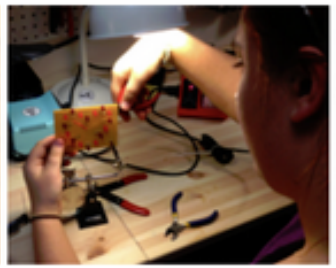
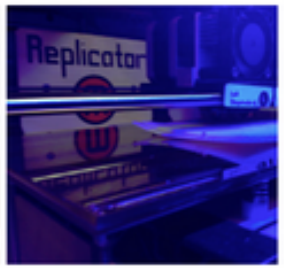

A RAPID TOUR OF MY
EXPLORATIONS IN E-TEXTILES
DESIGN USE BUILD
MAKEABILITY LAB
PAUL G. ALLEN SCHOOL
OF COMPUTER SCIENCE & ENGINEERING
UNIVERSITY of
WASHINGTON

CMSC838f

Tangible Interactive Computing

"Joy is a well-made object, equaled only to the joy of making it."

-a Canadian Native American tribe saying, as quoted by Mark Fraunfelder (author, co-founder of BoingBoing, & editor of MAKE Magazine)

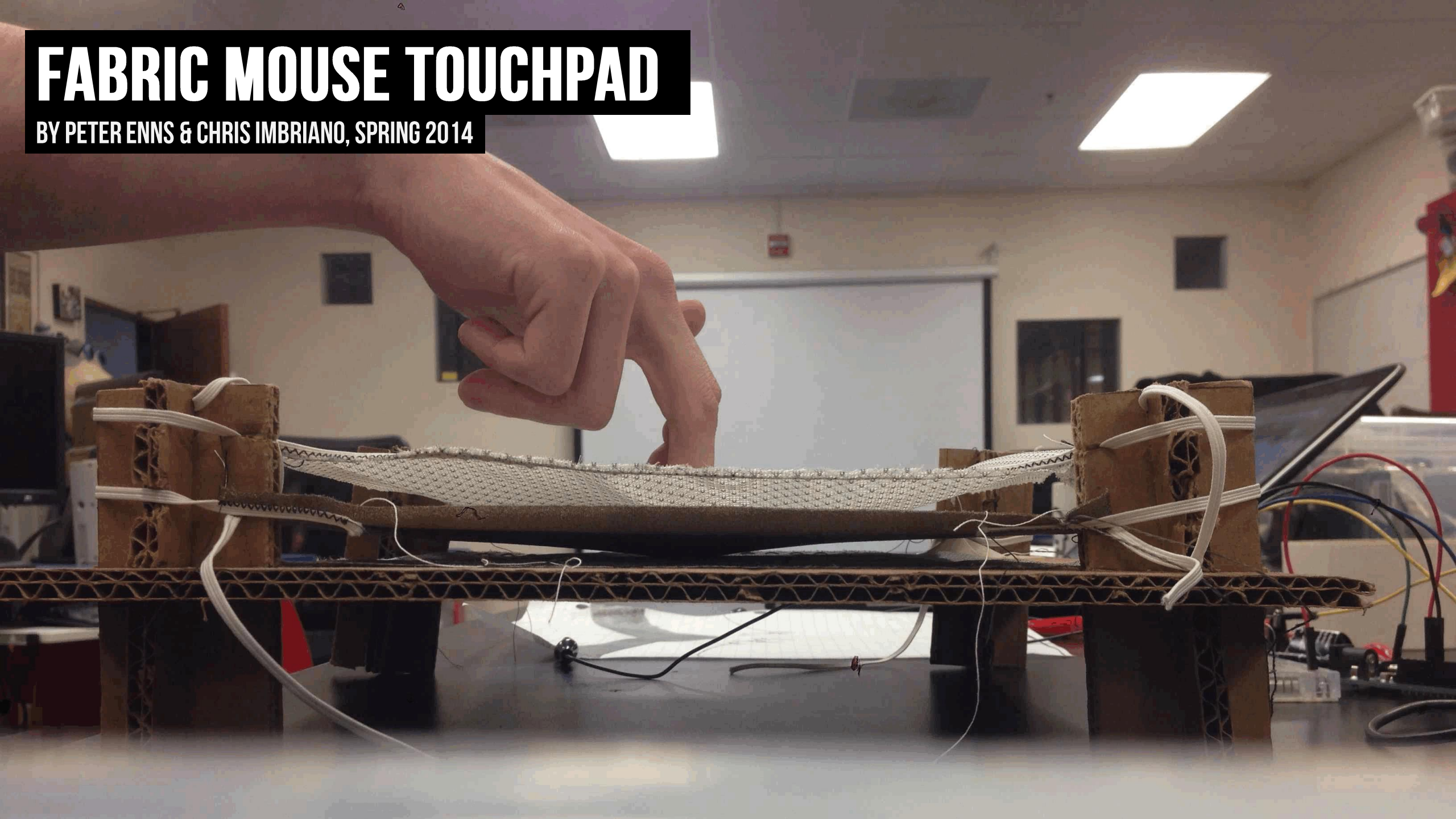
Preamble

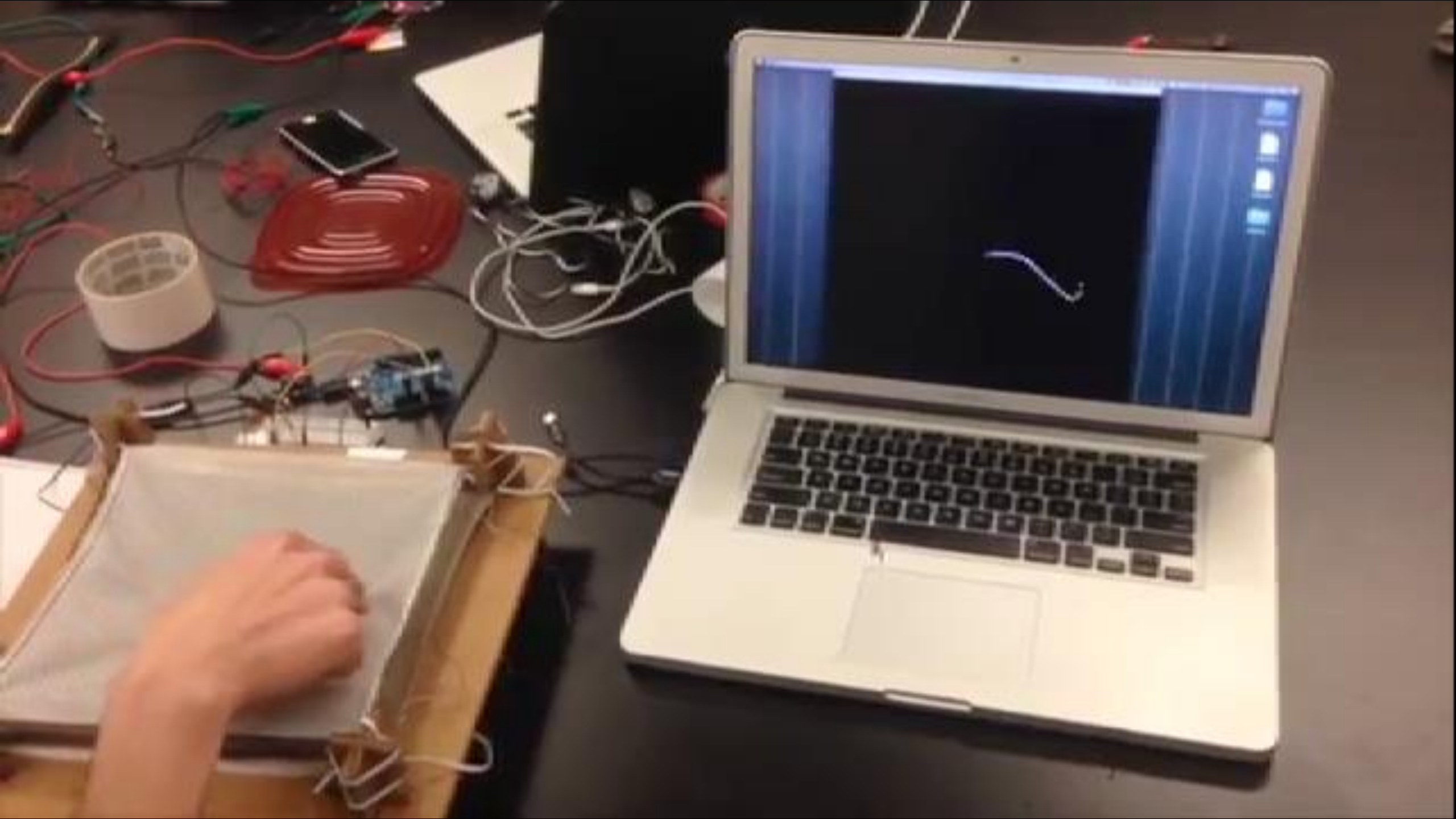
This class is about making, being creative, taking risks. We will make to learn and learn to make. We will use materials to help us think and to push our own boundaries of what interactive computing is and could be. I taught this class once before: http://cmsc838f-f12.wikispaces.com. It was, by most accounts, a success (I think!). I learned a lot. The class learned a lot. Most importantly, along the way, we had *fun* together, we *made* interesting things, and we *helped* each other (peer learning ftw).

As another indicator of success, the aforementioned Fall2012 class generated one MS thesis topic, one PhD thesis topic, and two publications (with more to come!). In addition, the instructables posted for the final project have garnered over 74,265 views and have been favorited 317 times (as of Jan. 2014) including HandSight (9,330 views

FABRIC MOUSE TOUCHPAD

BY PETER ENNS & CHRIS IMBRIANO, SPRING 2014





MUSICAL SPAGHETTI MADNESS

BY RICHARD JOHNSON, SPRING 2014

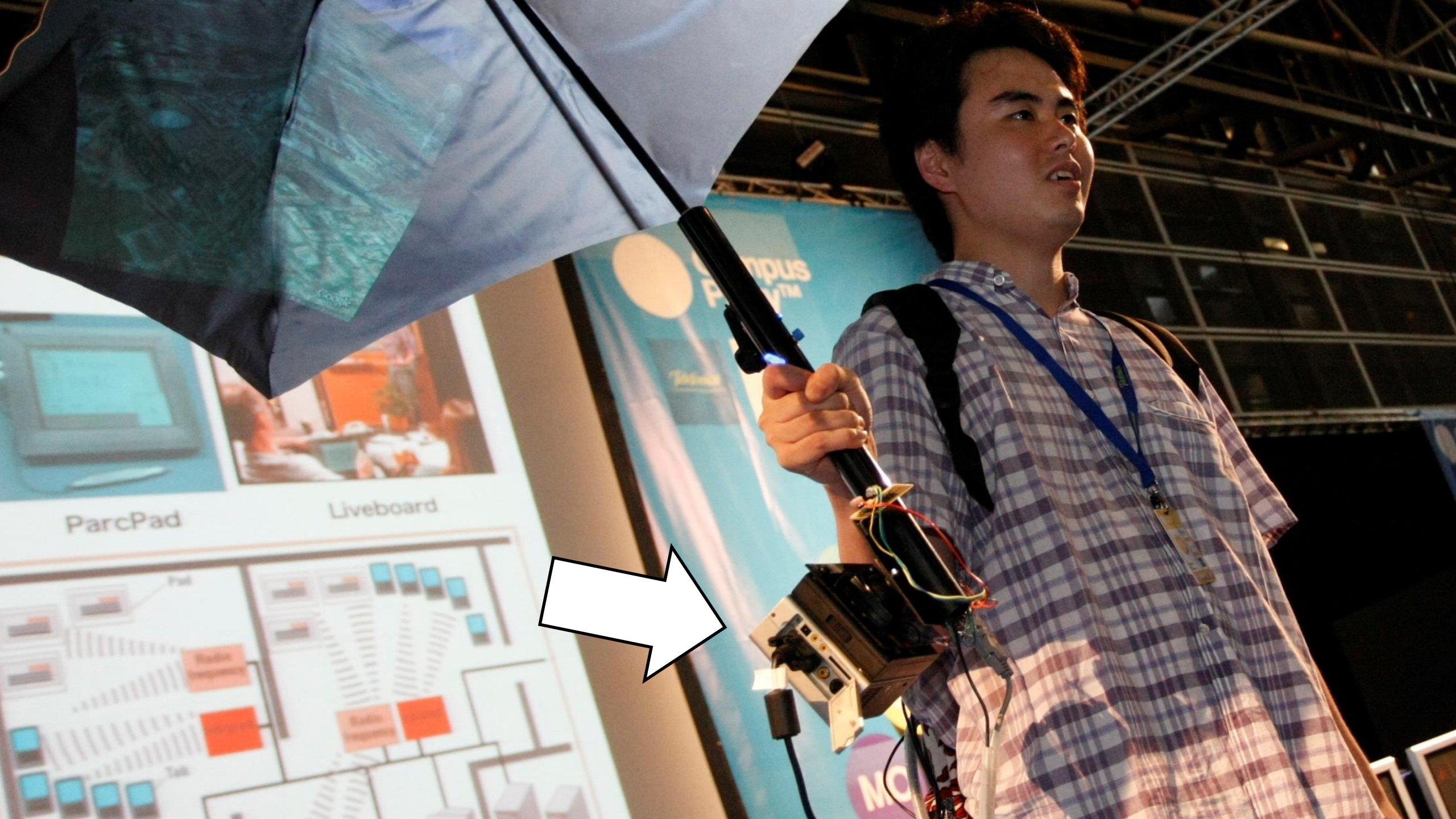
Interactive Wall Hanging

Designers: Jie Qi & John Clifford

Pileus: The Internet Umbrella

Designers: Sho Hashimoto & Takashi Matsumoto

Source: http://www.pileus.net/


ParcPad
Liveboard

Flutter

Designers: Halley Profita, Nicholas Farrow, Nikolaus Correll

Flutters in direction of sound

Microphone

Vibration motors

Source: IWSC2012

Electro-Mechanical Dress

Designer: Hussein Chalayan

Source: https://youtu.be/wXaONmuCgWE

T-Shirt Tetris

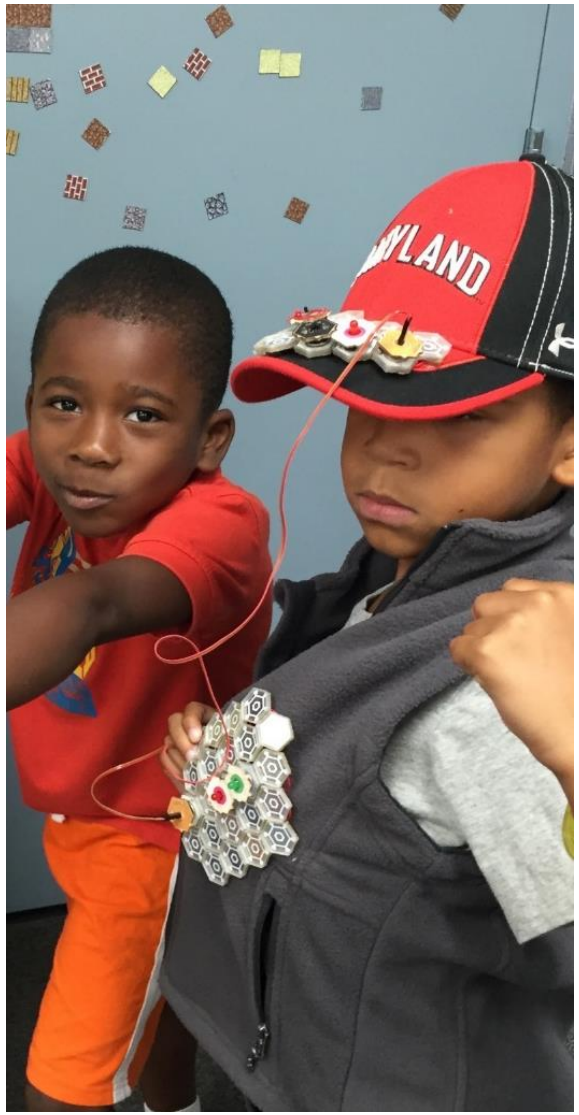
YouTube User: Marc Kerger

Source: http://youtu.be/dsi3bIHlKv4

SOCIAL FABRIC FITNESS
[CHI'14]

I LIKE THIS SHIRT
[CHI'14]

BODYVIS
[IDC'13, CHI'15 Honorable Mention, ICLS'16, IDC'16, CHI'17]

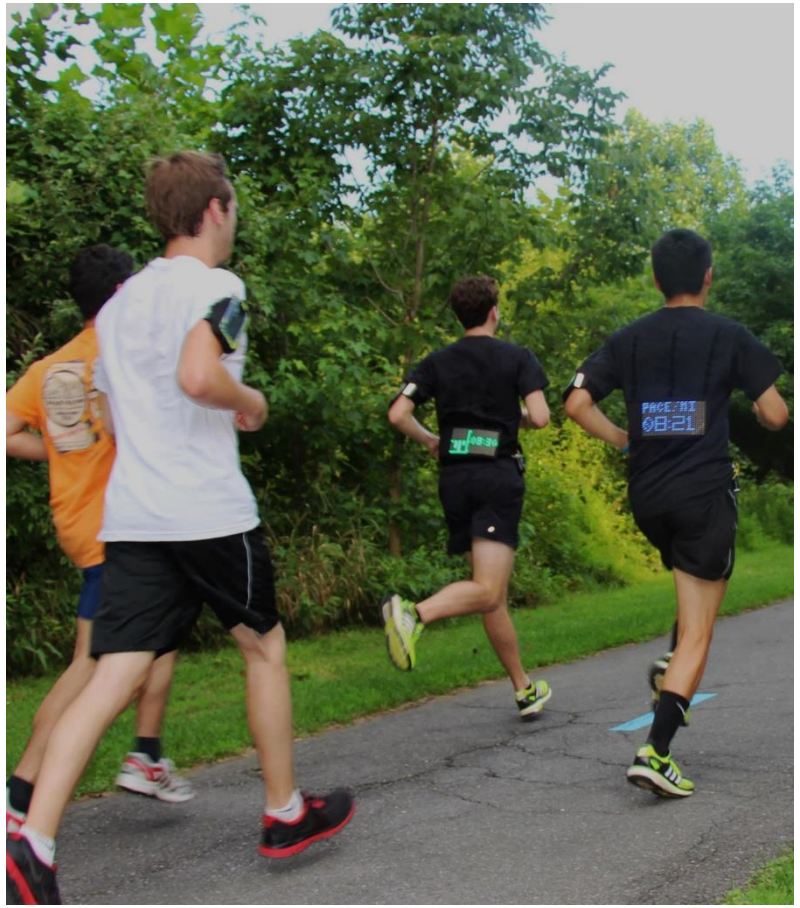


MAKERWEAR
[IDC'15, CHI'16 Best Poster, CHI'17 Best Paper]

HEALTH & WELLNESS

SOCIAL FABRIC FITNESS

With Matt Mauriello and Michael Gubbels



What if...

our clothes revealed information about our exercise? How would this change the fitness experience? For good or bad?

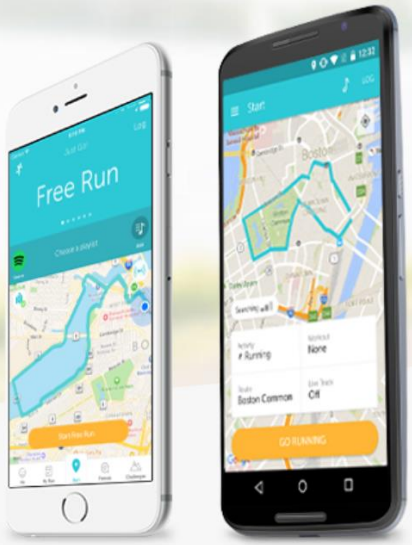
SOCIAL FABRIC FITNESS

[CHI'14]

Everyone. Every run.

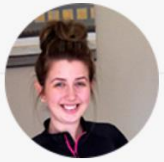
Runkeeper is a top running app and a community that helps people get out the door and stick with running.

Sign Up for Free Learn More



50 million runners strong

Welcome to the community!



Jordan, 24
Waterlooville, U.K.

"I love that I can look through my Runkeeper app to see the progress I have made."

