

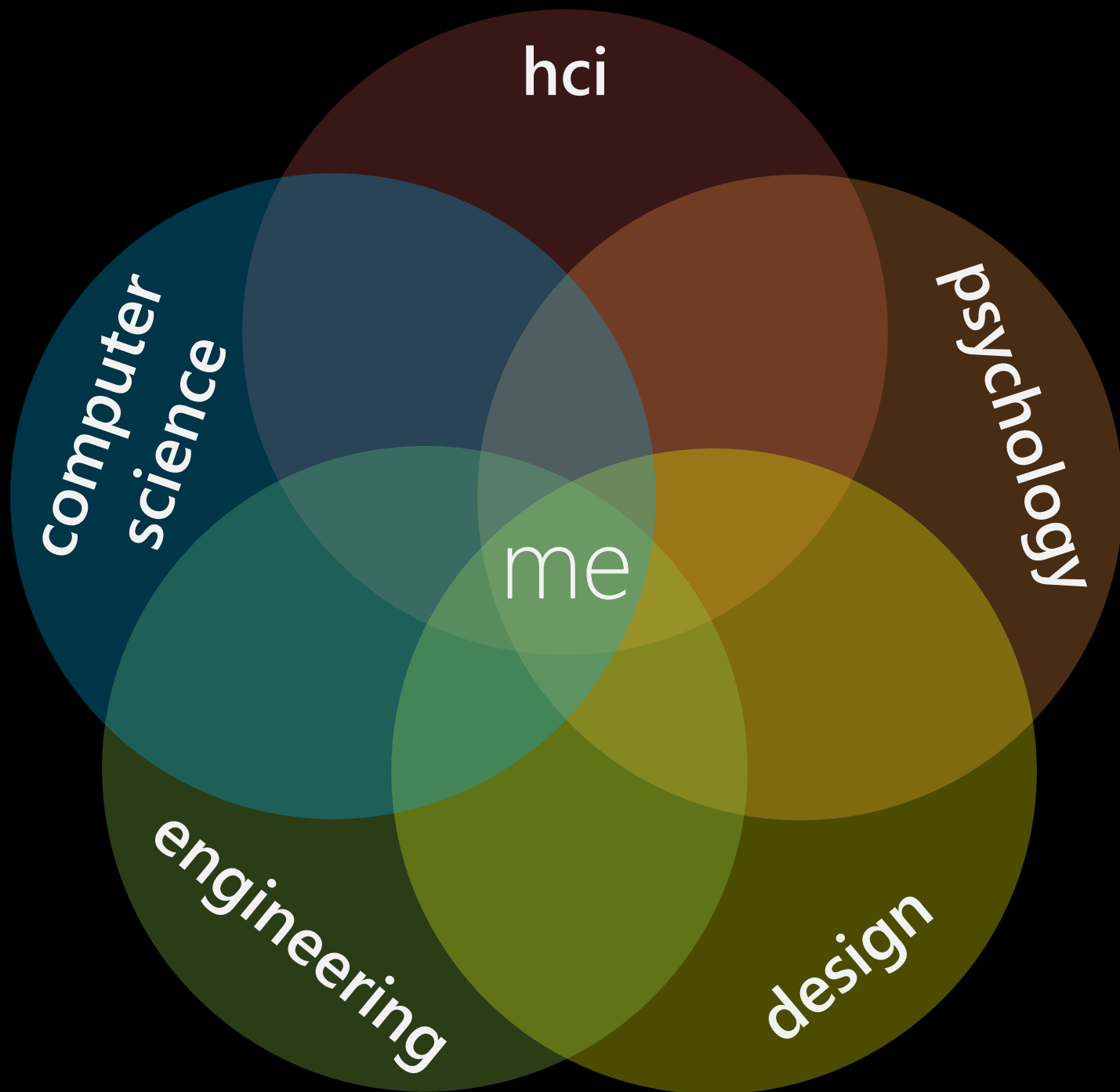
Making+Health: Social Fabric Fitness



@jonfroehlich
Assistant Professor
Computer Science
University of Maryland

Maker Movement in Health
Indiana University
April 21, 2014

me





Seattle, WA

Minneapolis, MN

Portland, OR

Ames, IA

Maryland!

Orange County, CA

Denver, CO

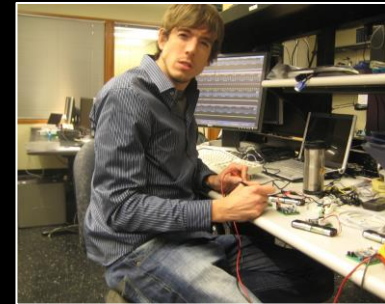




How does one go from



to



?



My Group

Started in 2012



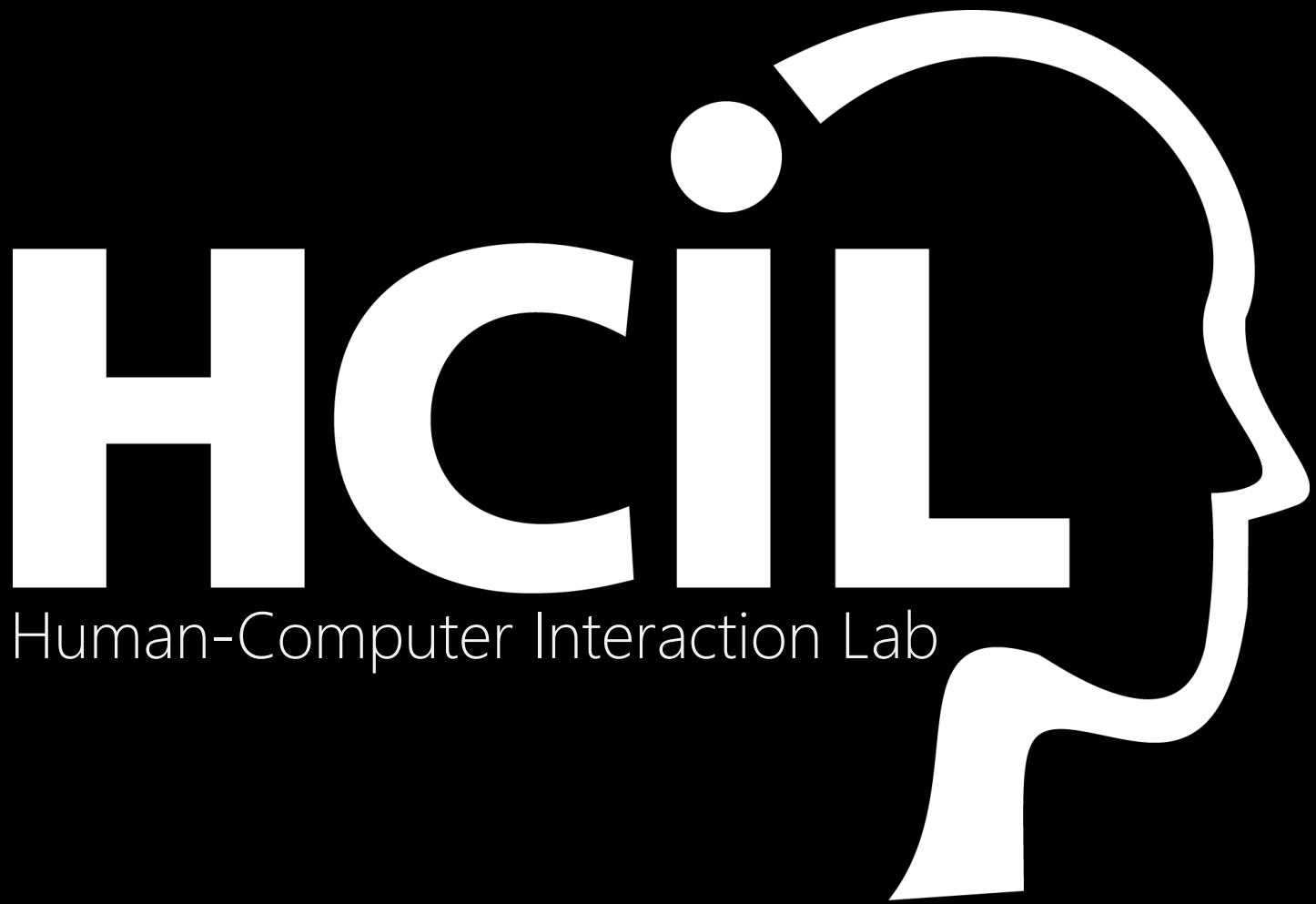
A group of seven people, mostly young adults, are captured in a moment of pure joy, jumping and cheering with their arms raised high. They are wearing bright green t-shirts, some of which feature a circular logo with the letters 'HCL'. The setting is an outdoor event space, possibly a fair or festival, with a large, modern building in the background and a white tent structure to the right. The ground is paved with light-colored bricks. The overall atmosphere is one of excitement and community. The text 'makeability lab' is overlaid in a white, lowercase, sans-serif font across the center of the image.

