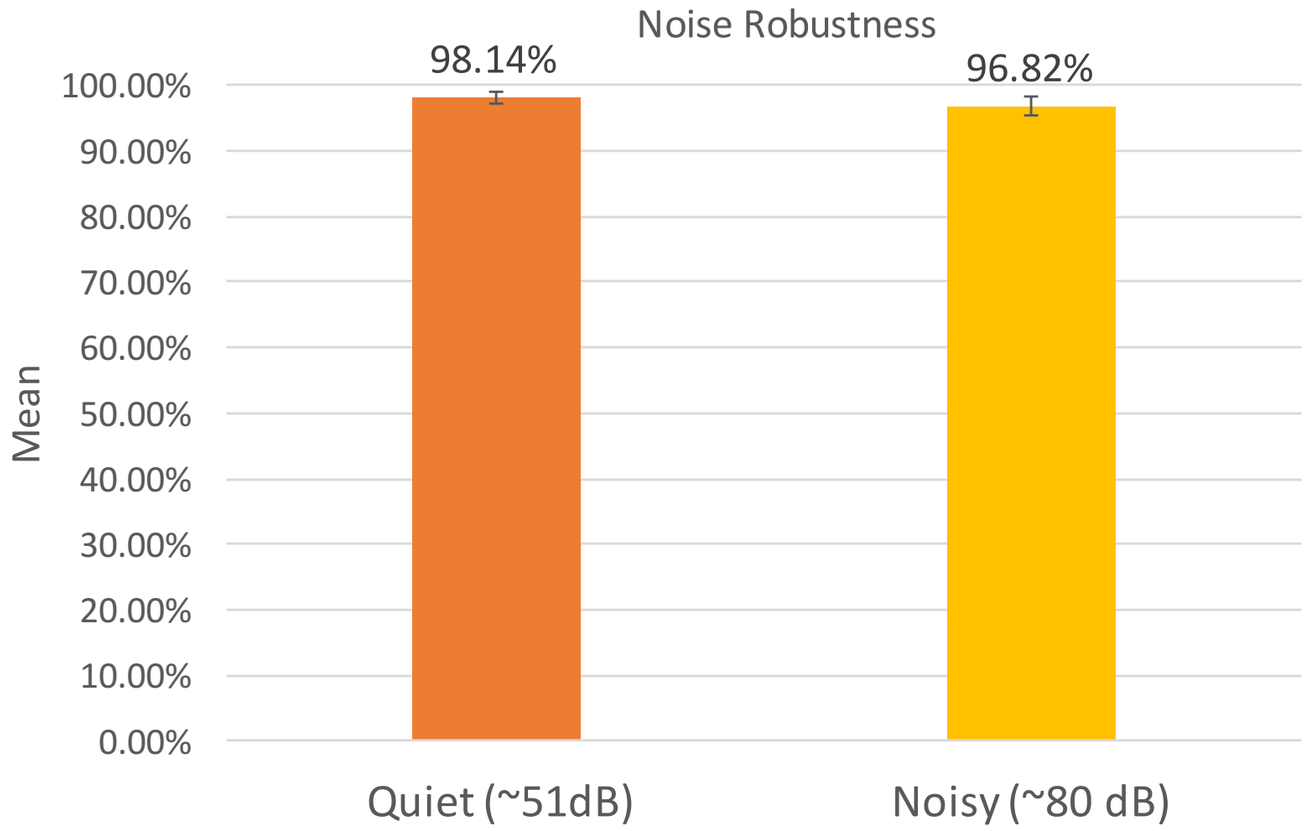
9 participants (**540** sets of data)

User Independent vs. Per-User



Noise robustness

Game controller in **quiet** and **noisy** environments



SUMMARY

Experiment

8 Form Factors

Technique

Passive
Squeezable
Soft
One Microphone

Application

4 Applications
High Accuracy
Robust to Noise

THANKS!

Liang He, Gierad Laput, Eric Brockmeyer, and Jon Froehlich

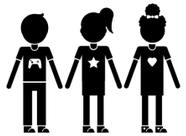
Media Acknowledgements

Dancer
By James Keuning
https://thenounproject.com/term/dancer/373924/

House
By Paulo Volkova
https://thenounproject.com/term/house/3966/

School
By Mike Wirth
https://thenounproject.com/term/school/23692

Bus Stop
By Iconathon
https://thenounproject.com/term/school-bus-stop/731/



Friends
By Marie Van den Broeck
https://thenounproject.com/term/friends/235419/

Boy
By Carlos Gonzalez
https://thenounproject.com/term/boy/364826/

Painting
Juan Pablo Bravo
https://thenounproject.com/term/painting/17015

Trampoline
Juan Pablo Bravo
https://thenounproject.com/term/trampoline/16998

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