Kaylyn, 26
Cambridge, MA

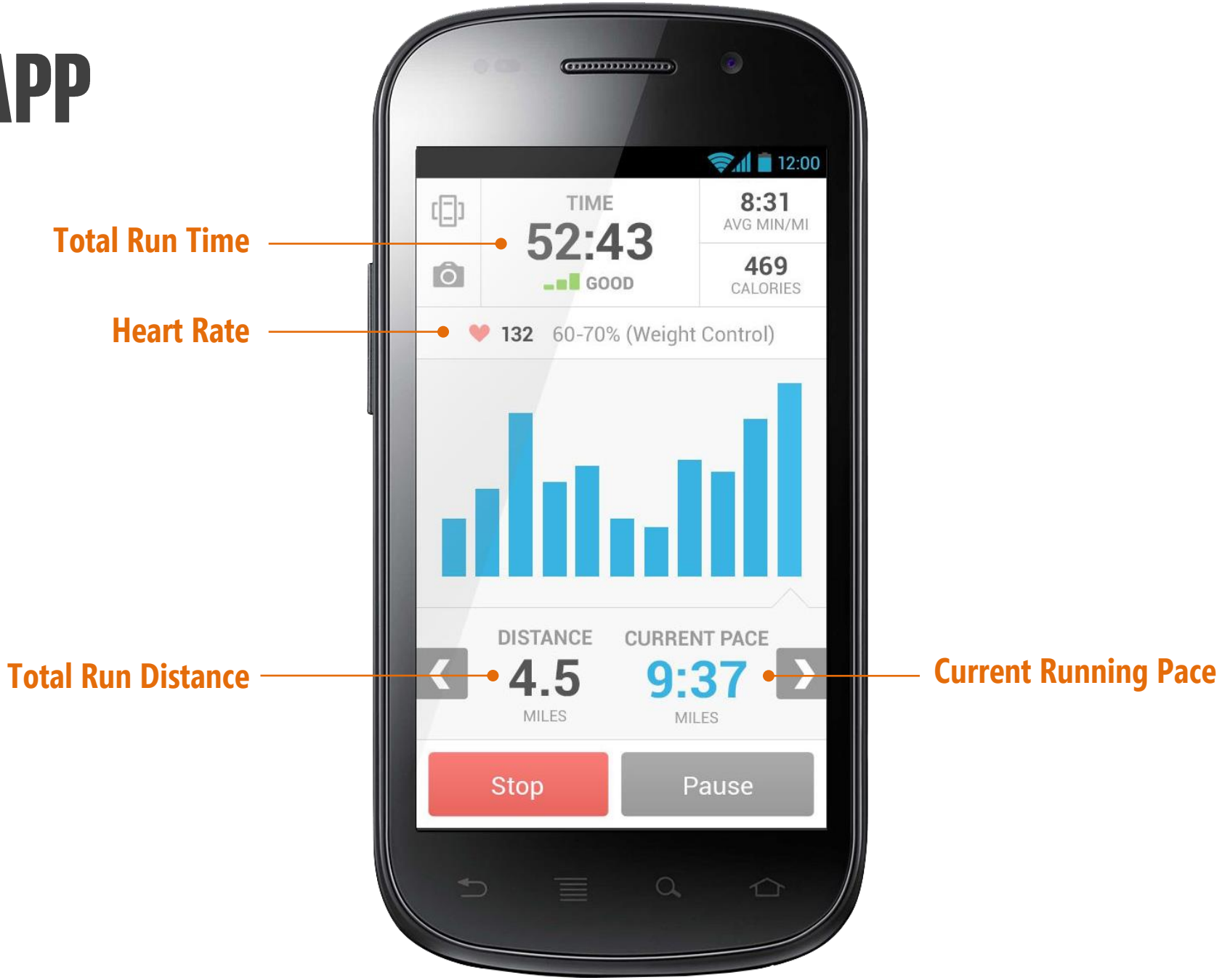
"I love how user friendly Runkeeper is. From training plans to workouts, it makes organizing my runs a breeze."

Derek, 45
Lexington, VA

"Runkeeper helps me set and reach my goals, motivating me to stay ahead of my family history of poor health."

RUNKEEPER

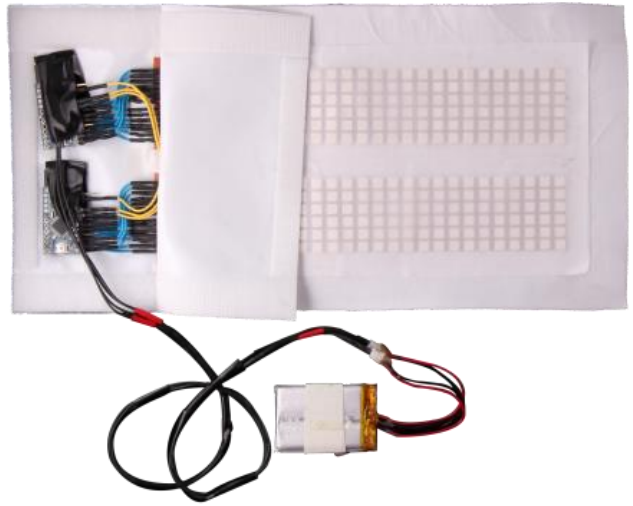
MOBILE APP



SOCIAL FABRIC FITNESS

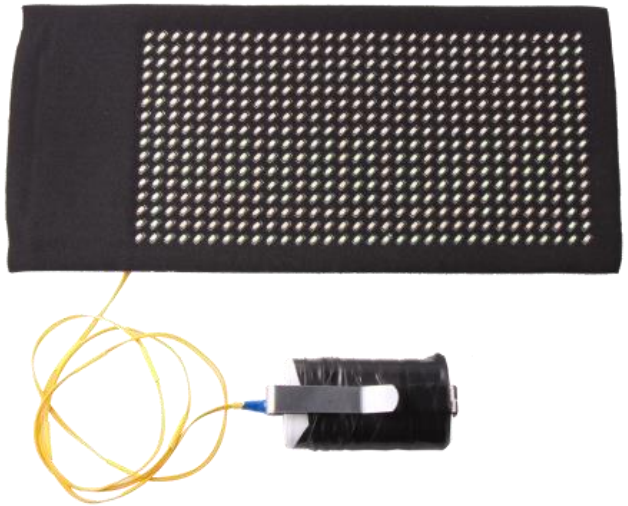
PROTOTYPE DISPLAYS

PROTOTYPE#1



PROTOTYPE#2

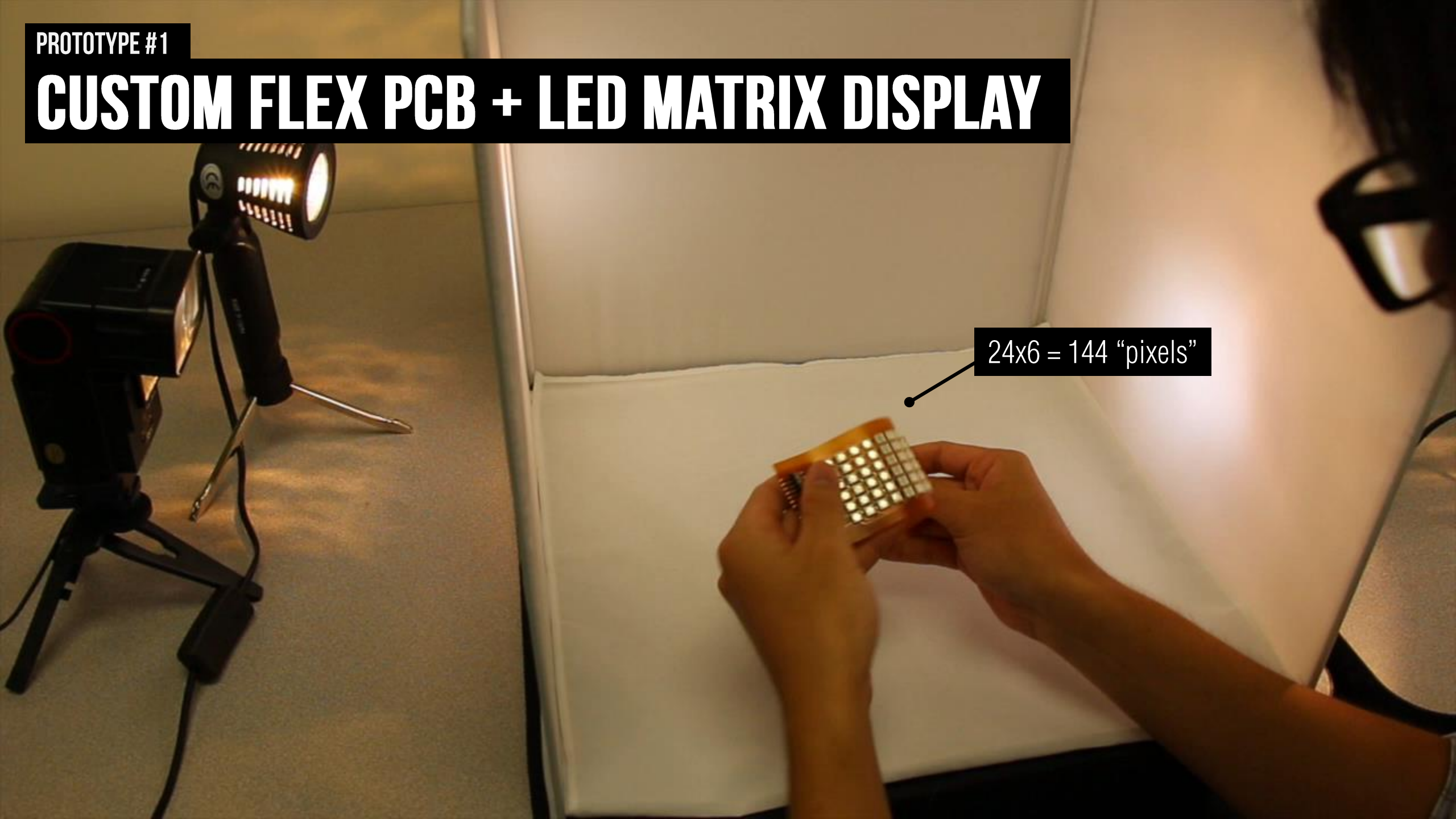
PROTOTYPE#3



We created **three prototypes**, which differed in display technology, resolution, viewability, weight