makeability lab

makeability lab

PhD: 4 (2 are 1st yrs)
MS: 2 (both iSchool)
UGrad: 3-5 per semester
High Sch: 1-2 per summer

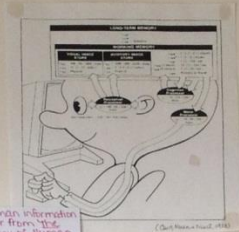
*A lablet within
the HCIL*



HCIL Begins

1983

Ben Shneiderman
Founding Director



The human information processor from the Psychology of Human-Computer Interaction



NOOBIE 1986
(A. DUBOIS'S MASTER'S THESIS AT MIT)



Lab in Comp. & Space Sciences Bldg
pre-1988



Ben Shneiderman
Trading Card
Appears in 1983 MIT Yearbook



PROF. ABRIEL ROSENFELD
(1931-2004)

World famous University of Maryland computer science professor... at the time, while teaching the course for Interactive Systems (1981), which introduced the Human-Computer Interaction lab.

Gifted by Ben Shneiderman



LeahFindlater



JenGolbeck



BenShneiderman



BenBederson



JonFroehlich



AnneRose



CatherinePlaisant



MarshiniChetty



VanessaFrias



JennyPreece



JessicaVitak



AllisonDruin



MonaLeighGuha



TammyClegg



JuneAhn



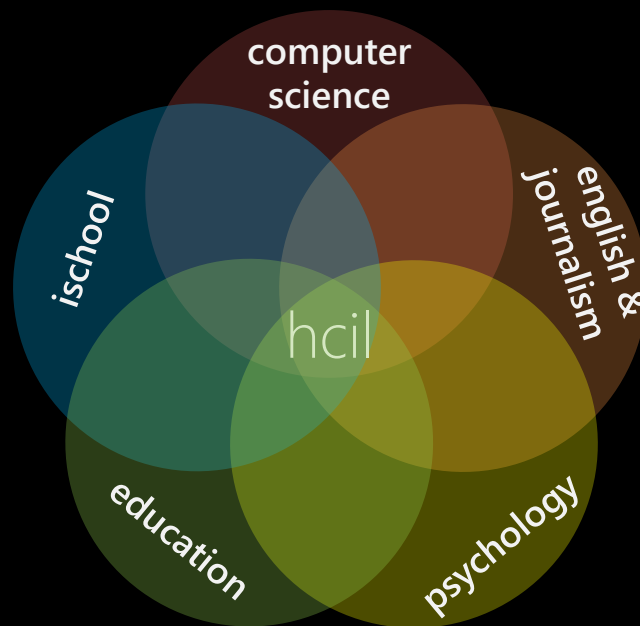
EvanGolub



TimClausner



KentNorman



KariKraus



IraChinoy

HCIL

Offices

Human-Computer Interaction Institute (HCIL) at Carnegie Mellon University

We Combine Human Computation, Computer Vision, and the Street View to Improve Sidewalk Accessibility and Curb Ramps

Curb Ramp Detection with Google Street View

Effectiveness for the Detected Curb Ramps

HCIL

2107 C
Catherine Plante



1993 1998 2003 2007

Ben Baderson 2nd Director

The

HCIL

2001 John Galloway with Director

2007 Lab expansion

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Main Lab


From Back



HCIL Usability Lab

With One-Way Transparent Mirror



A person is working on a yellow circuit board in a workshop. They are using a red-handled tool to adjust components on the board. The workspace is cluttered with various tools, including pliers, a soldering iron, and a multimeter. A white desk lamp is positioned over the work area. The background shows a pegboard with various tools hanging on it. The text "When I arrived in 2012, I observed a lack of space for combining materiality & computation" is overlaid on the image.

When I arrived in 2012, I observed a lack of space
for **combining materiality & computation**