PROTOTYPE #1

CUSTOM FLEX PCB + LED MATRIX DISPLAY

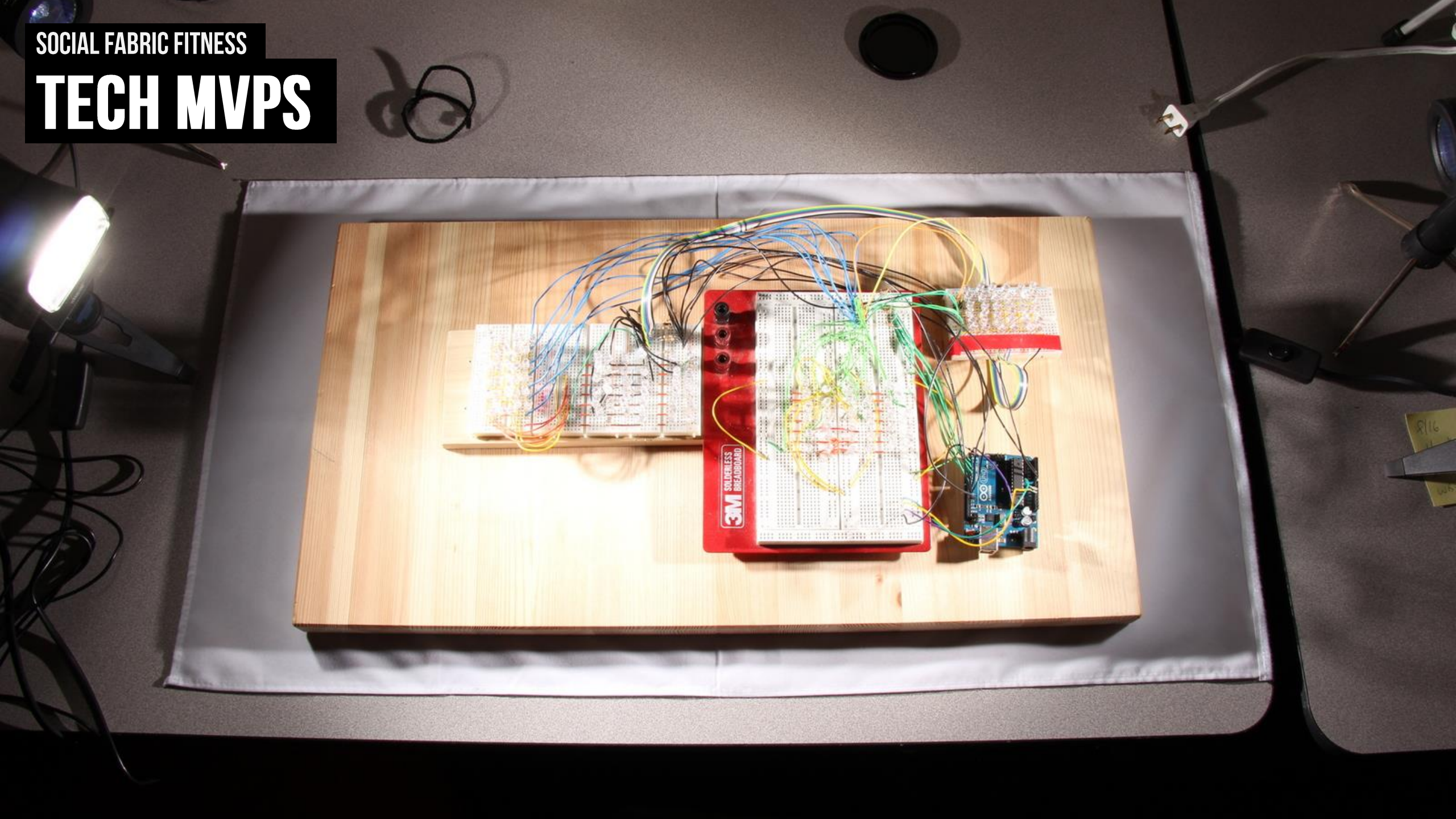


SOCIAL FABRIC FITNESS

LO-FI MOCKUPS

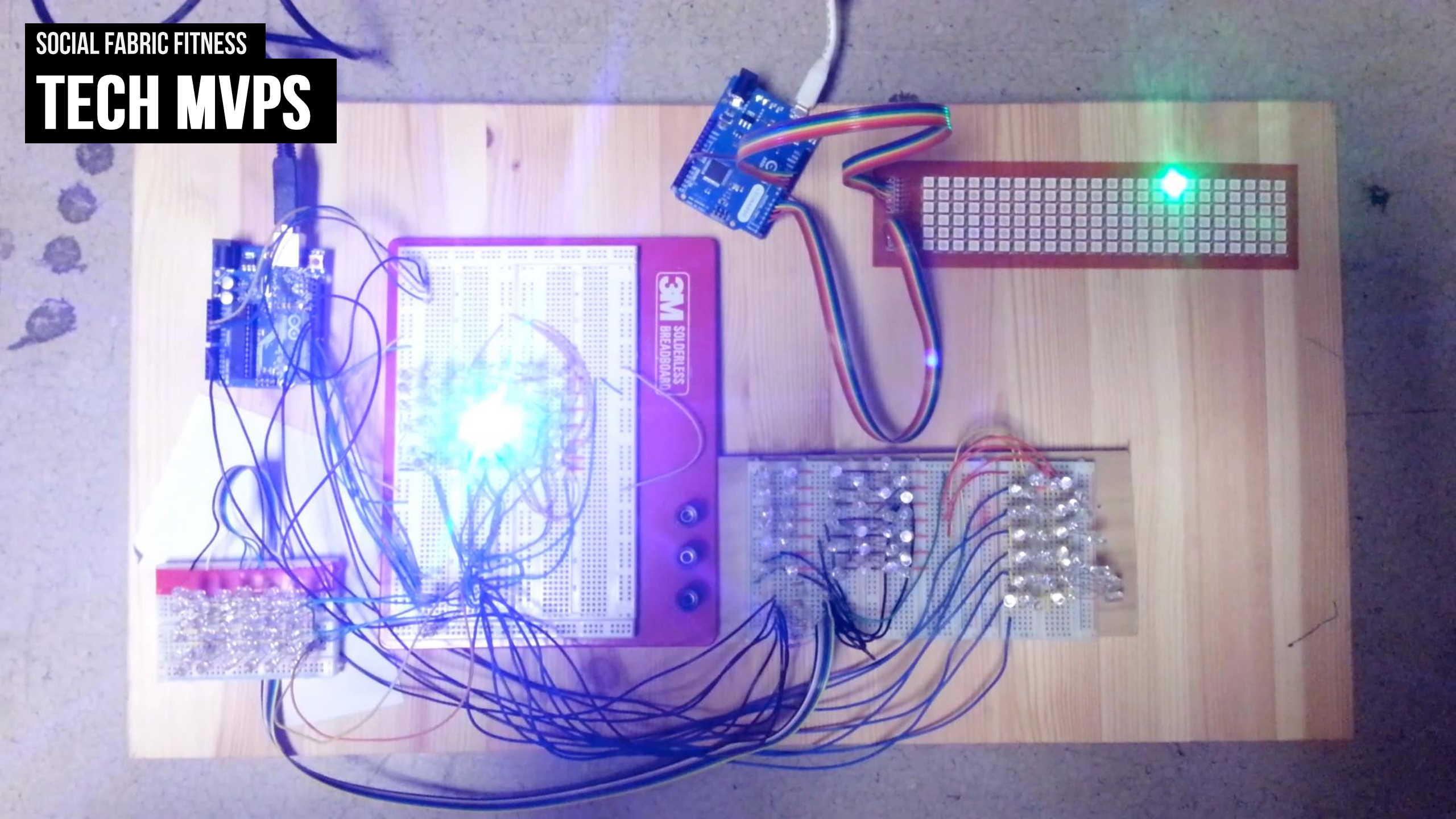
SOCIAL FABRIC FITNESS

TECH MVPS



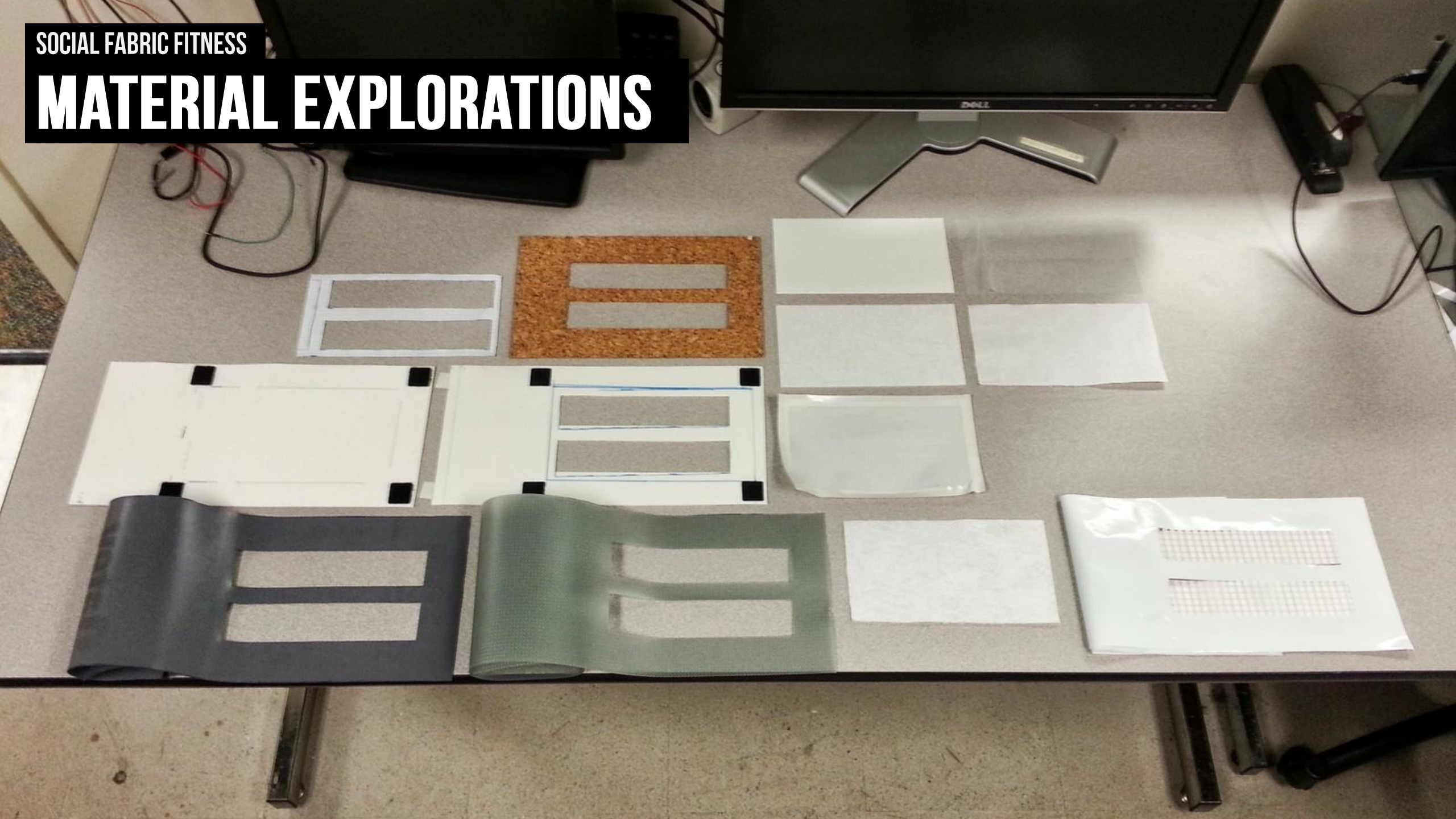
SOCIAL FABRIC FITNESS

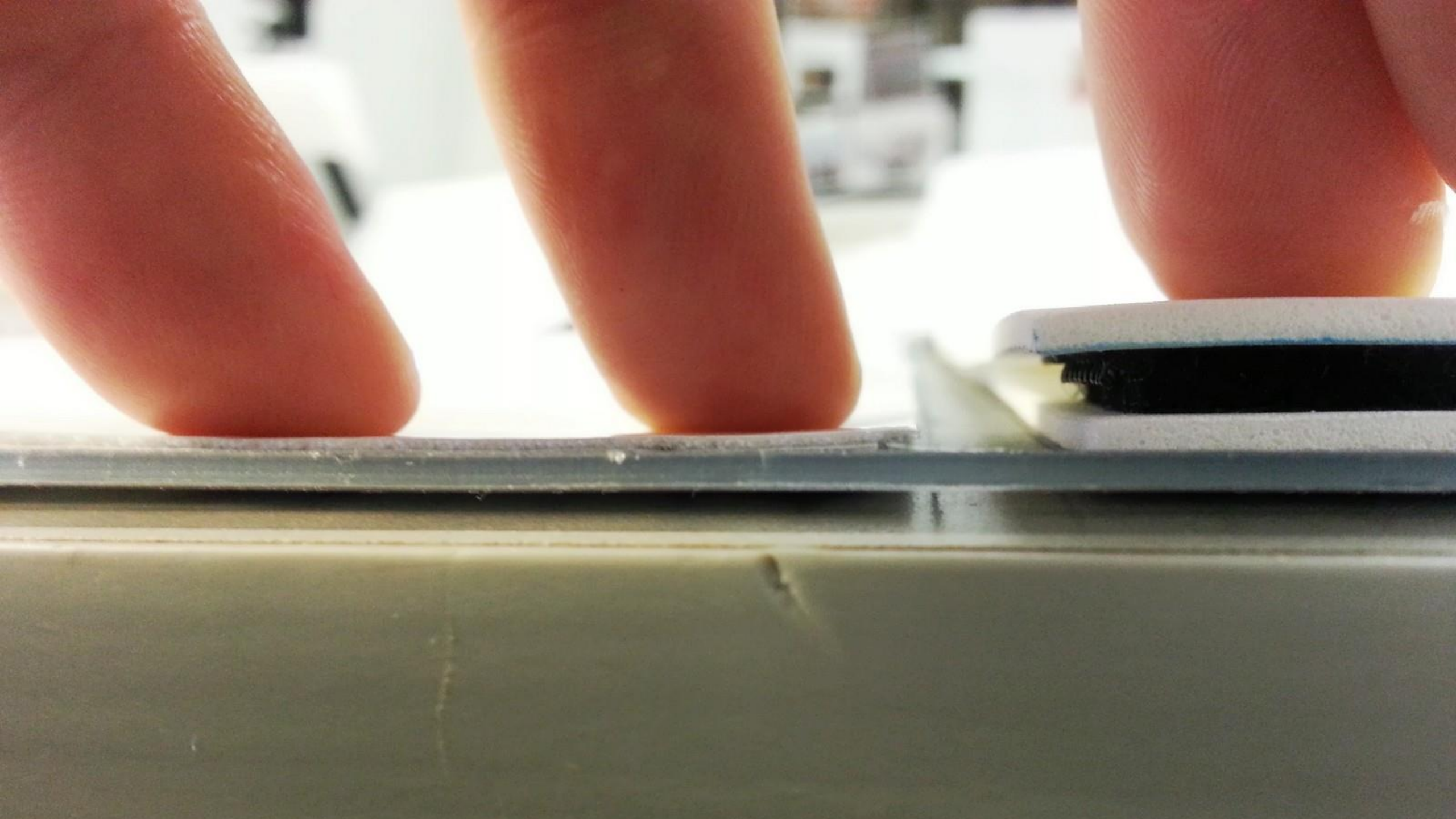
TECH MVPS



SOCIAL FABRIC FITNESS

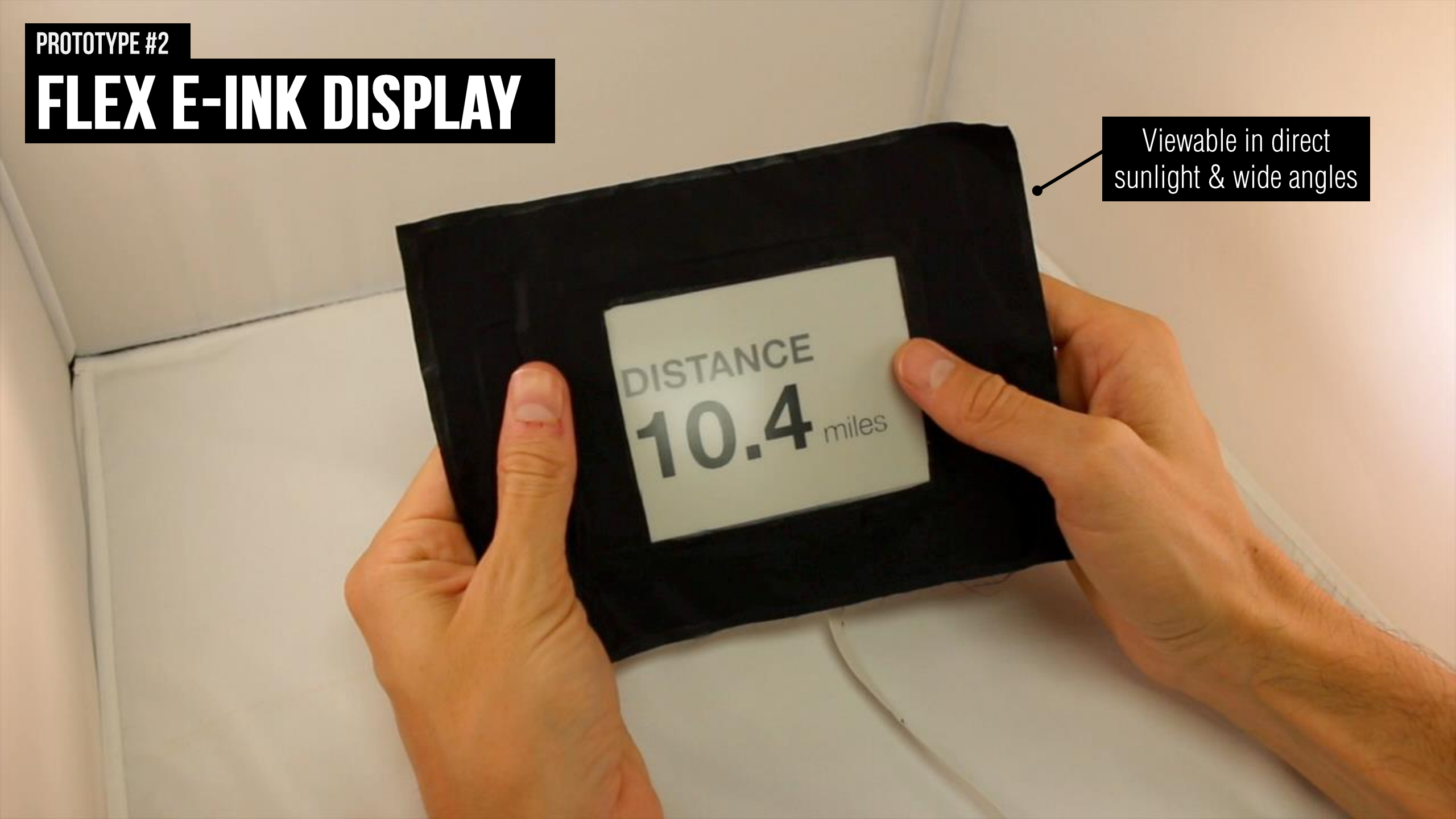
MATERIAL EXPLORATIONS





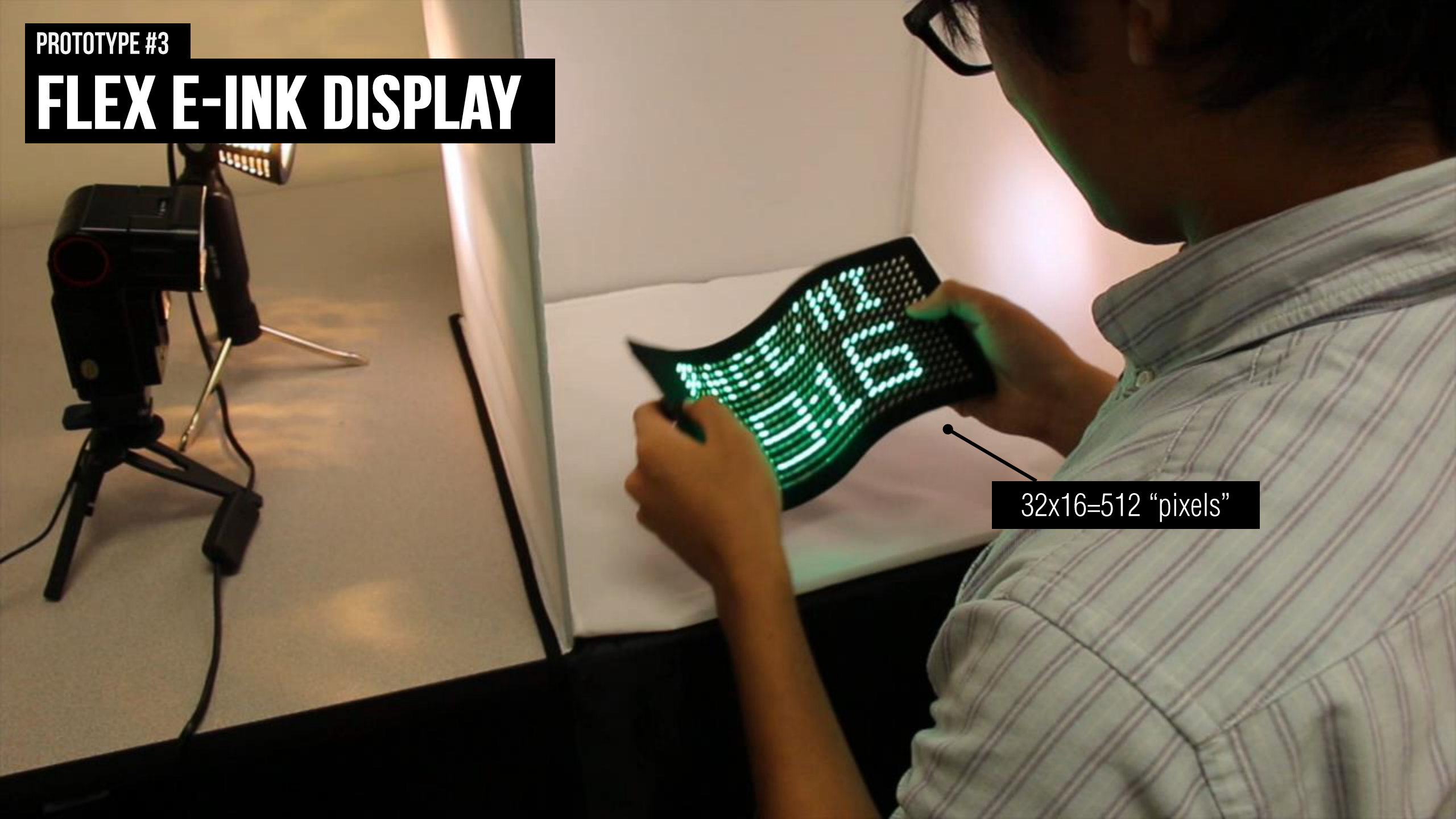
PROTOTYPE #2

FLEX E-INK DISPLAY



PROTOTYPE #3

FLEX E-INK DISPLAY



SOCIAL FABRIC FITNESS

PILOT TESTS

SOCIAL FABRIC FITNESS

PILOT TESTS

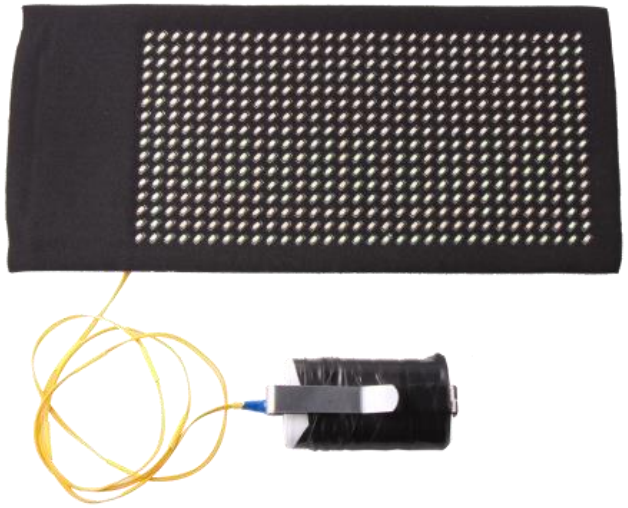
SOCIAL FABRIC FITNESS

PROTOTYPE DISPLAYS

PROTOTYPE#1

PROTOTYPE#2

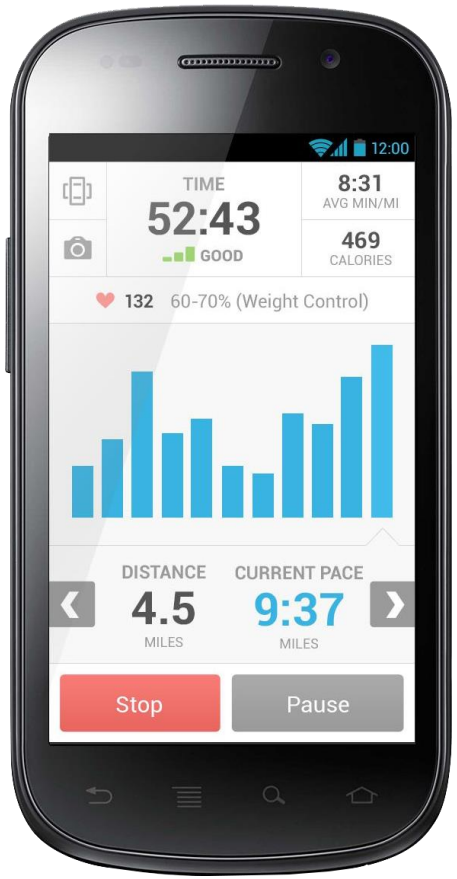
PROTOTYPE#3



Prototype #3 performed best in our pilots

SOCIAL FABRIC FITNESS

FINAL VISUALIZATIONS

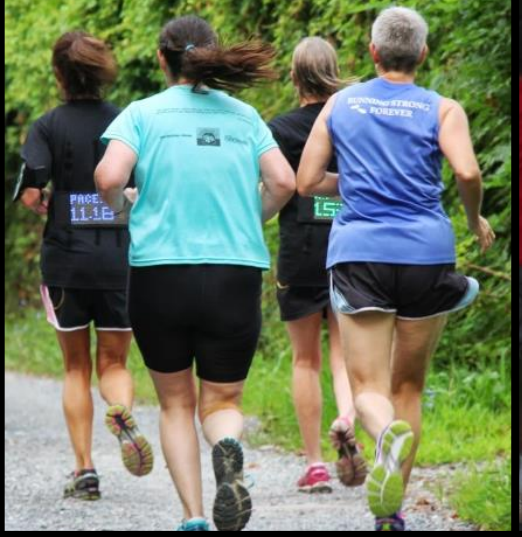


Wirelessly transmits via Bluetooth

SOCIAL FABRIC FITNESS

SOCIAL GOAL VIS







10 Groups:

52 runners

Avg Group Size:

5

Avg Age:

40.7

Avg Target Pace:

10:14

Avg Distance:

3.5 mi

SOCIAL FABRIC FITNESS

RACE DEPLOYMENTS

Male, 34
Target Pace: 6:10
County 8K

Female, 33
Target Pace: 8:20
County 8K

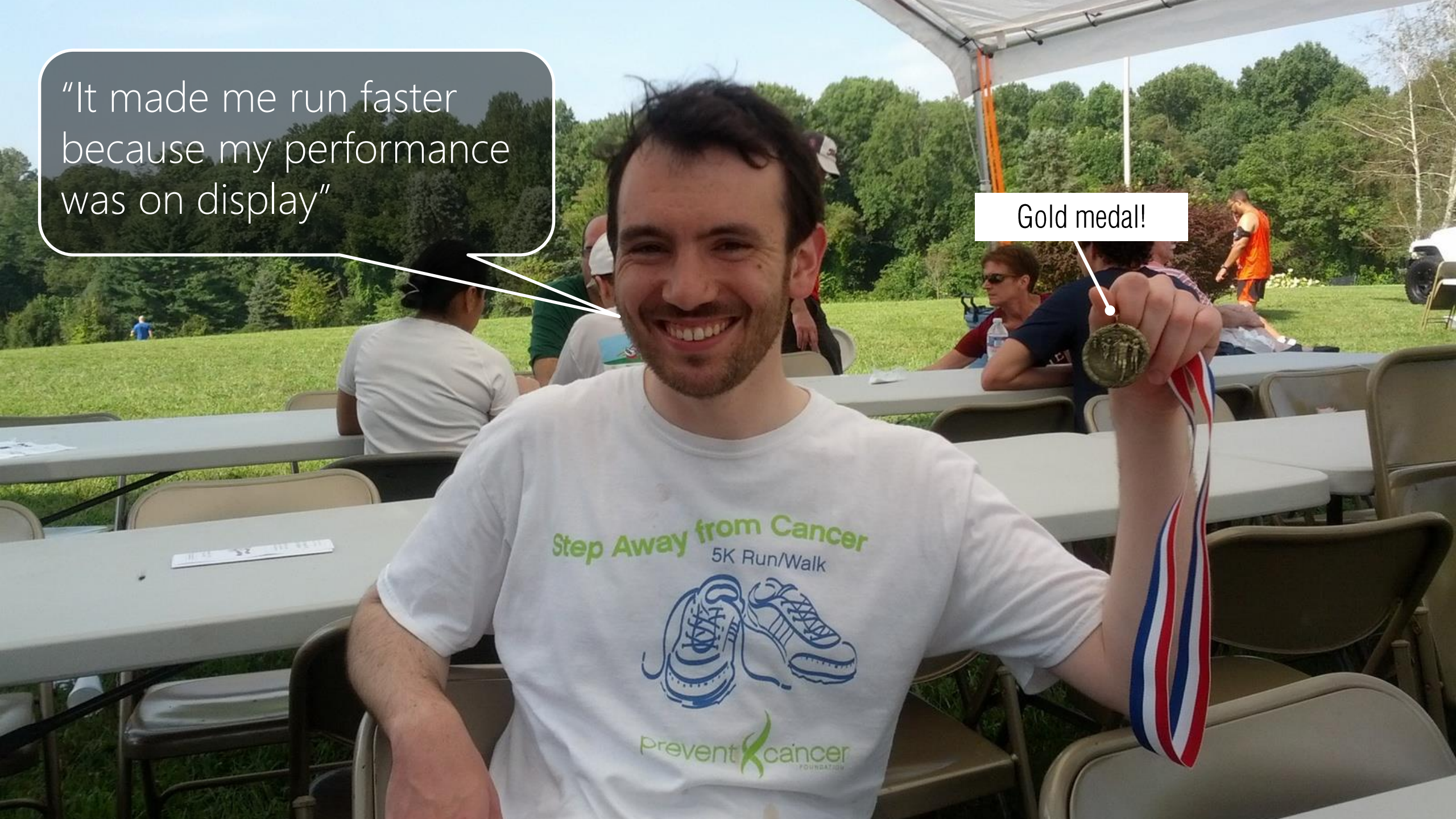
Male, 26
Target Pace: 7:45
Labor Day 10K

Male, 18
Target Pace: 8:30
Labor Day 10K


"It made me more aware of our pacing and kept me more focused on the run." –P4


"It motivated me to go faster than the pace displayed." –P17
We don't whine
We're fit and strong
But...a marathon
is mighty long!


Gold medal!
Step Away from Cancer
5K Run/Walk
Prevent Cancer
FOUNDATION


"It made me run faster because my performance was on display"
Gold medal!
Step Away from Cancer
5K Run/Walk
Prevent Cancer

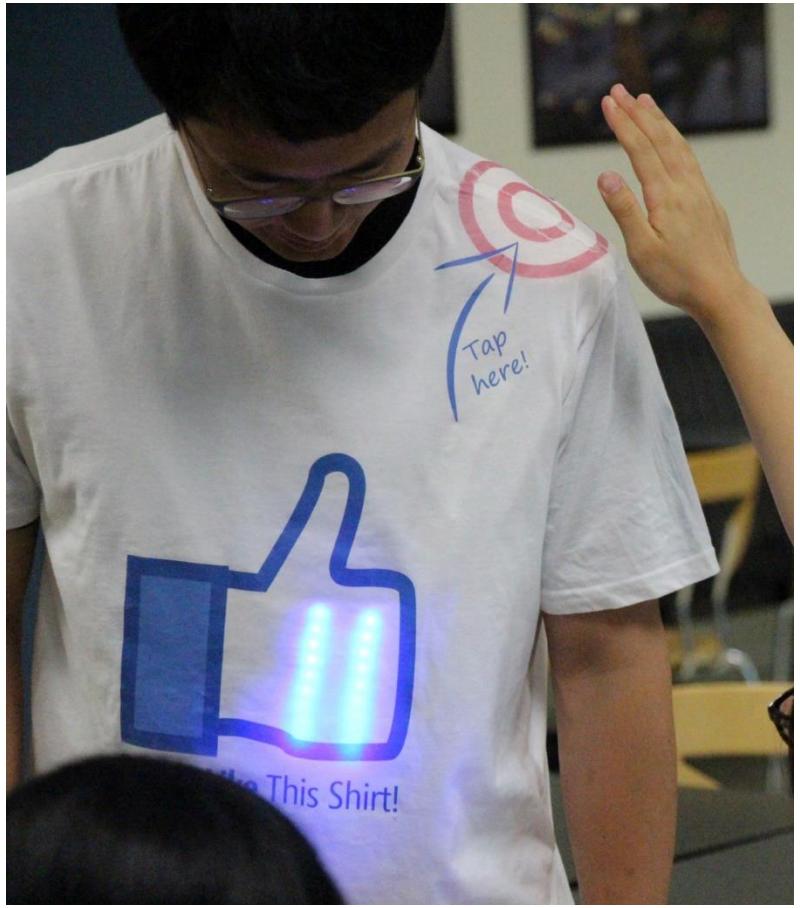

Potential Dichotomy
Increased motivation
vs. increased anxiety
SFF Externalizes
Performance


Source: http://www.erogear.com/

FUN/SILLY

I LIKE THIS SHIRT

With Ladan Najafizadeh and Seokbin Kang



I LIKE THIS SHIRT

[CHI'14]

What if...

we translated the dynamics of lightweight social interactions that arose in social media to the physical world?

Jon Froehlich
Edit Profile

- News Feed
- Messages 20+
- Events 1

GROUPS

- Arts District Hyatts... 20+
- REU-Combinatorial ... 4
- Workshop on Incon... 6
- CHI2015 in Seoul 20+
- Personal Informatics 13
- NSF CISE 2012 C... 14
- dorkbot seattle 20+
- Mobile Living Labs'...
- Manage Your Groups
- Create Group
- Find New Groups

FRIENDS

- Washington, Distric... 16
- University of Washi...
- University of Califo...
- HCIL, UMCP
- Microsoft Research
- Intel Research
- Intel Research

Update Status | Add Photos/Video

What's on your mind?

Sarita Yardi Schoenebeck
1 hr ·

Reposted my anonymous prof yaks on the UW campus and they were all immediately downvoted. I guess UW students don't want faculty in their Yik Yak. I blame James Fogarty

Like · Comment

James Fogarty, Julie Kientz, Meredith Ringel Morris and 9 others like this.

James Fogarty Maybe they just don't like reposts?
1 hr · Like · 2

Sarita Yardi Schoenebeck Well one of them called me a liar before it was downvoted. A skeptical bunch!
1 hr · Like · 2

Julie Kientz Well, if you were claiming to be a UW prof they weren't wrong... Maybe they could smell the wolverine blood in your post
1 hr · Like · 4

Write a comment...

June Ahn
3 hrs · Twitter ·

Excited to give my featured talk at #NSTA14 about @I_UMD work in informal science learning. Come by at 12:30: http://t.co/soE5VsLDff

1 event invite
Amanda Marisa Williams and 1 other

TRENDING

- **Michael Dukakis**: Former presidential candidate testifies for defendant in trial linked to Boston Marathon bombing
- **Selena Gomez**: Boom! Selena Gomez Puts Her Grown-Up Haters In Their Place
- **Apple Inc.**: Company unveils thinner iPads, new Mac operating system and 'Retina 5K' high-res display at live event

See More

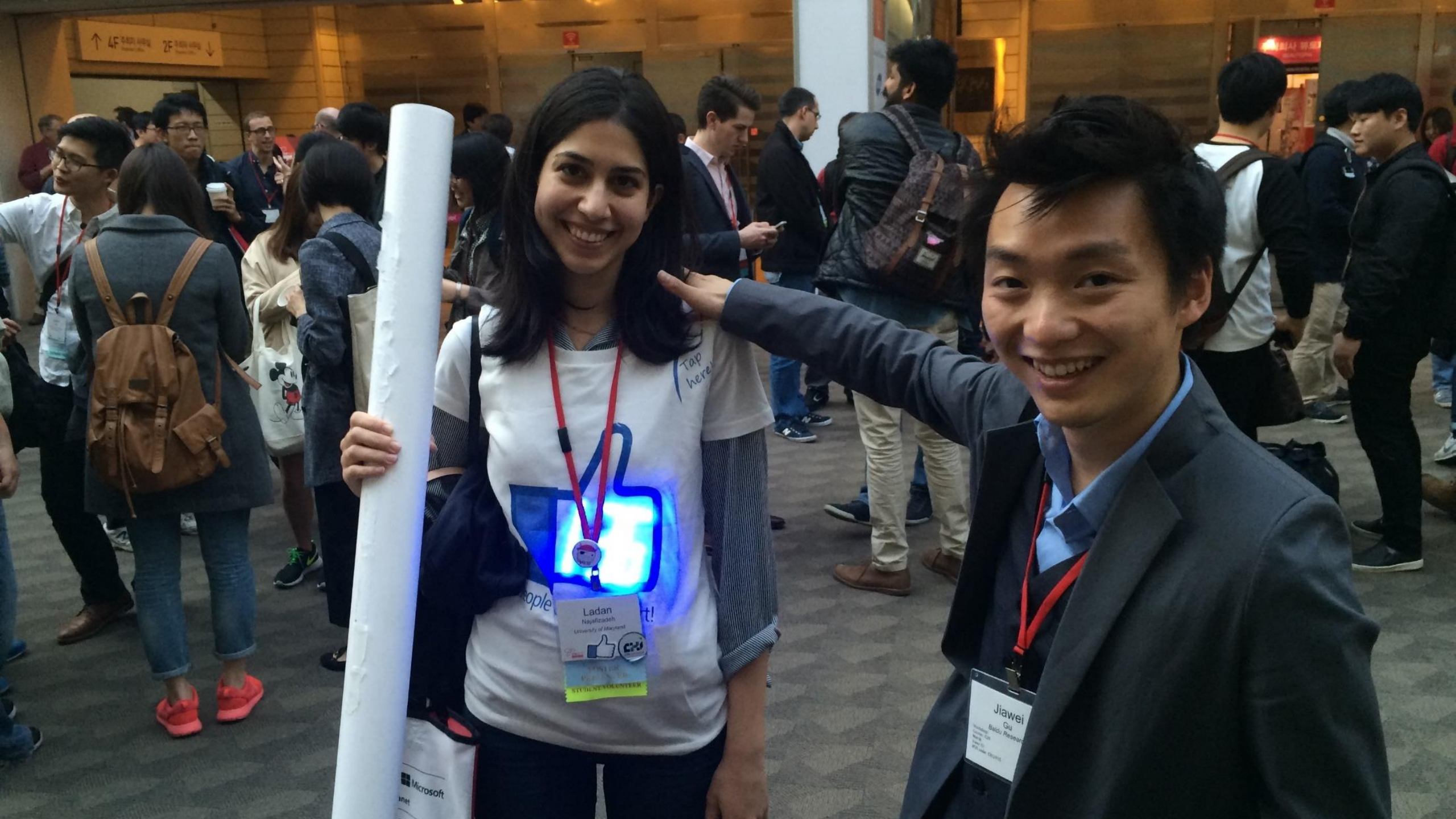
Chat (21)


417
PEOPLE LIKE THIS SHIRT


Tap
here!


Tap
here!
This Shirt!


es: a Playful Concept of
ction
rvices using Wi-Fi Direct
d friends and strangers
llaborative Video Challenges
Pass it forward
Interact with nearby users
Future work
Implementation of the prototype is in progress
A large-scale user study will be organized with it in order to understand its user experience and social impact
More concepts for proximity-based playful so interaction will be researched
nikova, Thomas Olsson
land
"I LIKE THIS
EXPLORING THE TRANSLATION OF SOCIAL MECHANISMS IN THE VIRTU
PHYSICAL EXPERIENCES
GOAL
Tap here!
People Like This Shirt!


Ladan
Najafizadeh
Jiawei
Gu
Microsoft


Tap here!
Brad
Myers
Carnegie Mellon University
CHI Academy
ACM Fellow
PRESENTER


CHI 2015
CROSSINGS
SEOUL • KOREA
James
Landay
Stanford University
Ladan
Nayafizadeh
University of Maryland


Tap here!
People Like This Shirt!


Tap here!
People Like This Shirt!
Tap here!
People Like This Shirt!


Tap here!
People Like This Shirt!

STEM EDUCATION

BODYVIS

With Tamara Clegg, Leyla Norooz, Seokbin Kang, and many others

BODYVIS

[IDC'13, CHI'15 Honorable Mention, ICLS'16, IDC'16, CHI'17]

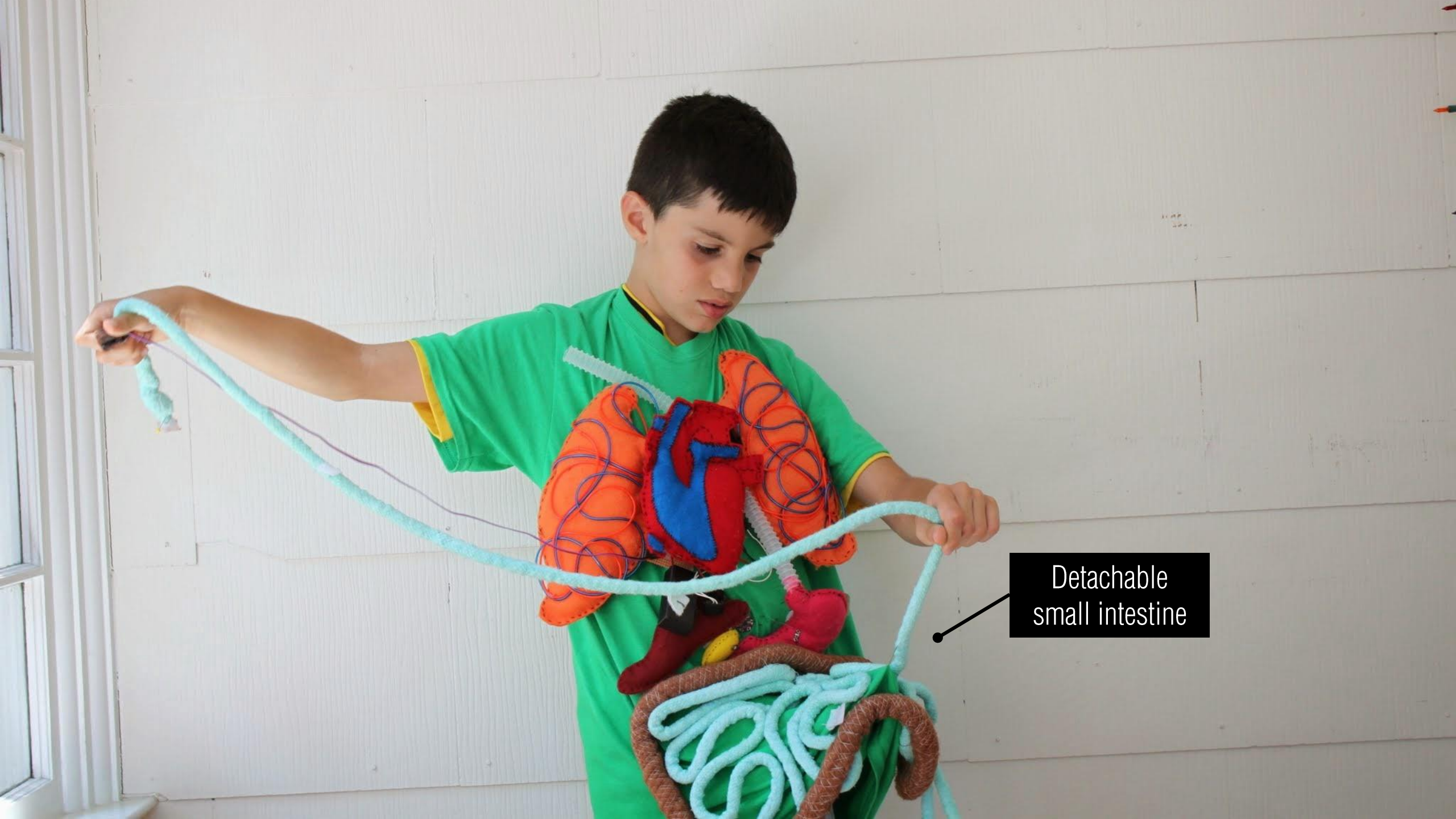
How can we...

design wearables that use the human body and physical activity as a platform for experimentation & scientific inquiry?

"Does my heart beat faster when running vs. reading a book? Why?"

"How does my breathing rate compare to my classmate's and why may this be?"

"How does food travel through my body?"


Detachable
small intestine

BODYVIS PROTOTYPES

PROTOTYPE 1: MID-FI

Stuffed fabric organs
Heartrate Only
LEDs, EL-Wire
Arduino Uno

PROTOTYPE 2

Improved Anatomy
Heartrate, Breathing
LEDs
Lilypad Arduino

PROTOTYPE 3

Labeled, Removable Anatomy
Heartrate, Breathing, Digestion
LEDs, Sound, Touchscreen
Arduino Uno, Smartphone

PROTOTYPE 4: HI-FI

Added Organs (*e.g.,* Bladder)
Heartrate, Breathing, Digestion
LEDs, Sound, Haptics, Touchscreen
Arduino BLE Mini, Smartphone

BODYVIS PROTOTYPES

PROTOTYPE 1

Stuffed fabric organs
Heartrate Only
LEDs, EL-Wire
Arduino Uno

PROTOTYPE 2

Improved Anatomy
Heartrate, Breathing
LEDs
Lilypad Arduino

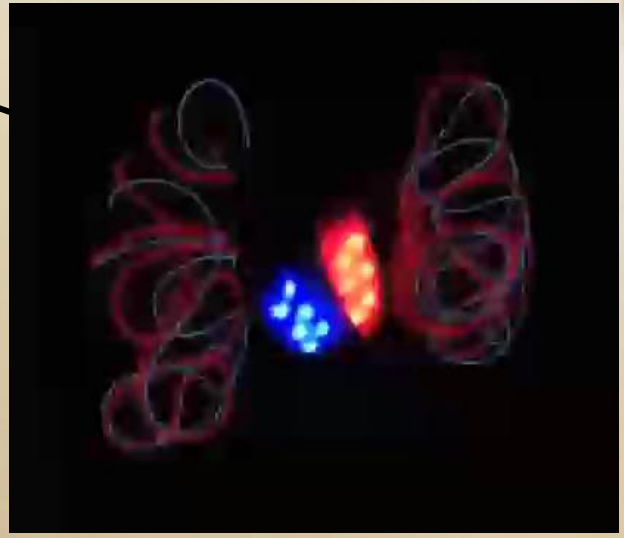
PROTOTYPE 3

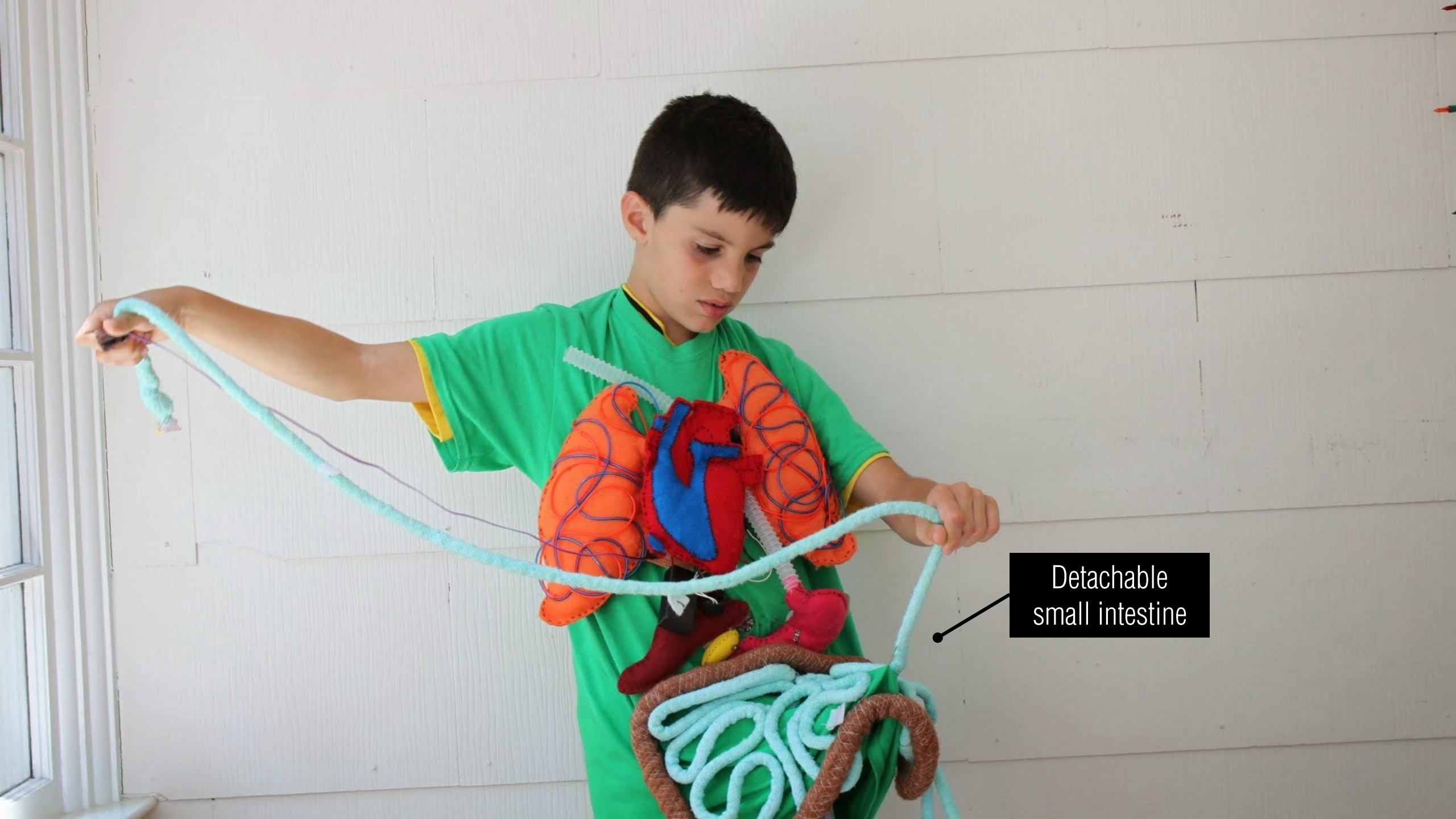
Labeled, Removable Anatomy
Heartrate, Breathing, Digestion
LEDs, Sound, Touchscreen
Arduino Uno, Smartphone

PROTOTYPE 4

Added Organs (*e.g.,* Bladder)
Heartrate, Breathing, Digestion
LEDs, Sound, Haptics, Touchscreen
Arduino BLE Mini, Smartphone

Optical heart rate sensor




Detachable
small intestine

BODYVIS PROTOTYPES

BODYVIS: FOUR GENERATIONS

PROTOTYPE 1

Stuffed fabric organs
Heartrate Only
LEDs, EL-Wire
Arduino Uno

PROTOTYPE 2

Improved Anatomy
Heartrate, Breathing
LEDs
Lilypad Arduino

PROTOTYPE 3

Labeled, Removable Anatomy
Heartrate, Breathing, Digestion
LEDs, Sound, Touchscreen
Arduino Uno, Smartphone

PROTOTYPE 4

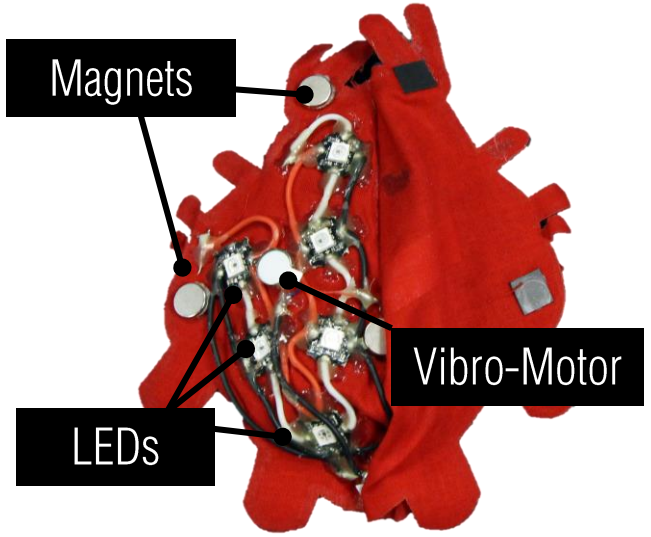
Added Organs (*e.g.,* Bladder)
Heartrate, Breathing, Digestion
LEDs, Sound, Haptics, Touchscreen
Arduino BLE Mini, Smartphone