TIME

Bits

SMALL BUSINESS

How the 'Mak' ... the U.S. Fear

OCTOBER 20, 2012

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nexus7



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The Real
Romney



Philippine
Economy Set to
Become Asia's
Newest Bright
Spot



New Program:
Columbia Management

HCIL Hackerspace

Front Entrance



Building the Hackerspace

Making the Whiteboard Wall

Wood glue



Building the Hackerspace

Making the Workbench



Building the Hackerspace

Making the Workbench



Building the Hackerspace

Making the Workbench



Workspace

HCIL Hackerspace



Workspace

HCIL Hackerspace



Physical Making

HCIL Student Leyla Norooz



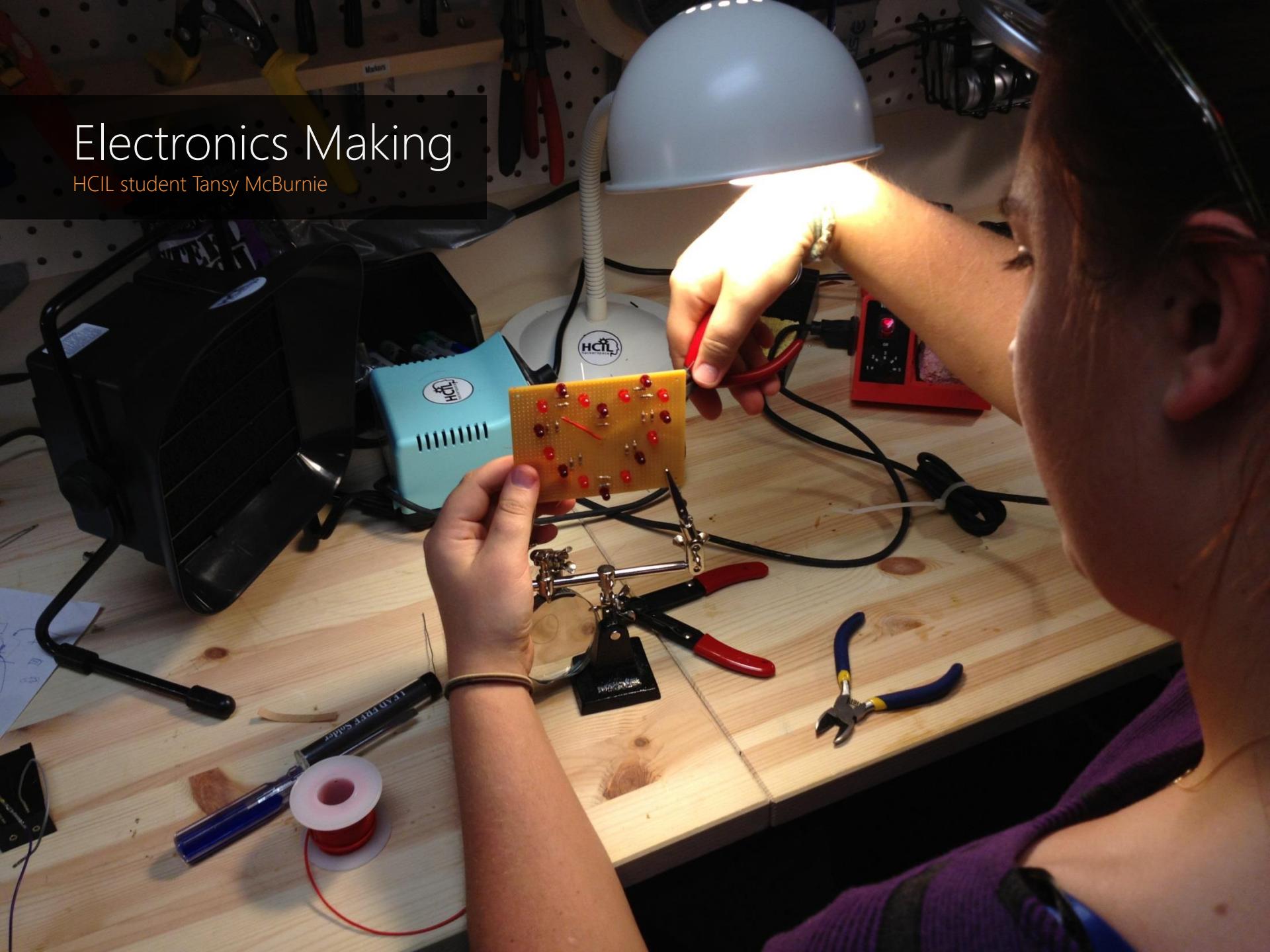
Craft/Fabric Making

HCIL student Matt sewing



Electronics Making

HCIL student Tansy McBurnie



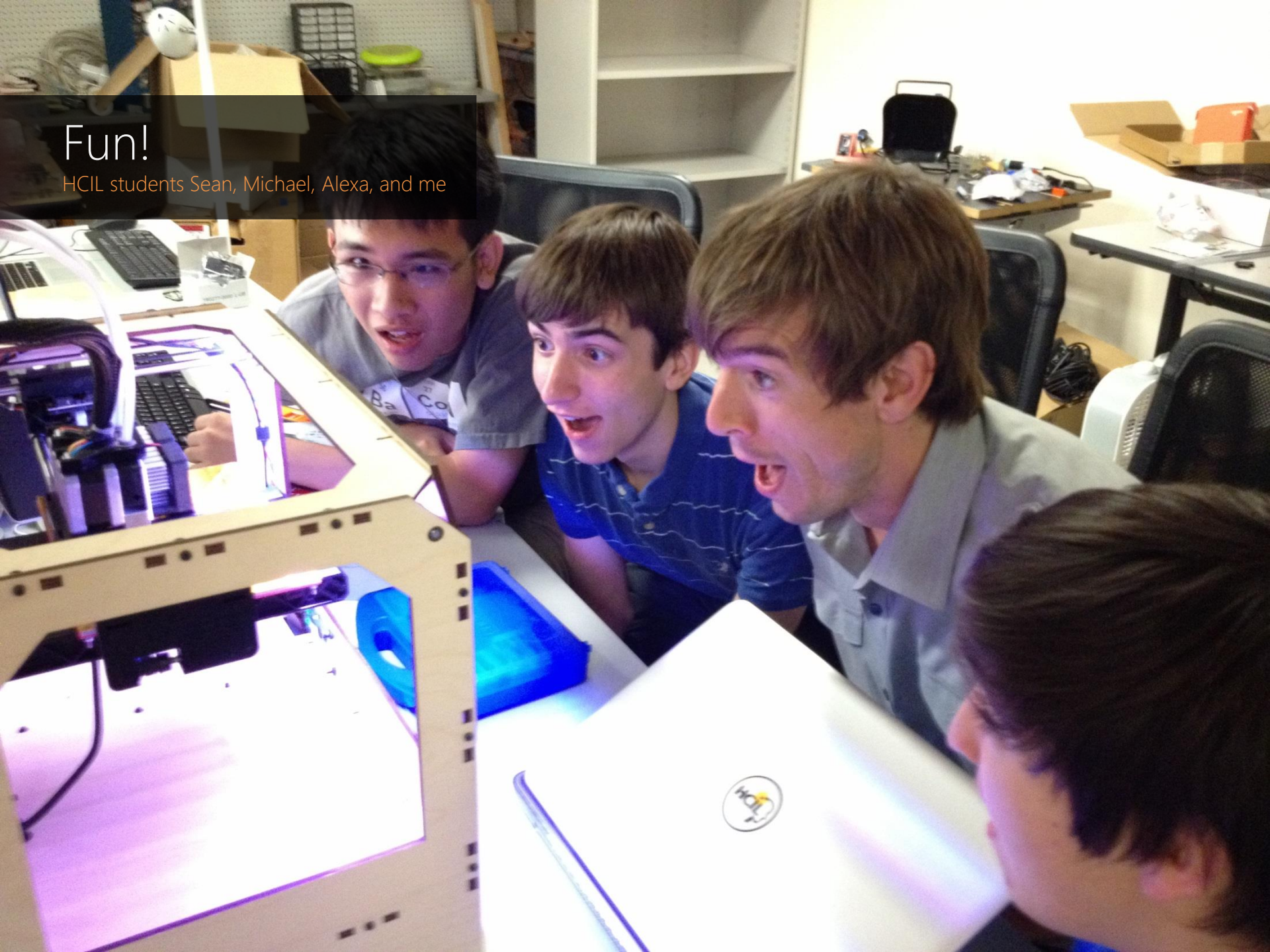
Rapid Prototyping

HCIL Hackerspace mannequin: Manny

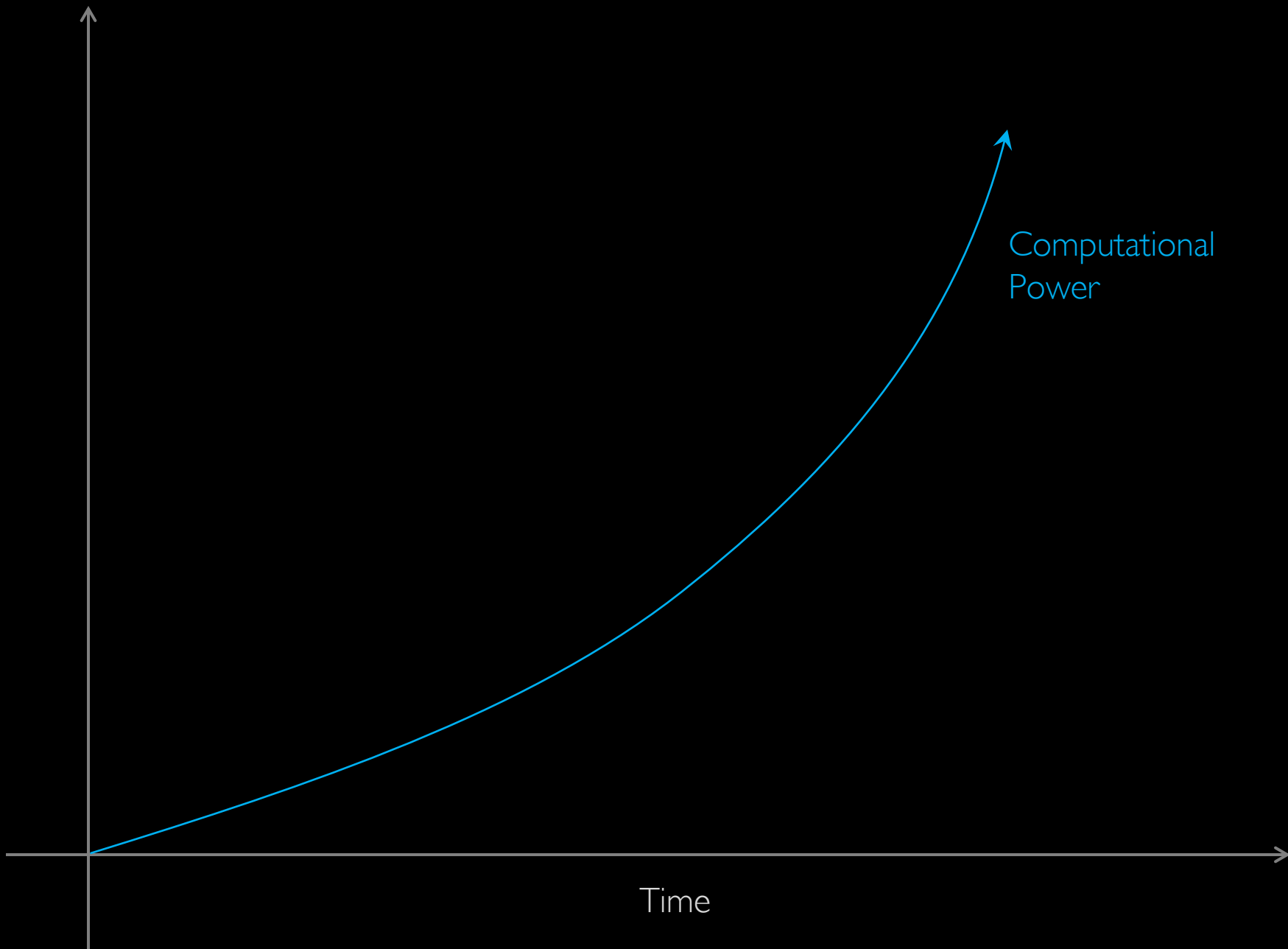


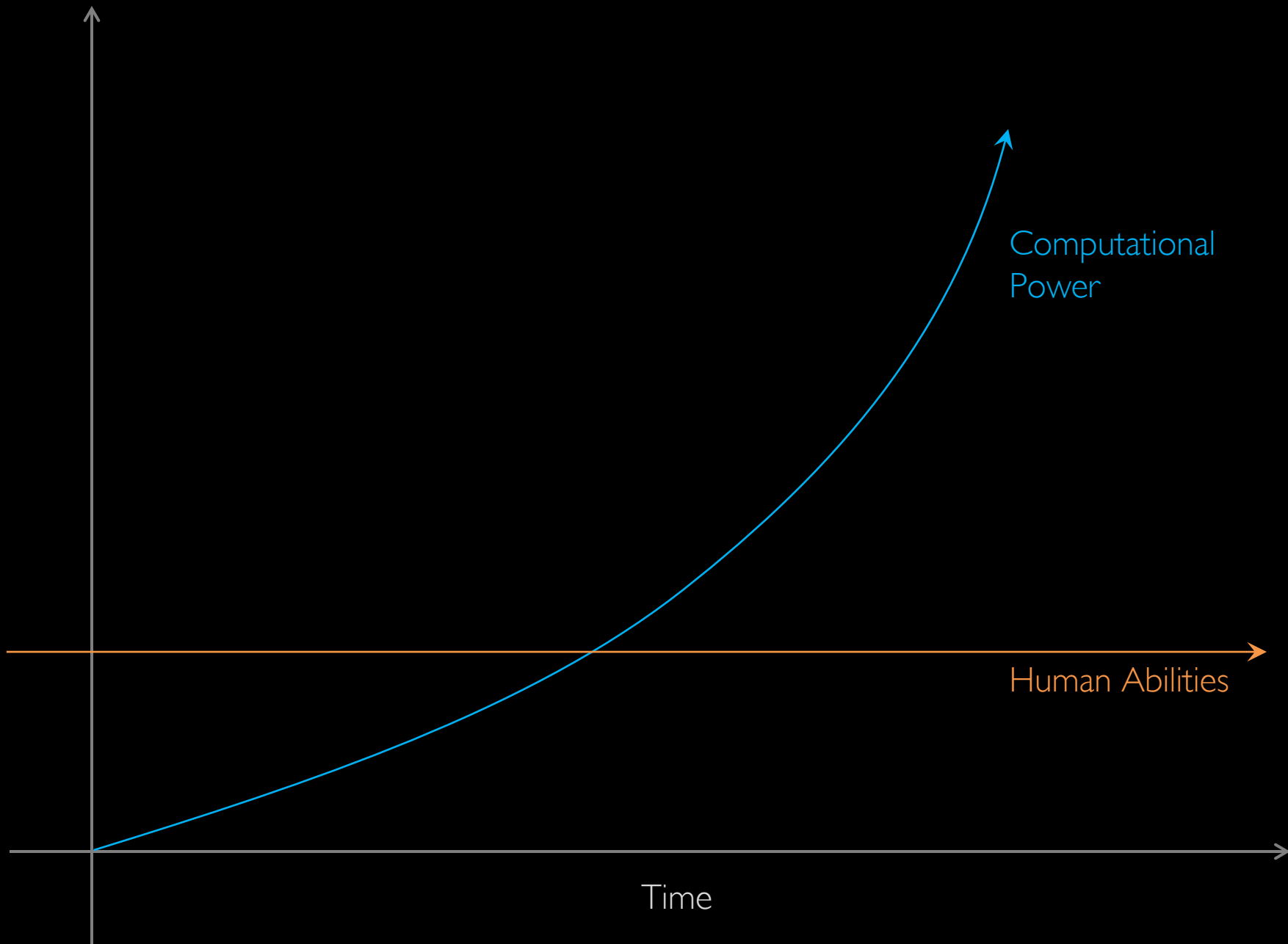
Fun!