Esophagus
Lung
Lung
Liver
Large Intestine
Small Intestine

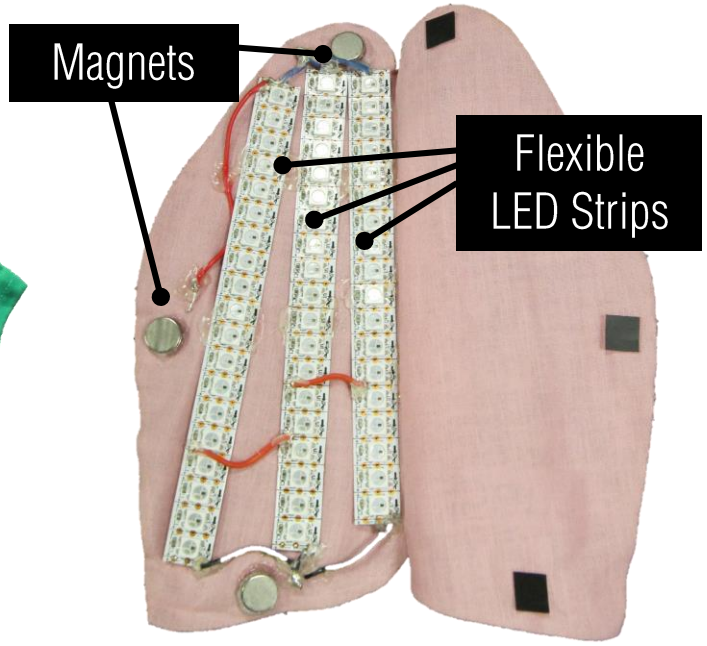
BODYVIS

HOW IT WORKS

HEART



LUNGS

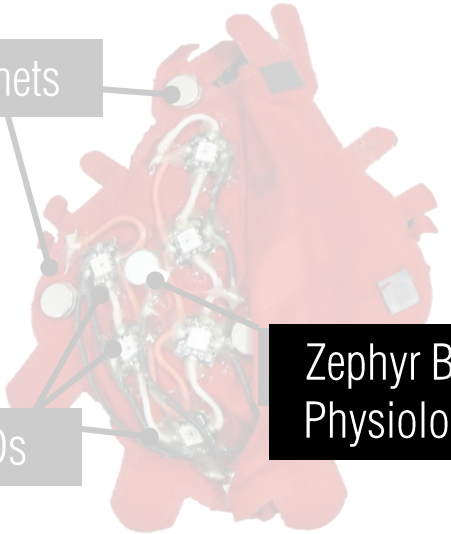


STOMACH

BODYVIS

HOW IT WORKS

HEART

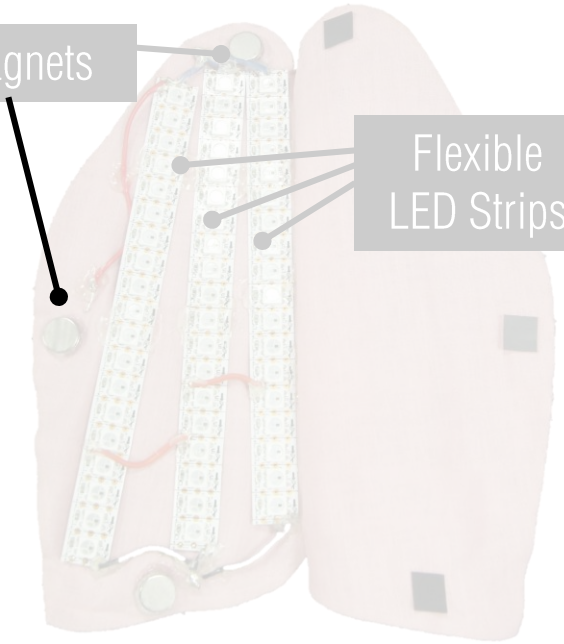


Magnets

LEDs

Zephyr BioHarness 3
Physiological Sensor

LUNGS



Magnets

Flexible
LED Strips

STOMACH

Samsung
Galaxy S4 Mini

BODYVIS

SENSING SYSTEM

Wirelessly transmits
via Bluetooth

Wirelessly transmits
via BLE

ZEPHYR BIOHARNESS 3

Worn directly on skin
Senses heart, breathing, movement

SAMSUNG GALAXY S4 MINI

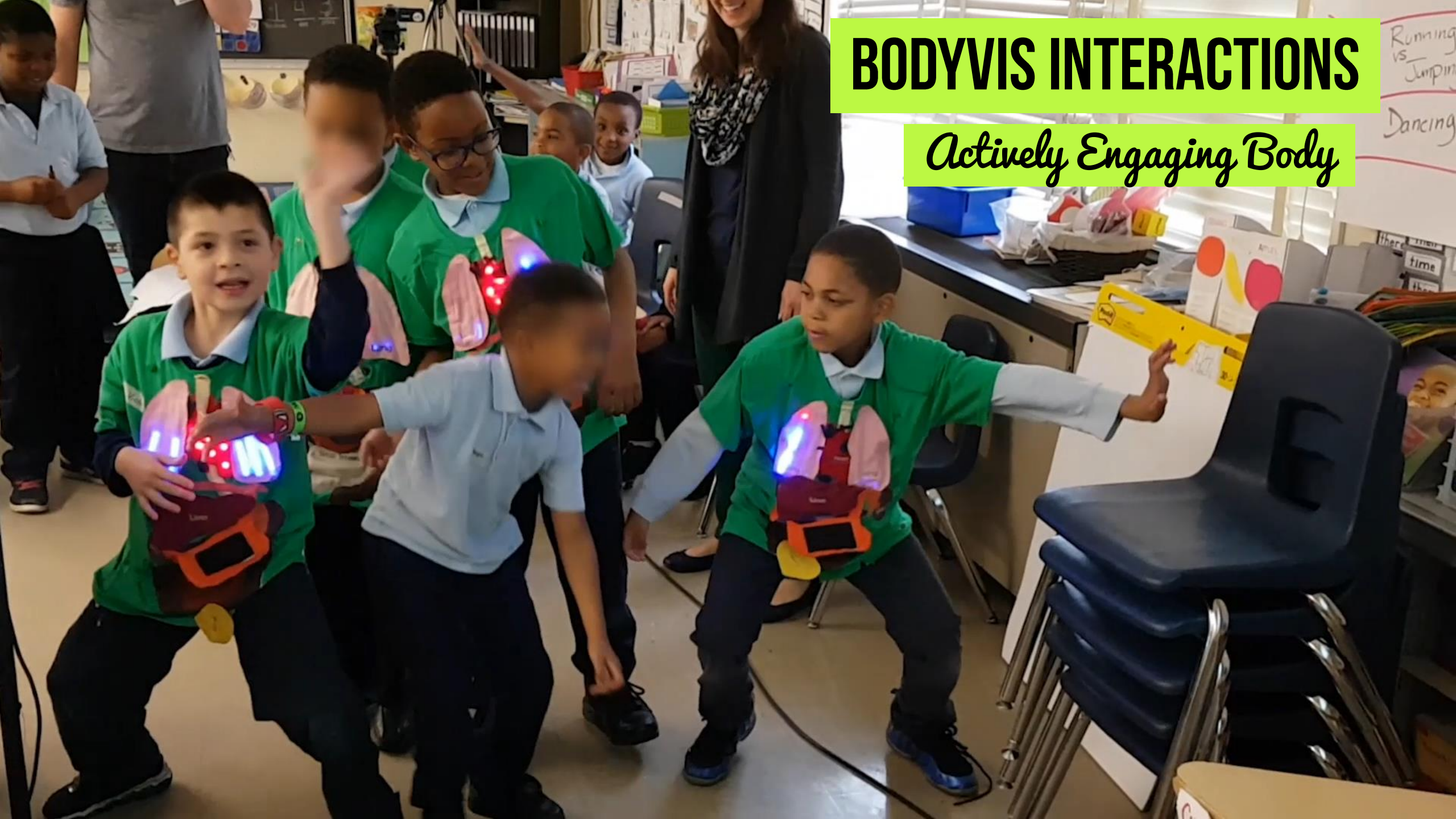
Serves as stomach
Processes physiological data
Plays sound & vibrates

REDBEARLAB BLE MINI ARDUINO

Sewn into shirt
Directly wired to LEDs, Vibro-motors,
digestion button, etc.


OVERALL REACTIONS
High Engagement


OVERALL REACTIONS
High Engagement


BODYVIS INTERACTIONS
Actively Engaging Body

UNEXPECTED FINDING

How Does It Work?

STE(A)M EDUCATION

MAKERWEAR

With Majeed Kazemitabaar and many others

MAKERWEAR

[IDC'15, CHI'16 Best Poster, CHI'17 Best Paper]

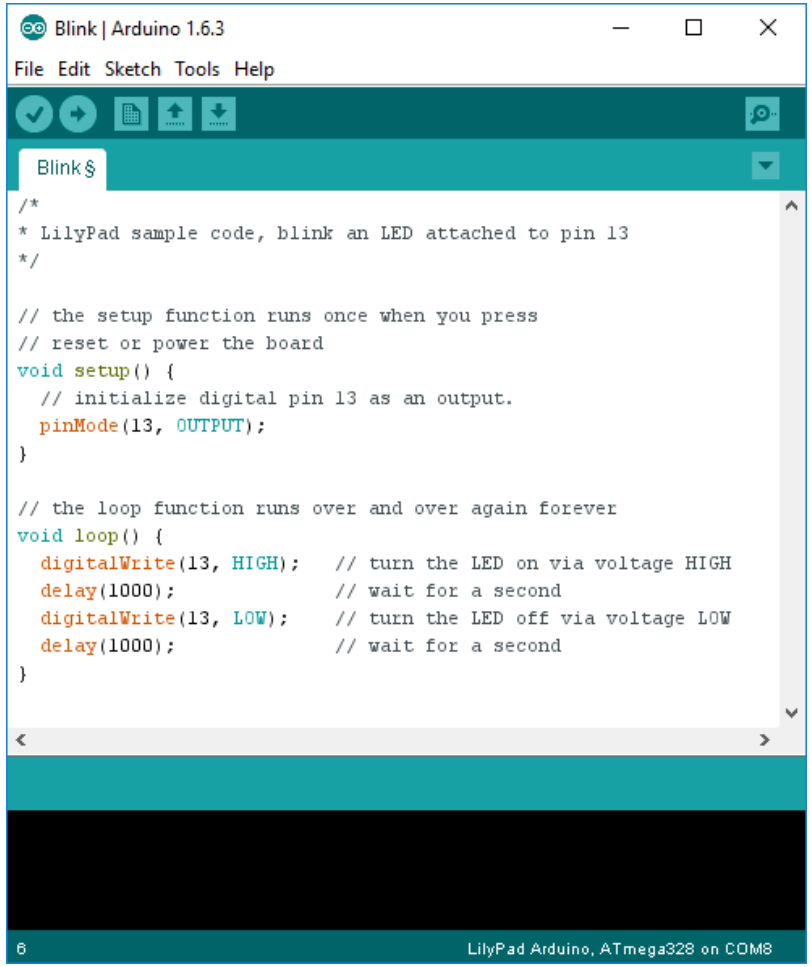
How can we...

enable young children to build their own interactive wearables?


LILYPAD ARDUINO

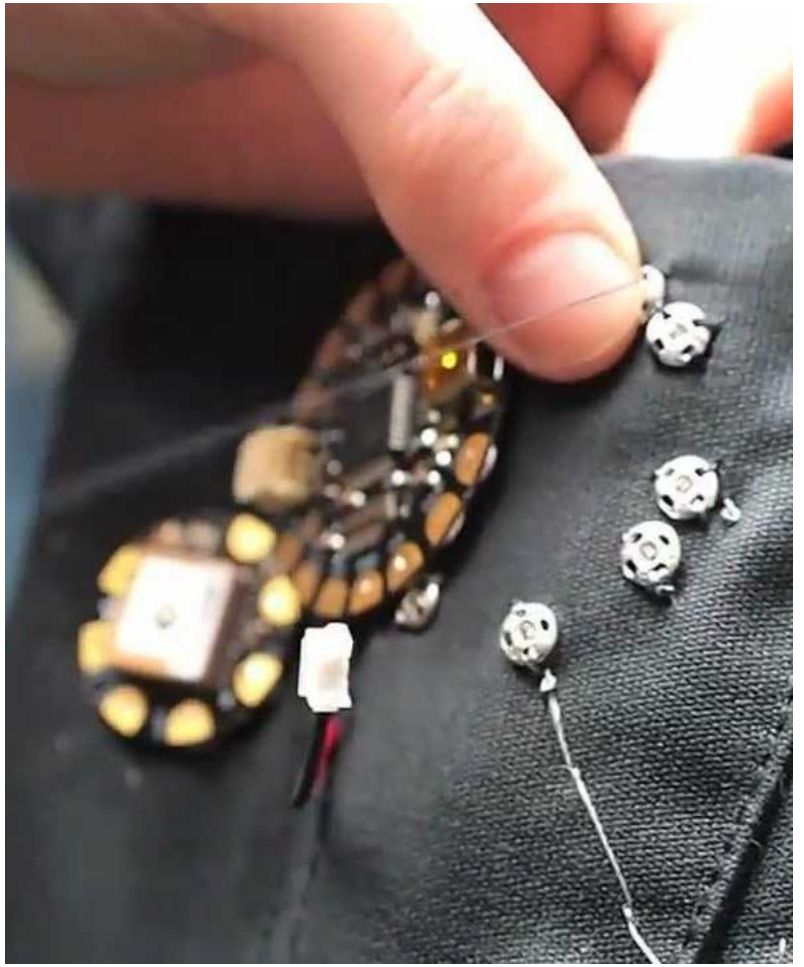
See: Buechley & Hill, 2010; Kafai, Lee, *et al.*, 2014; Kafai, Fields, & Searle, 2014

CURRENT WEARABLE TOOLKITS

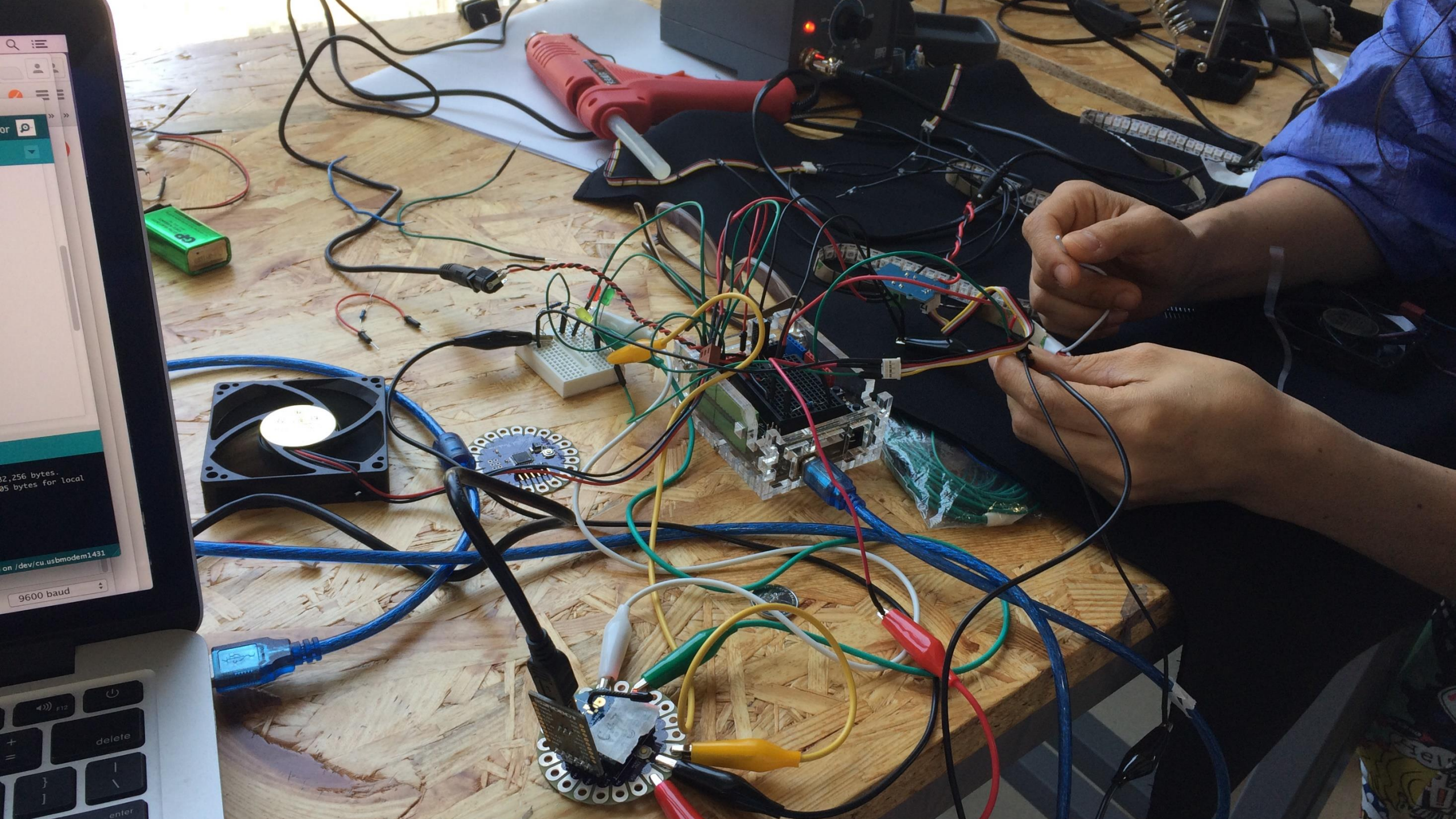


EMBEDDED PROGRAMMING

BASIC CIRCUIT & ELECTRONICS KNOWLEDGE



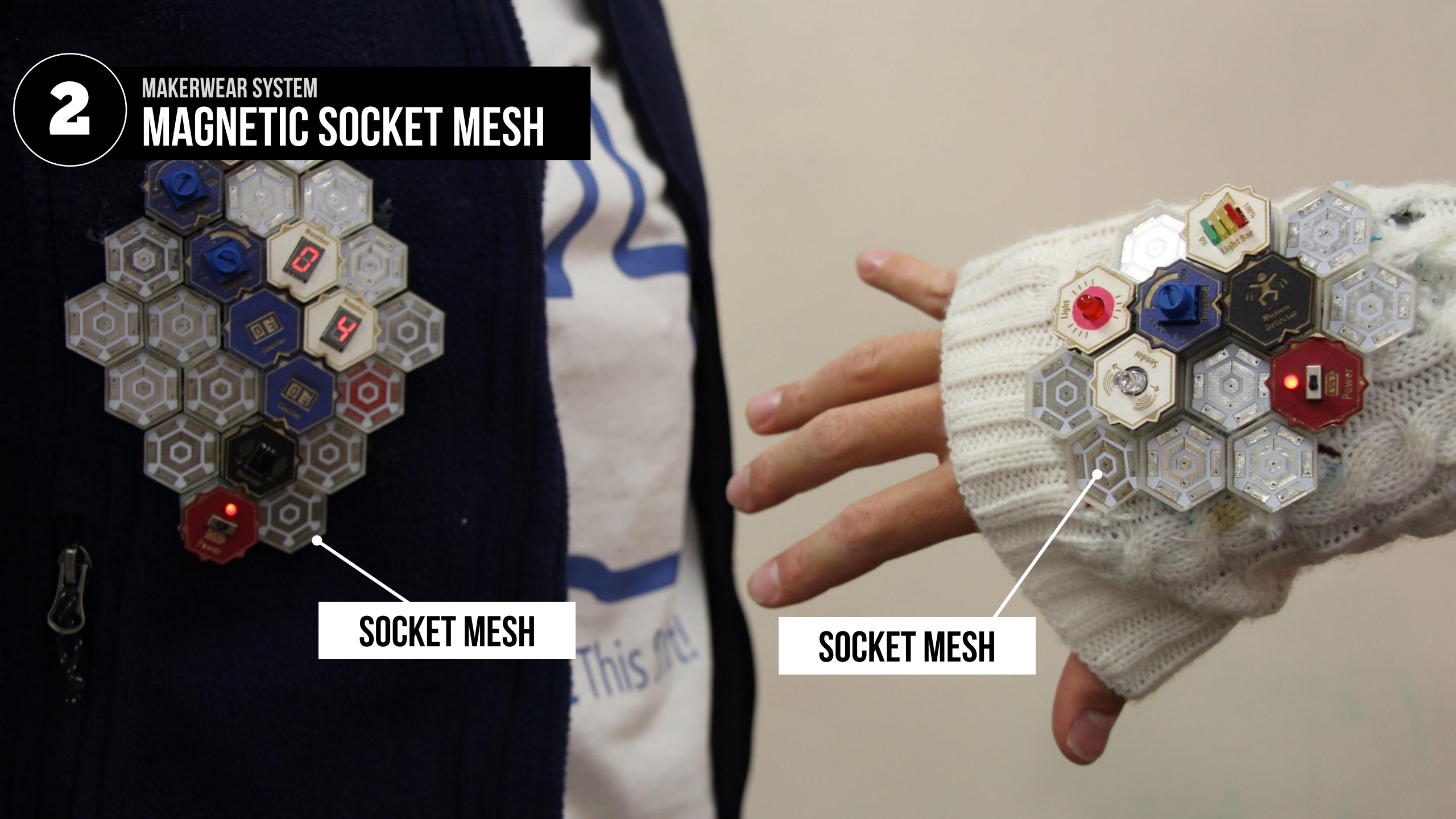
MANUAL SKILLS LIKE SEWING / SOLDERING

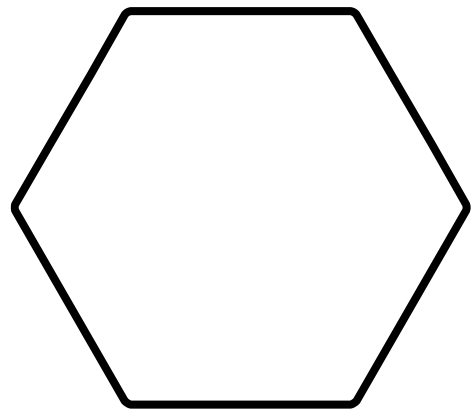

32,256 bytes.
05 bytes for local
on /dev/cu.usbmodem1431
9600 baud
delete
enter

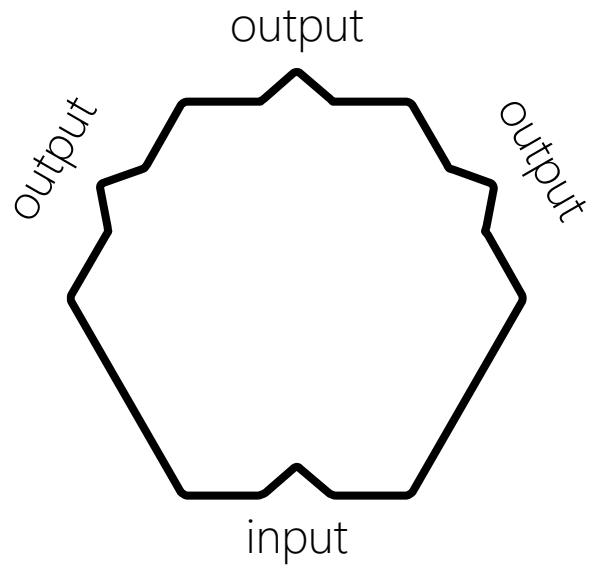
THE MAKERWEAR SYSTEM

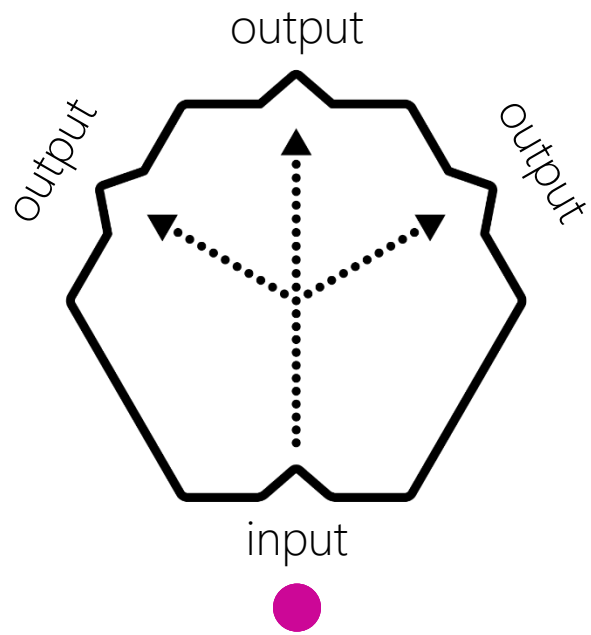
https://github.com/MakerWear

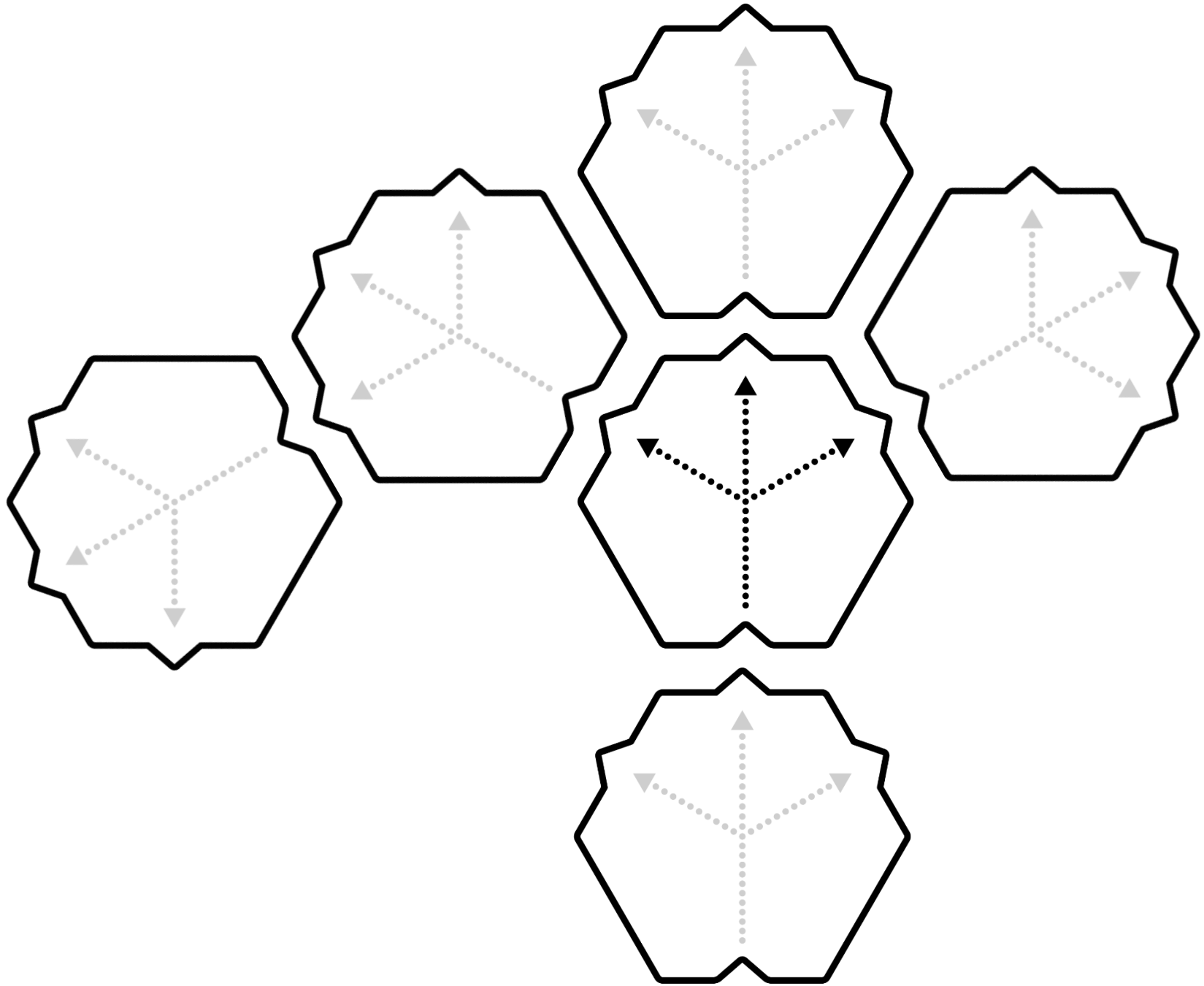

1
MAKERWEAR SYSTEM
TANGIBLE MODULES
Power
Vibration
Number
Sound Maker
Light
Spinner
Tilt Sensor
Counter
Motion Detector
Fade
Slow
Fast
Vibration
Number


2
MAKERWEAR SYSTEM
MAGNETIC SOCKET MESH
SOCKET MESH
SOCKET MESH



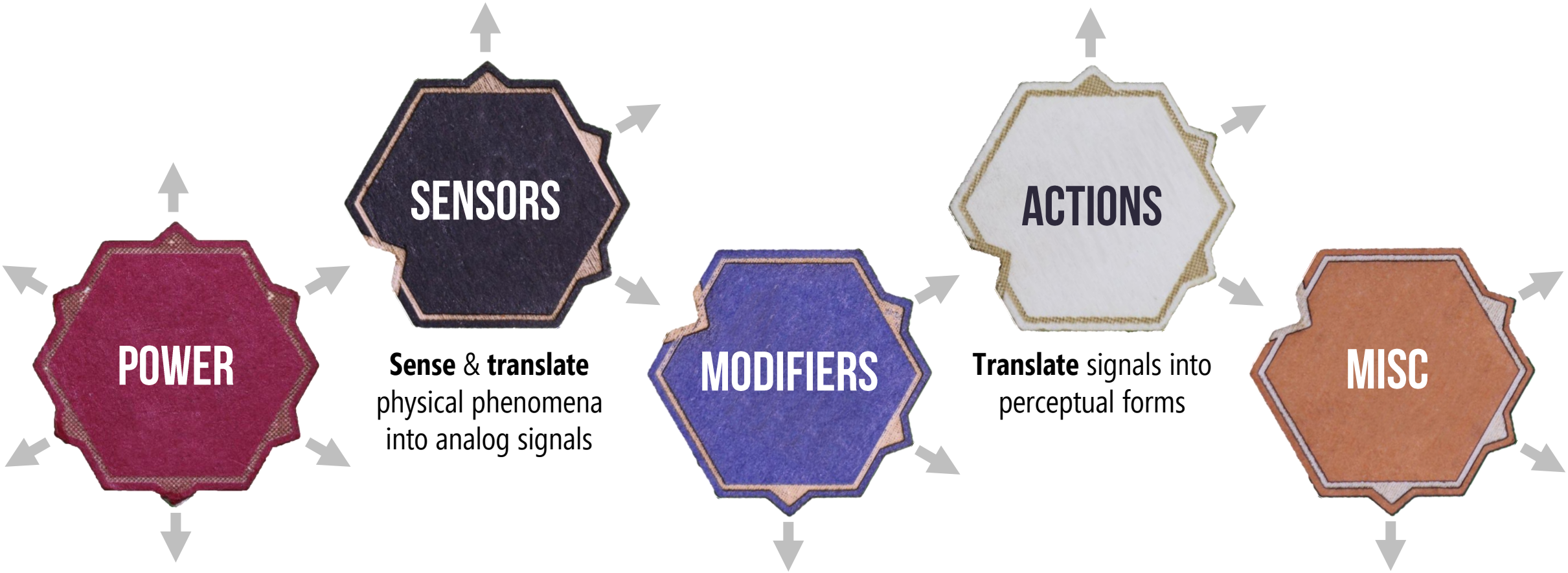

output
output
output
input


output
output
output
input



MAKERWEAR SYSTEM

5 MODULE TYPES



Provides **power** to all connected modules

Sense & **translate** physical phenomena into analog signals

Transform signals into other types of signals

Translate signals into perceptual forms

Miscellaneous (*e.g.,* DIY module)

MAKERWEAR SYSTEM

MODULE LIBRARY: 33 MODULES

12 SENSORS

Motion Detector

Distance

Sunlight Detector

Tilt Sensor

Light Sensor

Receiver

Impact Sensor

Color Detector


Heartbeat

Button

Temperature

Sound Sensor

9 ACTIONS

Light Bar

Yellow Light

Rotator

Green Light

MultiColor Light

Spinner

Blue Light

Number

Vibration

Red Light

Sender

Sound Maker

7 MODIFIERS

Volume Knob

Sine Wave

Threshold

Counter

Fade

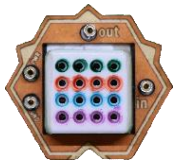
Inverter

Square Wave

4 MISC

Wire Start

Wire End

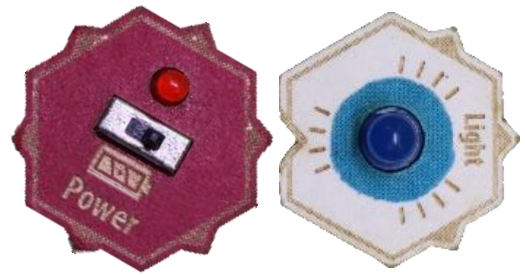

DIY Electronic


Bridge

1 POWER

Power


ABV
Power


Power
Light


Power
Motion Detector
Light

MAKERWEAR EXAMPLES

“MOTION-REACTIVE CLOTHES”

Motion-reactive clothes!

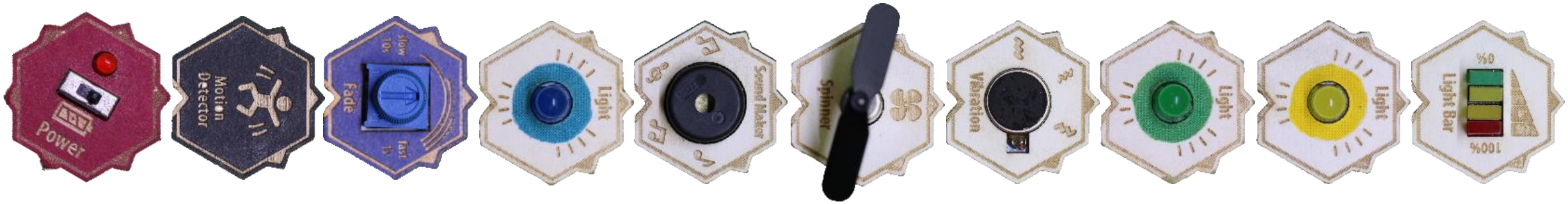
MAKERWEAR EXAMPLES

“MOTION-REACTIVE CLOTHES”

Now with fade effect

MAKERWEAR EXAMPLES

“MOTION-REACTIVE CLOTHES”



MAKERWEAR EXAMPLES

“MOTION-REACTIVE CLOTHES”

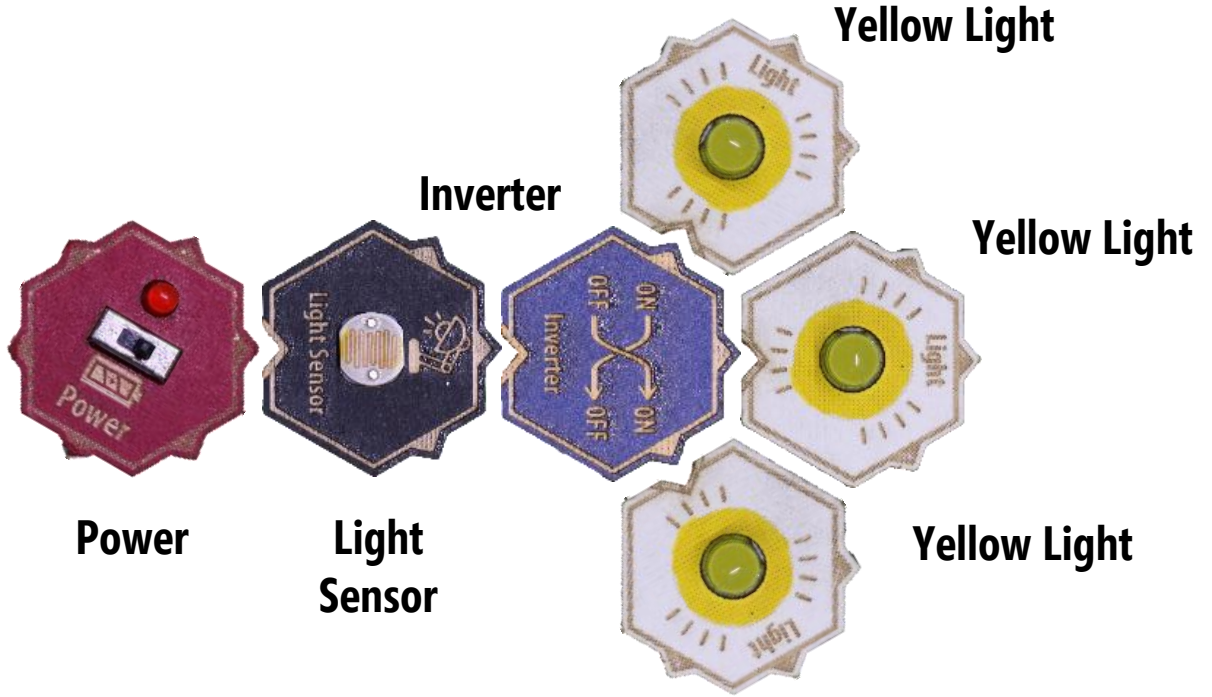
MAKERWEAR EXAMPLES

“MOTION-REACTIVE CLOTHES”

We can create a **diverse** set of designs **tangibly**

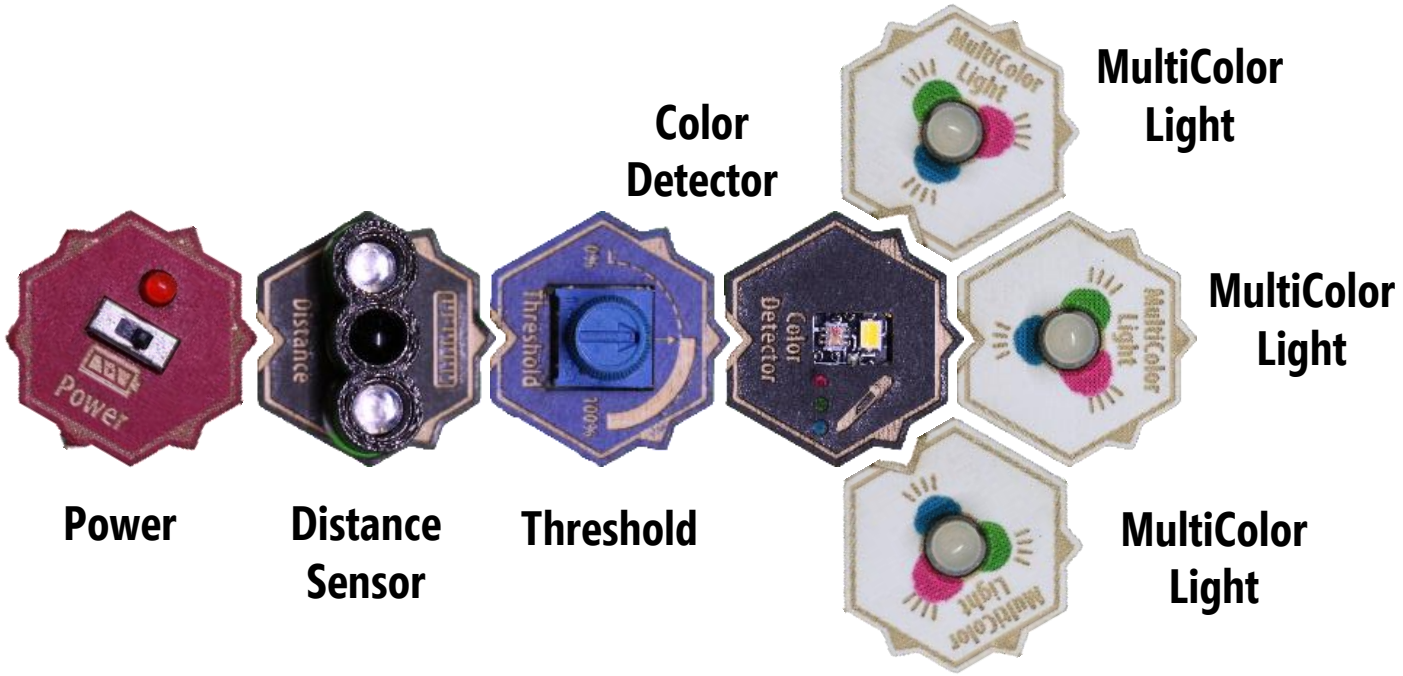
MAKERWEAR EXAMPLES

“AUTO-HEADLAMP HAT”



MAKERWEAR EXAMPLES

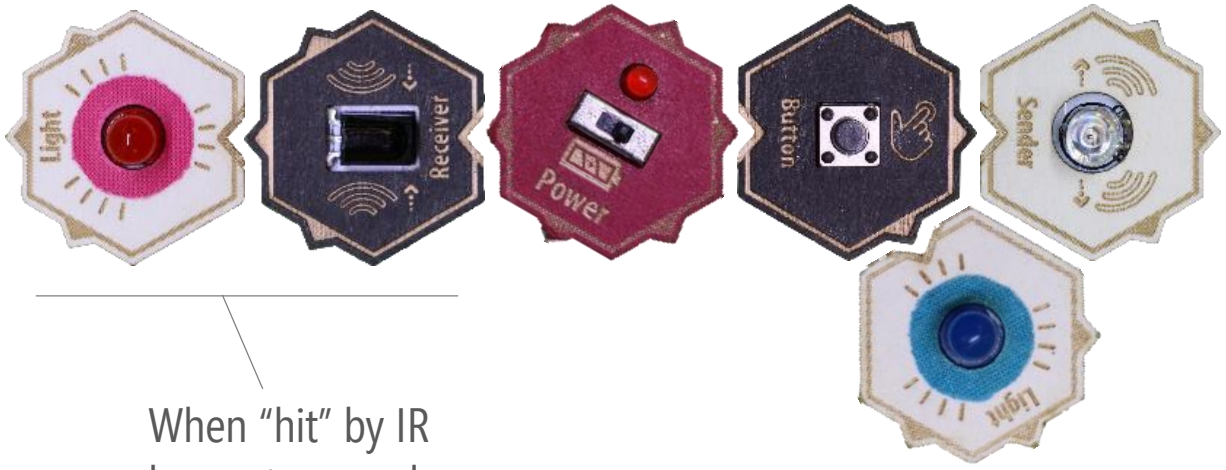
“CHAMELEON CLOTHES”



MAKERWEAR EXAMPLES

“LASER TAG ARMBAND”

When button pressed, shoots “laser” (IR beam) and turns on blue LED



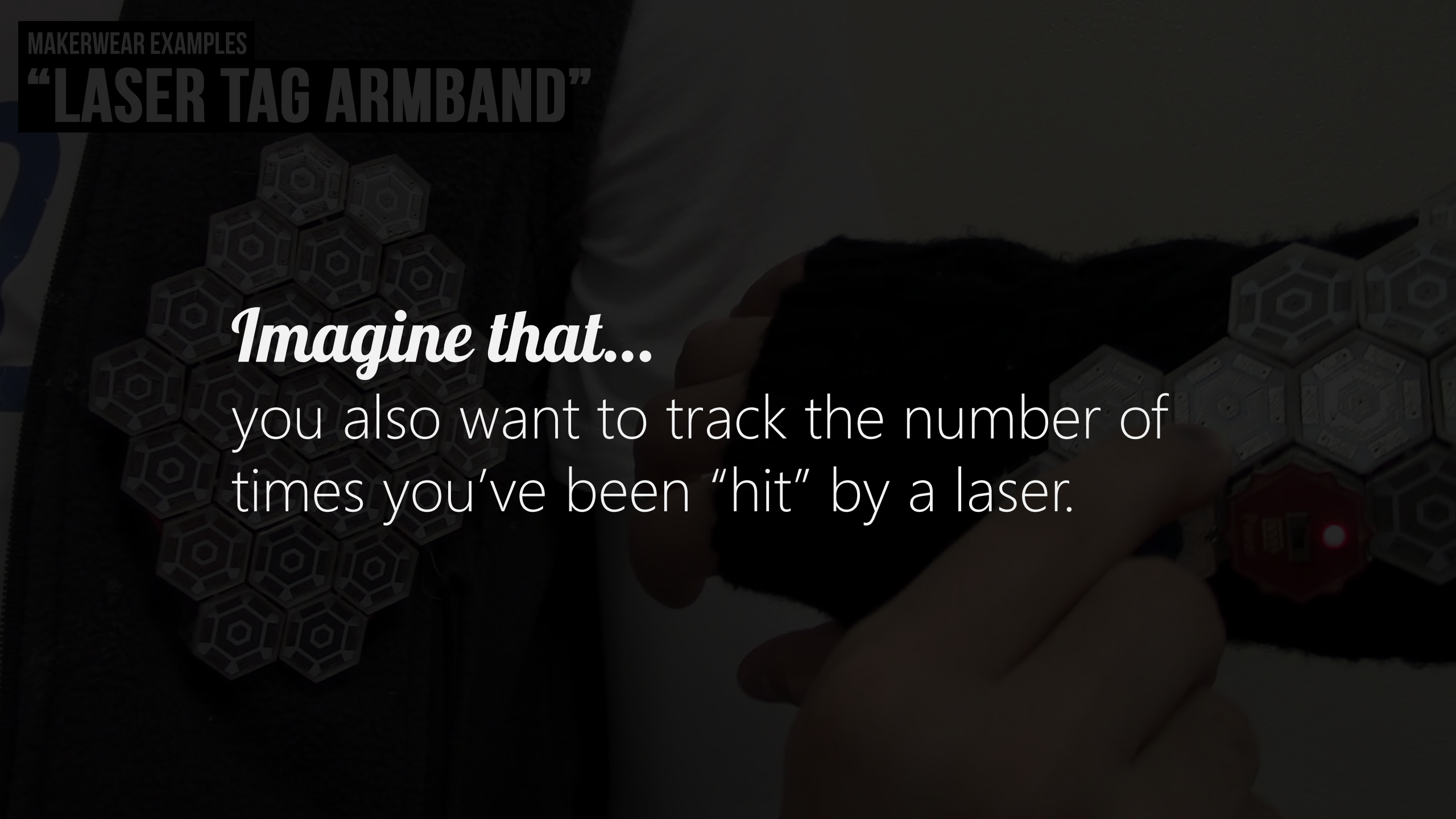
When “hit” by IR beam, turns red

MAKERWEAR EXAMPLES

“LASER TAG ARMBAND”

MAKERWEAR EXAMPLES

"LASER TAG ARMBAND"



Imagine that...

you also want to track the number of times you've been "hit" by a laser.