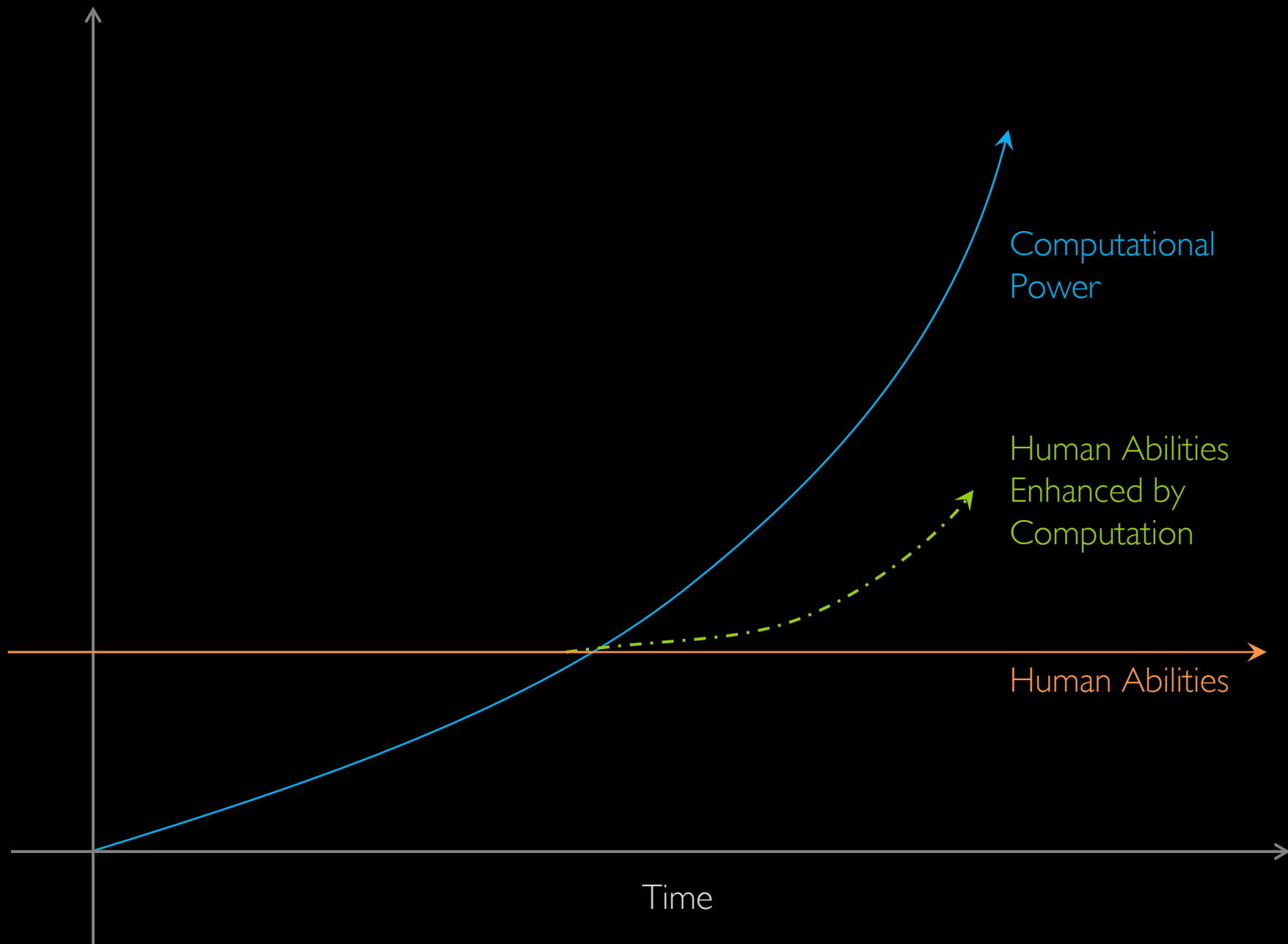
HCIL students Sean, Michael, Alexa, and me



The inspiration for our work is partly **technical**, partly **social**.