Now imagine that...
you want to add in an “end game” condition that activates an alarm when a max hit count is reached.


Number
Light
Power
Button
Light
Sonde
Power


MAKERWEAR WORKSHOPS

MAKERWEAR FINDINGS

OVERALL

Highly engaged in making

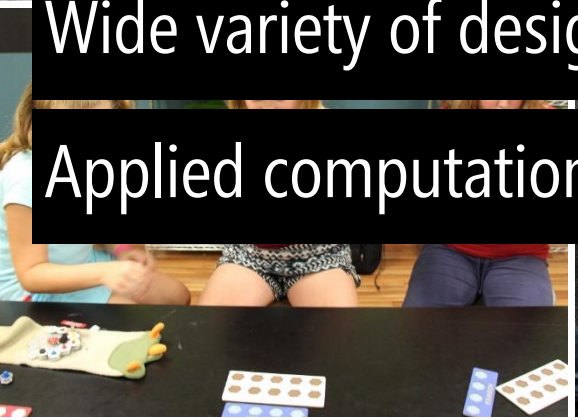
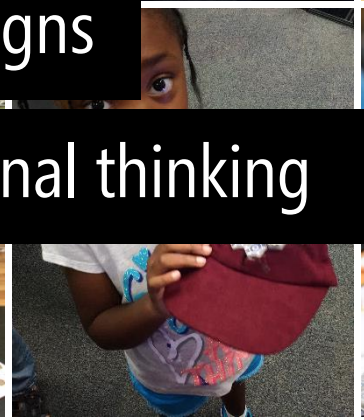
Wide variety of designs

Applied computational thinking

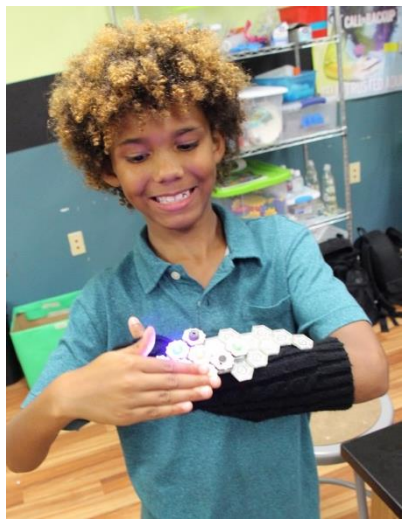








MAKERWEAR FINAL PROJECTS

WHAT DID CHILDREN MAKE?

SPORTS/FITNESS

38%

ROLE PLAY

31%

SOCIO-DRAMATIC PLAY

19%

OTHER

13%

MAKERWEAR FINAL PROJECTS

WHAT DID CHILDREN MAKE?

SPORTS/FITNESS

38%

ROLE PLAY

31%

SOCIO-DRAMATIC PLAY

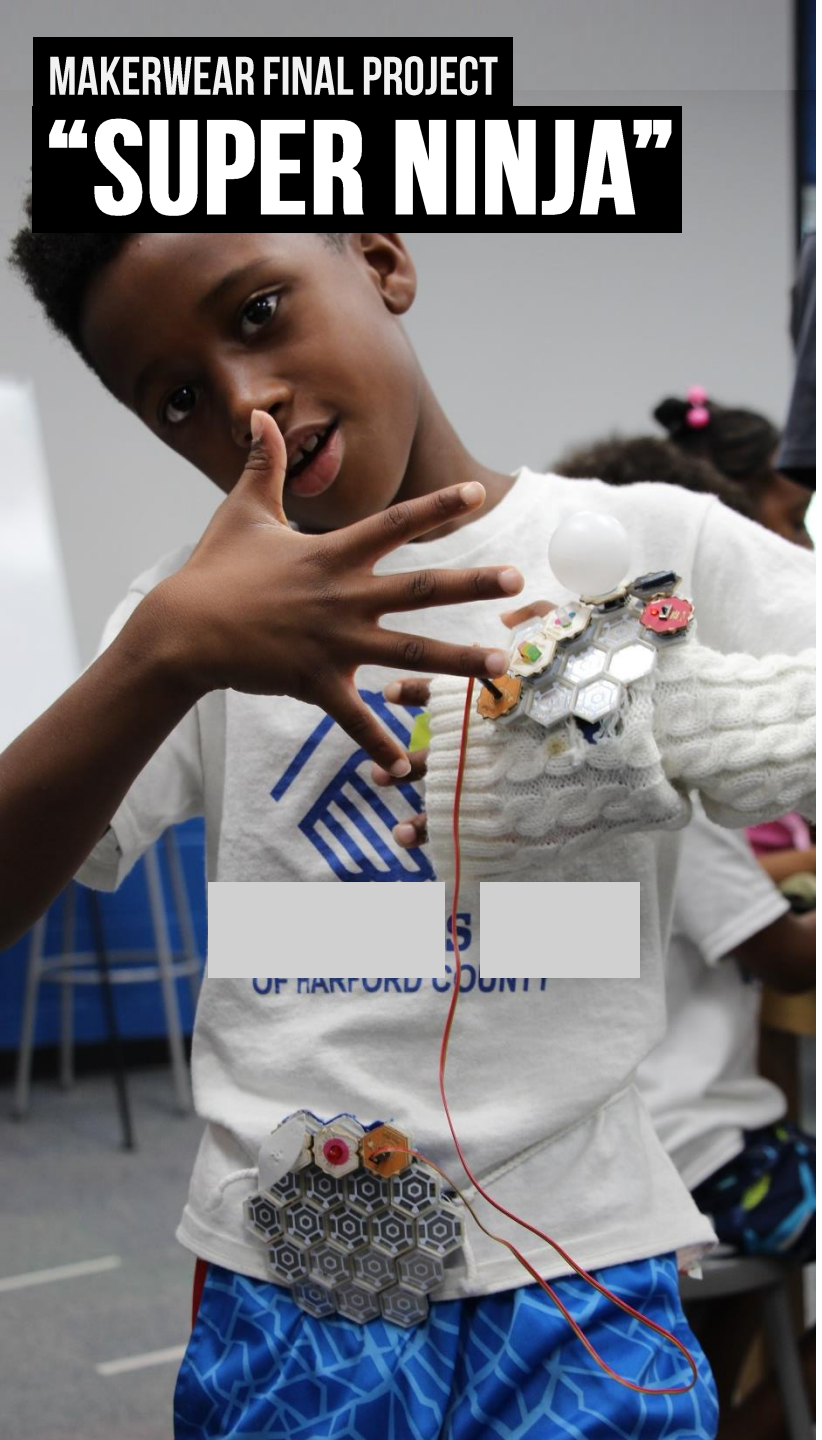
19%

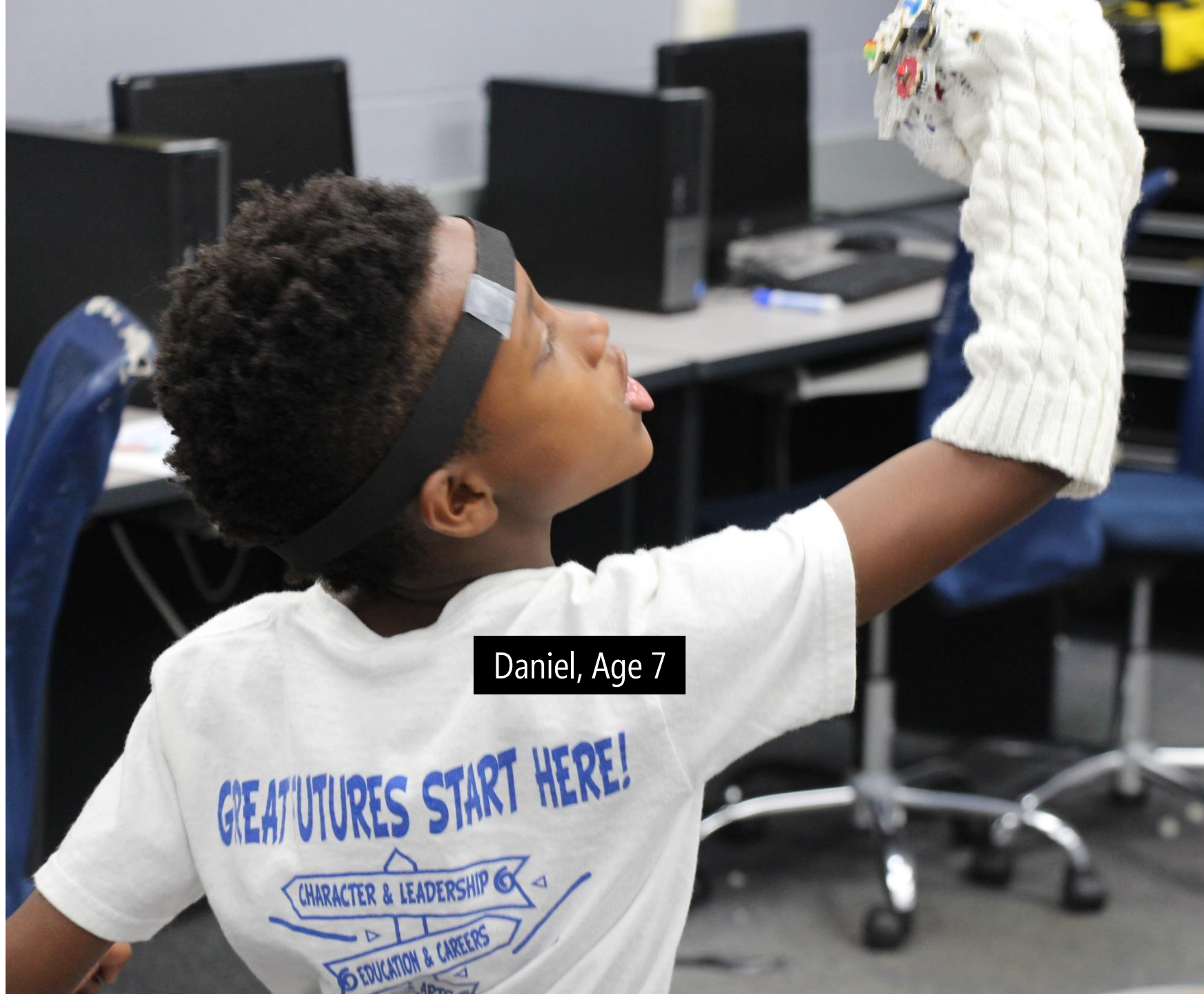
OTHER

13%

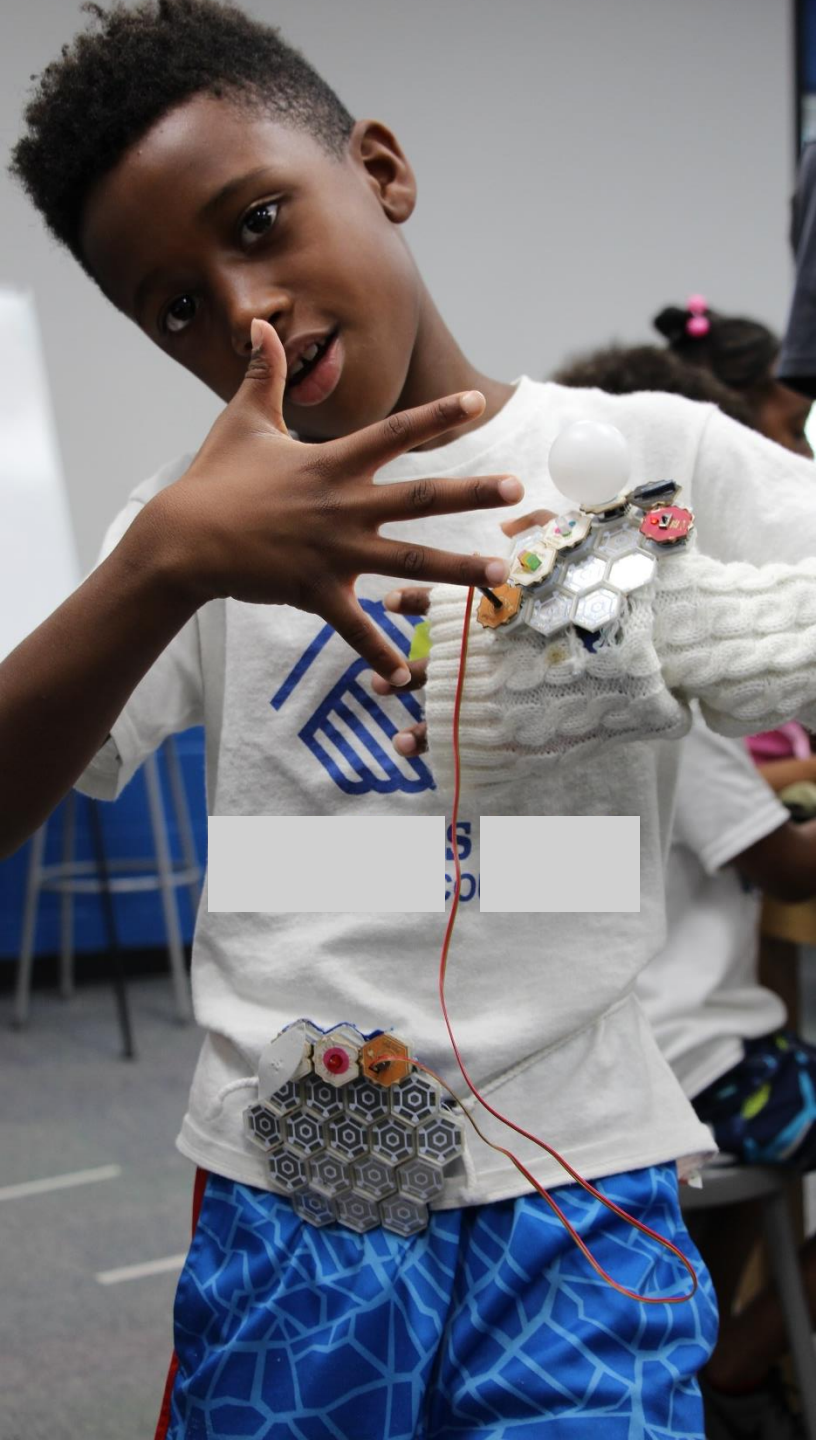
MAKERWEAR FINAL PROJECT

“SUPER NINJA”





Daniel, Age 7

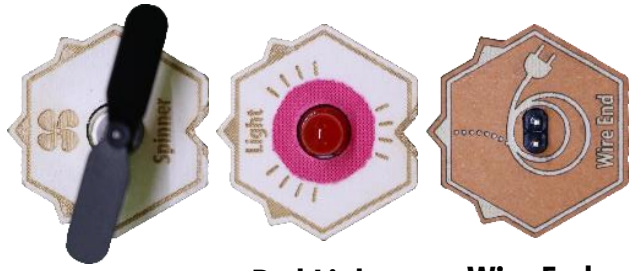


SUPER NINJA

Maker: Daniel, Age 7
9 modules: 5 actions, 2 misc, 1 sensor
2 socket meshes
2 lo-fi pieces

"UPPER CUT" ARMBAND

"NINJA" BELT



MAKERWEAR FINAL PROJECTS

WHAT DID CHILDREN MAKE?

SPORTS/FITNESS

38%

ROLE PLAY

31%

SOCIO-DRAMATIC PLAY

19%

OTHER

13%

MAKERWEAR FINAL PROJECT

“MAGIC POKÉMON”

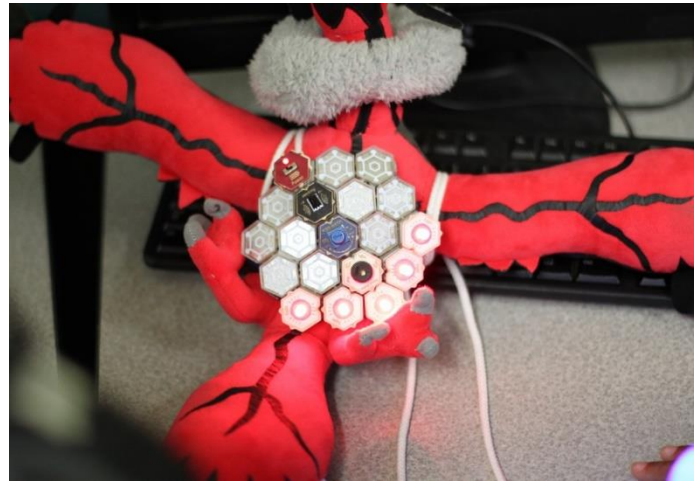
Austin, Age 9

MAGIC YVELTAL POKÉMON

Maker: Austin, Age 9
14 modules: 9 actions, 2 sensors, 1 modifier
2 socket meshes
3 lo-fi pieces + pokemon

VEST

POKÉMON DOLL



MAKERWEAR FINAL PROJECTS

WHAT DID CHILDREN MAKE?

SPORTS/FITNESS

38%

ROLE PLAY

31%

SOCIO-DRAMATIC PLAY

19%

OTHER

13%

MAKERWEAR FINAL PROJECT

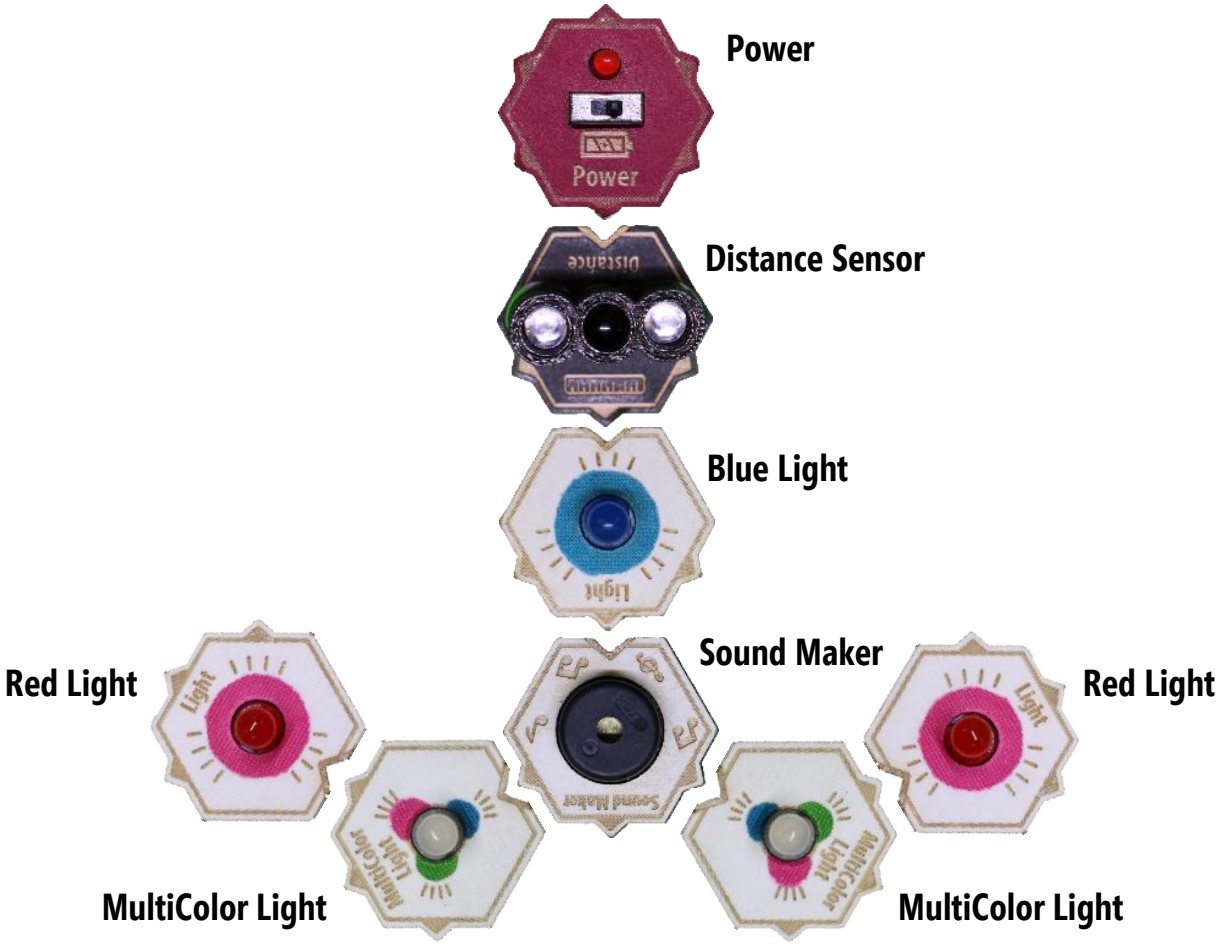
“SMART LACROSSE STICK”