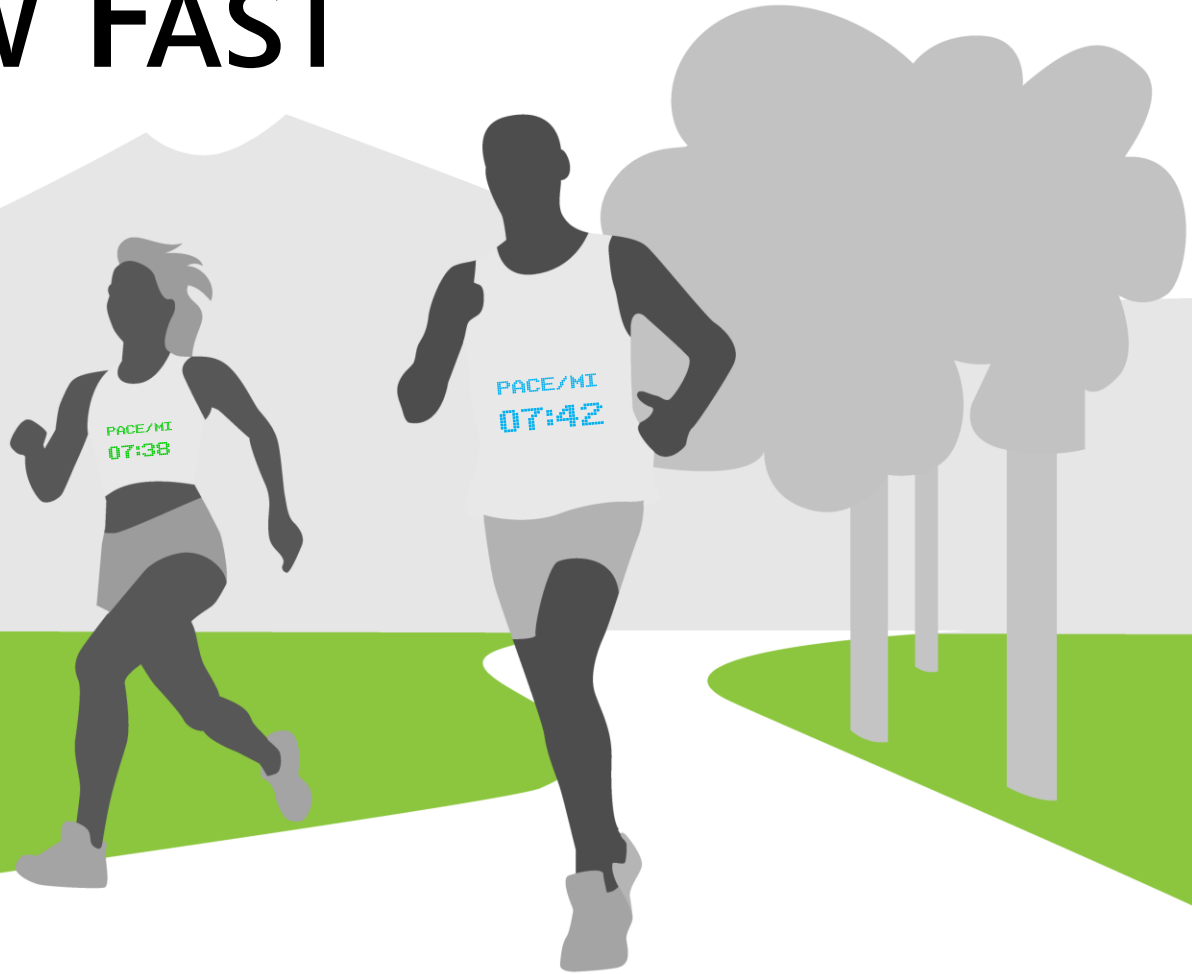




Social Fabric Fitness



WHAT IF OUR CLOTHES COULD SHOW HOW FAST WE RUN?



Since the 1990s, **running** has experienced
unprecedented growth in the US



Plethora of Run Trackers

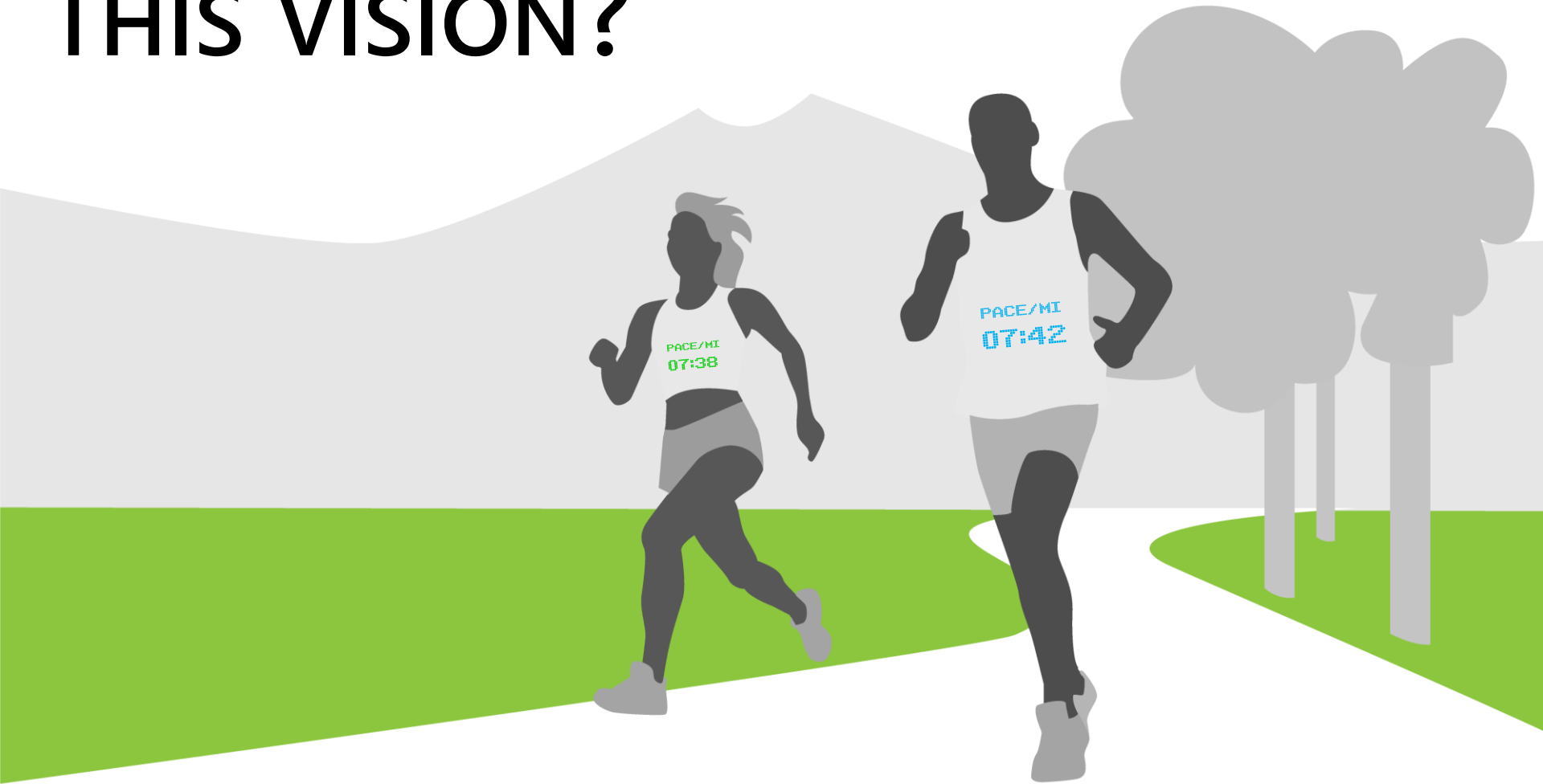


Built for the individual!

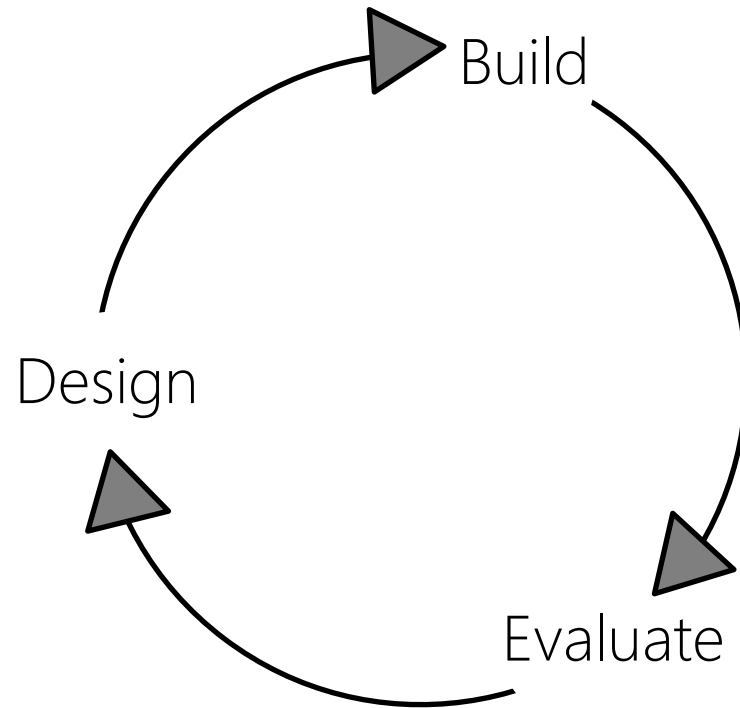
Can we create a **wearable and glanceable feedback display** to support group runners?

What does it feel like to have **“private” data
reappropriated for a public display** that you wear?

HOW SHOULD WE PURSUE THIS VISION?



The Iterative Design Process



SFF: Design and Evaluation Process

Ideation &
Lo-Fi
Prototyping

Parallel Prototyping 3 Designs

Informal Pilot Studies

Select & Refine
Final Design

Pilot
Testing

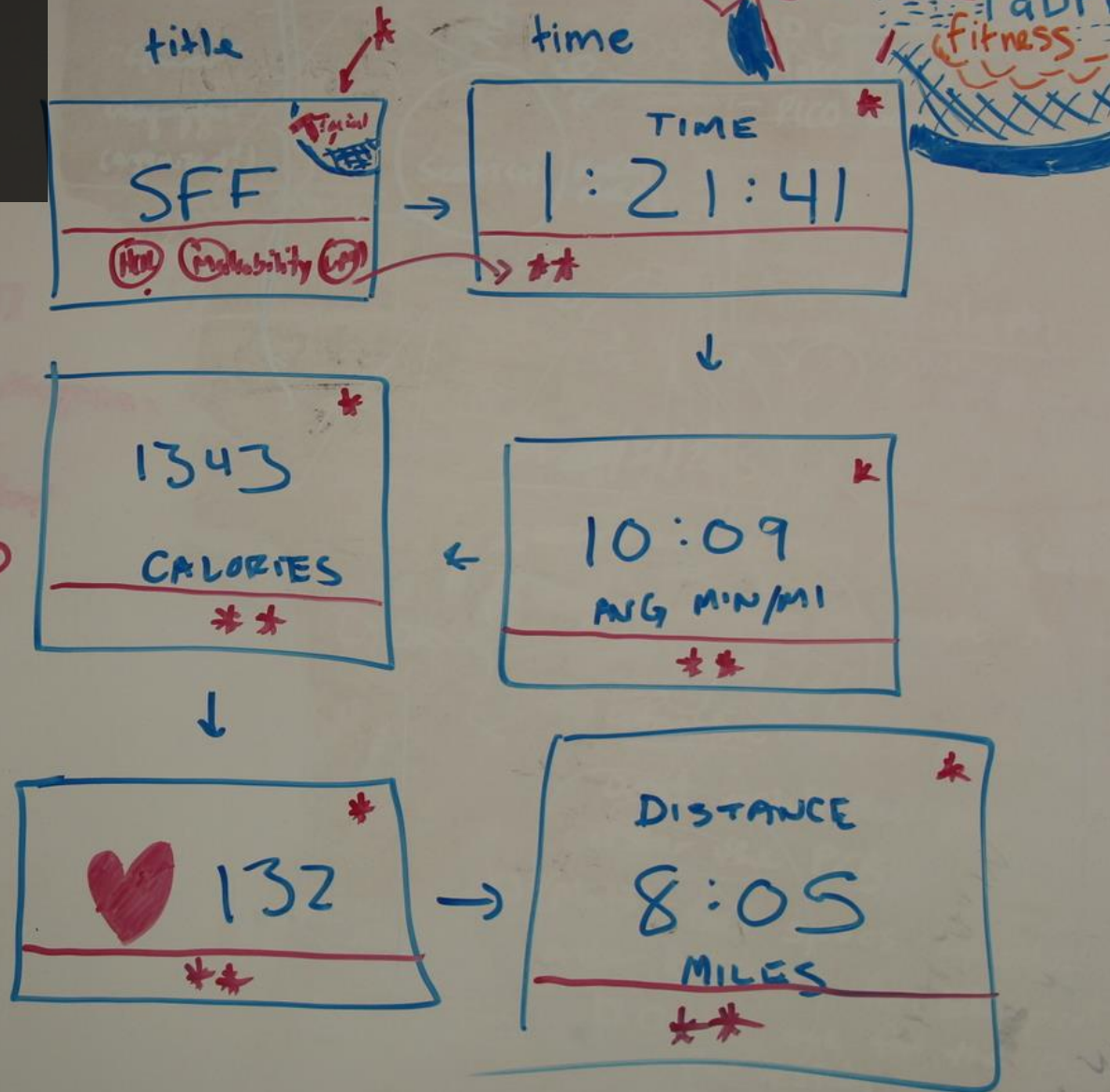
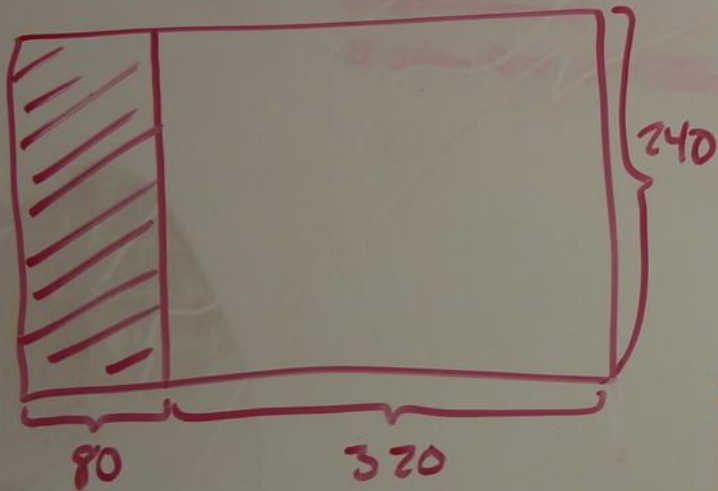
Field Study of 10
Pre-Existing
Running Groups