Sarah, Age 9


BAD
AD's
SUPERMAN
LOVES STEM
KEEP
GOING

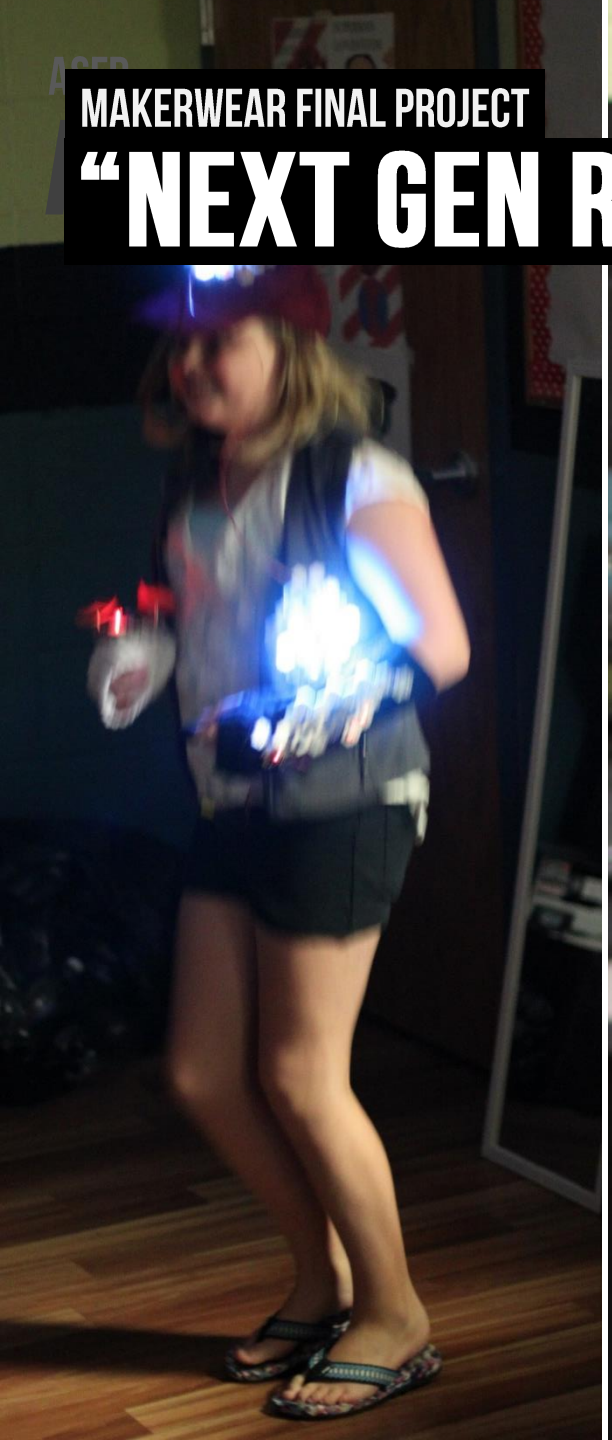
SMART LACROSSE STICK

Maker: Sarah, Age 9
8 modules: 6 actions, 1 sensor
1 socket mesh
3 lo-fi pieces + lacrosse stick

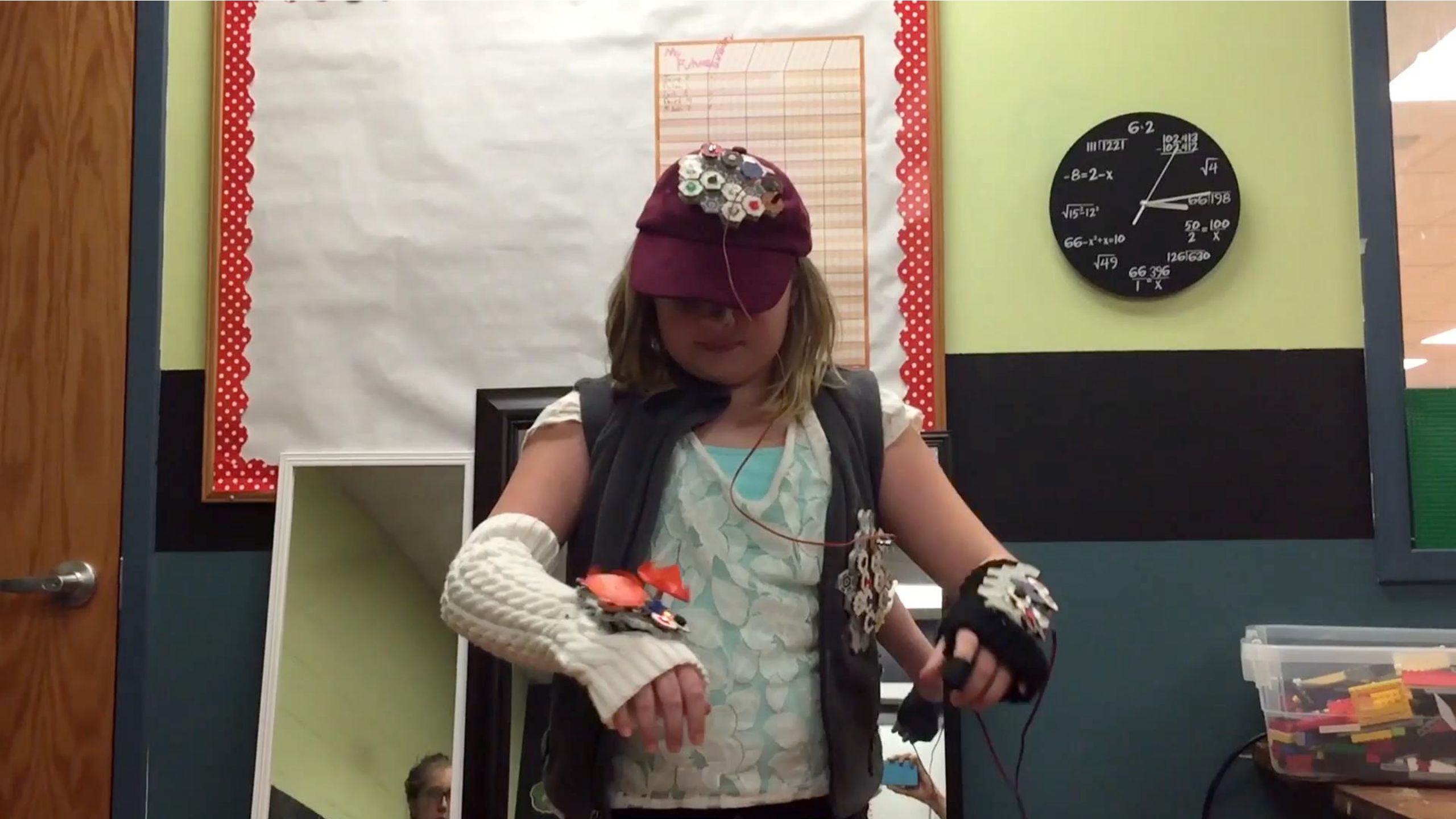


MAKERWEAR FINAL PROJECT

“NEXT GEN RUNNING CLOTHES”



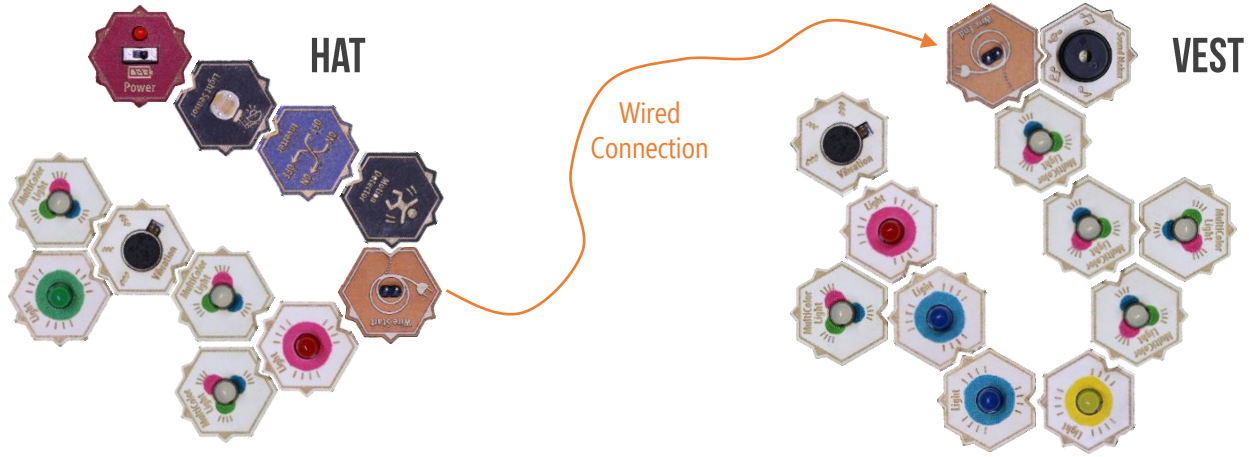
Amelia, Age 10


6·2
111221
-8=2-x
√4
66198
√15²-12²
66-x²+x=10
√49
126630
66 396
1 x

NEXT GENERATION RUNNING CLOTHES

Maker: Amelia, Age 10
40 modules: 25 actions, 3 sensors, 5 modifiers
4 socket meshes; 2 lo-fi pieces

MOTION-REACTIVE LIGHT-UP SAFETY HAT & VEST



"AIR CONDITIONING" ARMBAND

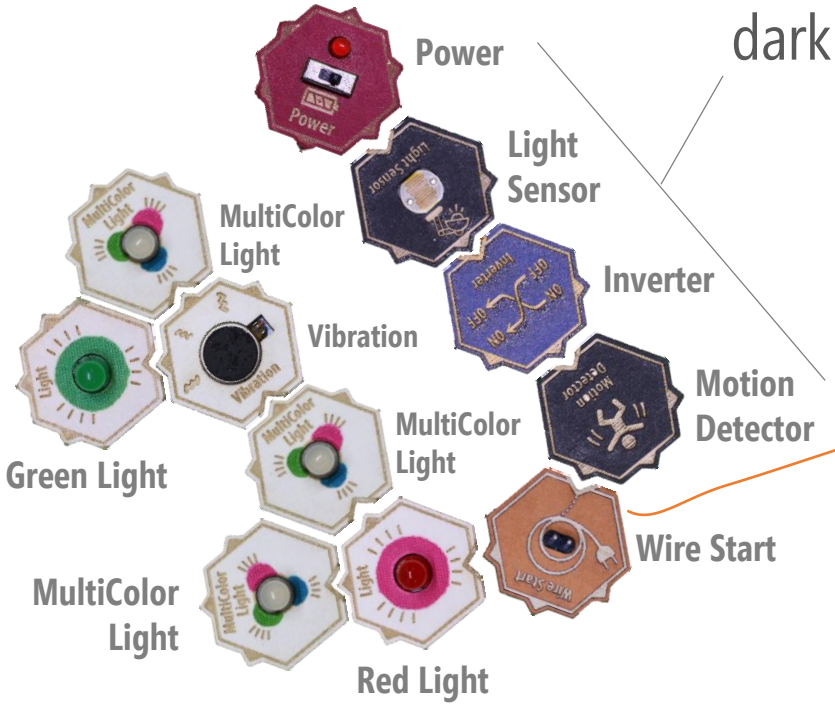
"HEART TRACKER" ARMBAND

NEXT GENERATION RUNNING CLOTHES

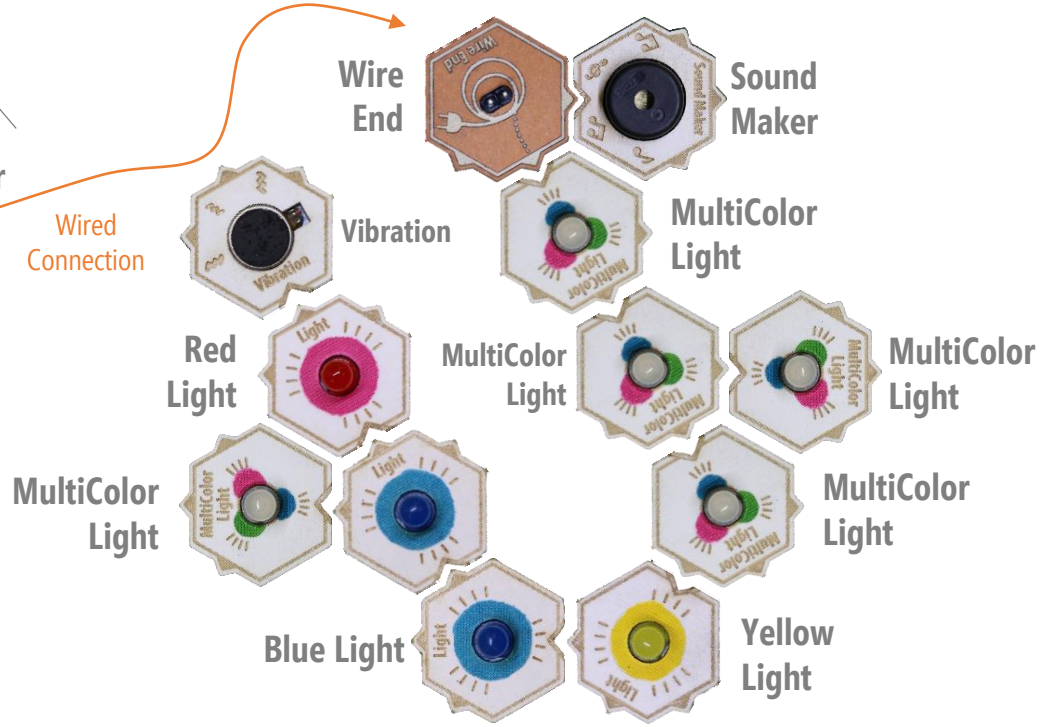
Maker: Amelia, Age 10
40 modules: 25 actions, 3 sensors, 5 modifiers
4 socket meshes; 2 lo-fi pieces

MOTION-REACTIVE HAT

Activate hat & vest only when it's dark **AND** the wearer is moving



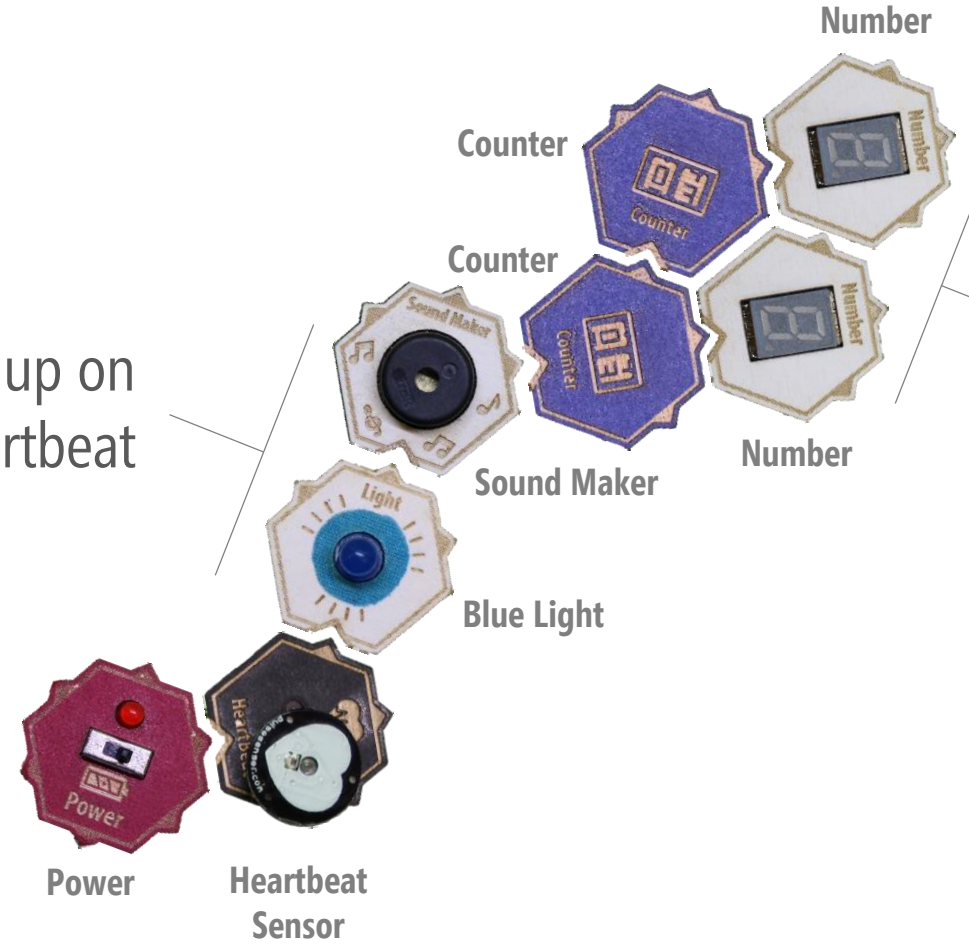
MOTION-REACTIVE VEST



NEXT GENERATION RUNNING CLOTHES

Maker: Amelia, Age 10
40 modules: 25 actions, 3 sensors, 5 modifiers
4 socket meshes; 2 lo-fi pieces

"HEART TRACKER" ARMBAND

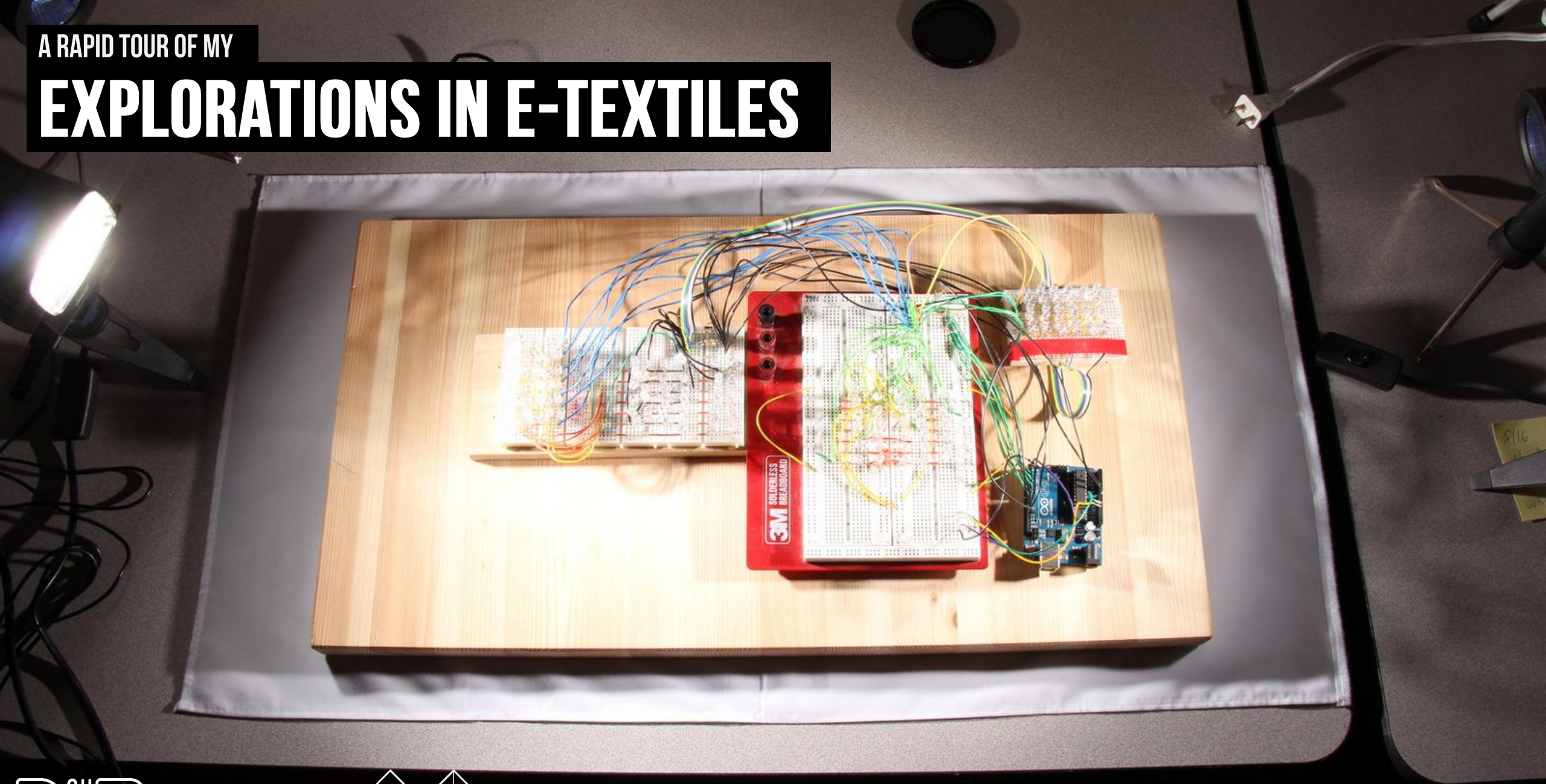


Beeps & lights up on each heartbeat

Counts heartbeats up to 99

A RAPID TOUR OF MY

EXPLORATIONS IN E-TEXTILES



DESIGN USE BUILD

MAKEABILITY LAB

PAUL G. ALLEN SCHOOL
OF COMPUTER SCIENCE & ENGINEERING

UNIVERSITY of WASHINGTON