2 Case
Studies
at Races

Designing the Visual Content

Glanceable & Easy-to-understand

- calcs. time/d
- time



Comfort

Low-Fidelity Prototypes



Engineering

Responsive & Robust



Fabric/Craft

Building the Jerseys

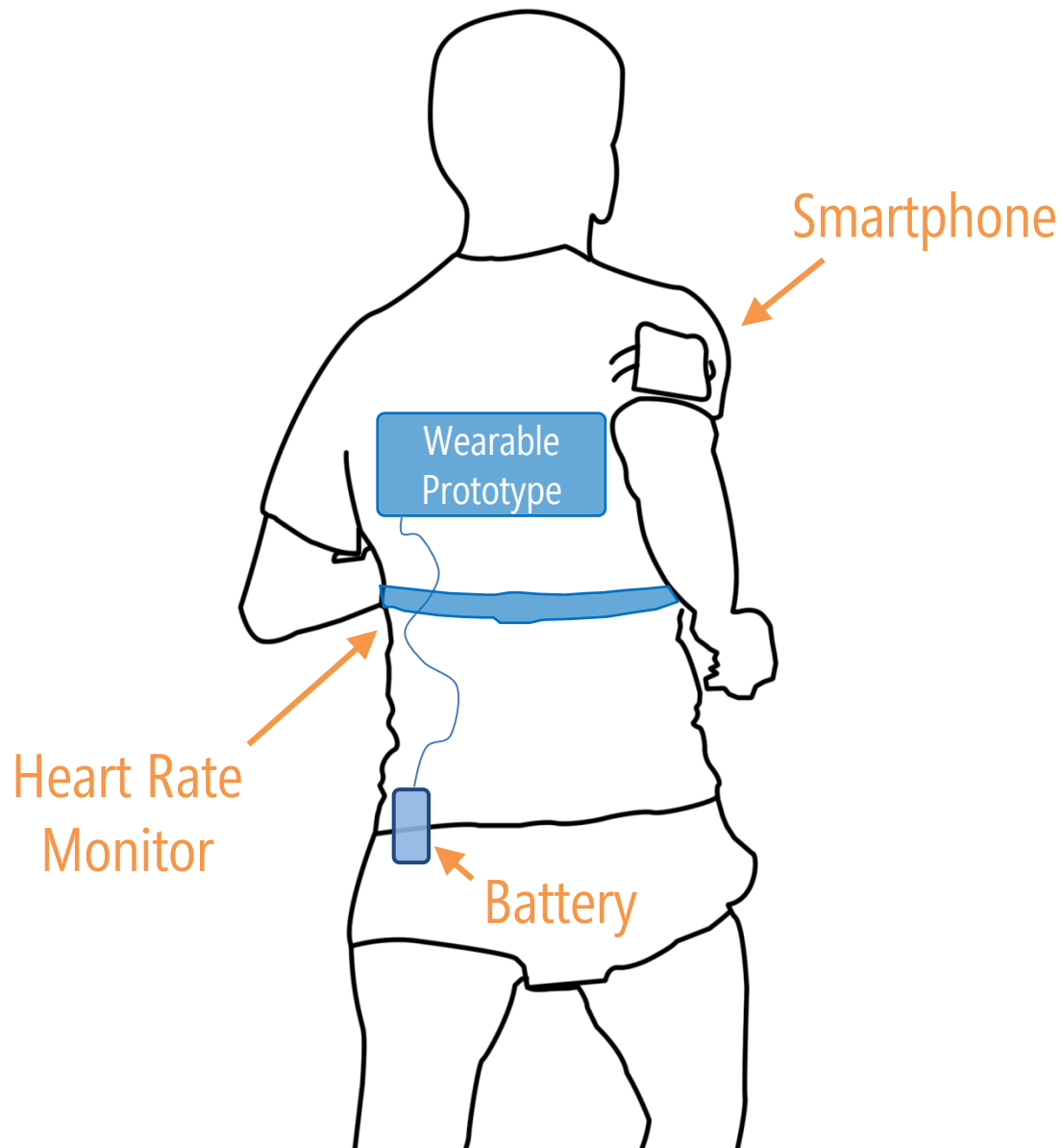


Pilot Studies

Examining our prototypes in the field



SFF: System Design



SFF: System Design

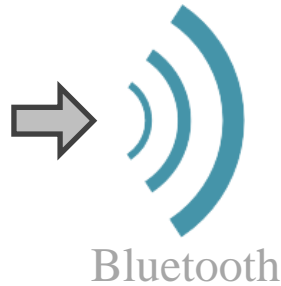
Smartphone



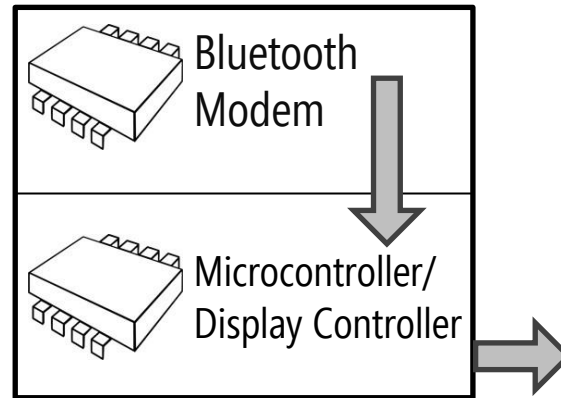
1. Sense & process running data. Wirelessly transmit to display hardware.

SFF: System Design

Smartphone



Display Hardware



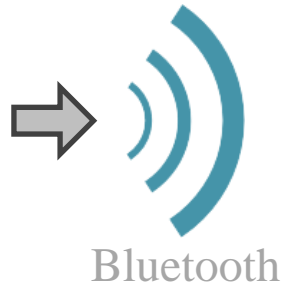
Hard-Wire Link

1. Sense & process running data. Wirelessly transmit to display hardware.

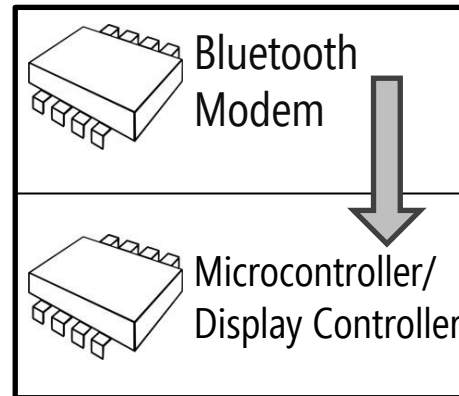
2. Receive running data; process & send to the display via hard wire link.

SFF: System Design

Smartphone

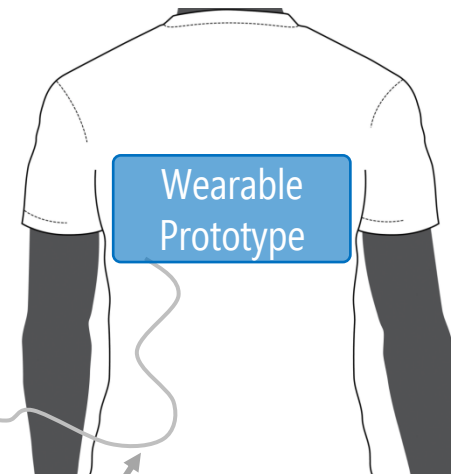


Display Hardware



Hard-Wire Link

Wearable



1. Sense & process running data. Wirelessly transmit to display hardware.

2. Receive running data; process & send to the display via hard wire link.

3. Visualize running data on the wearable display

SFF: System Design

Smartphone

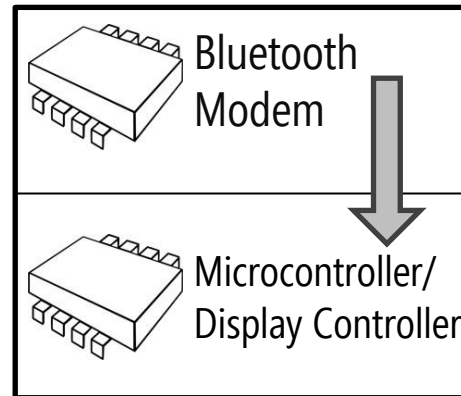


Wireless HR Data



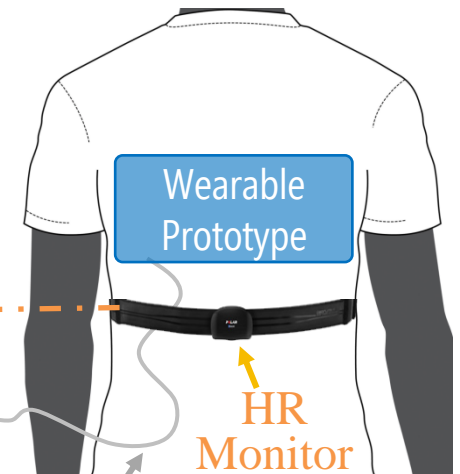
Bluetooth

Display Hardware



Hard-Wire Link

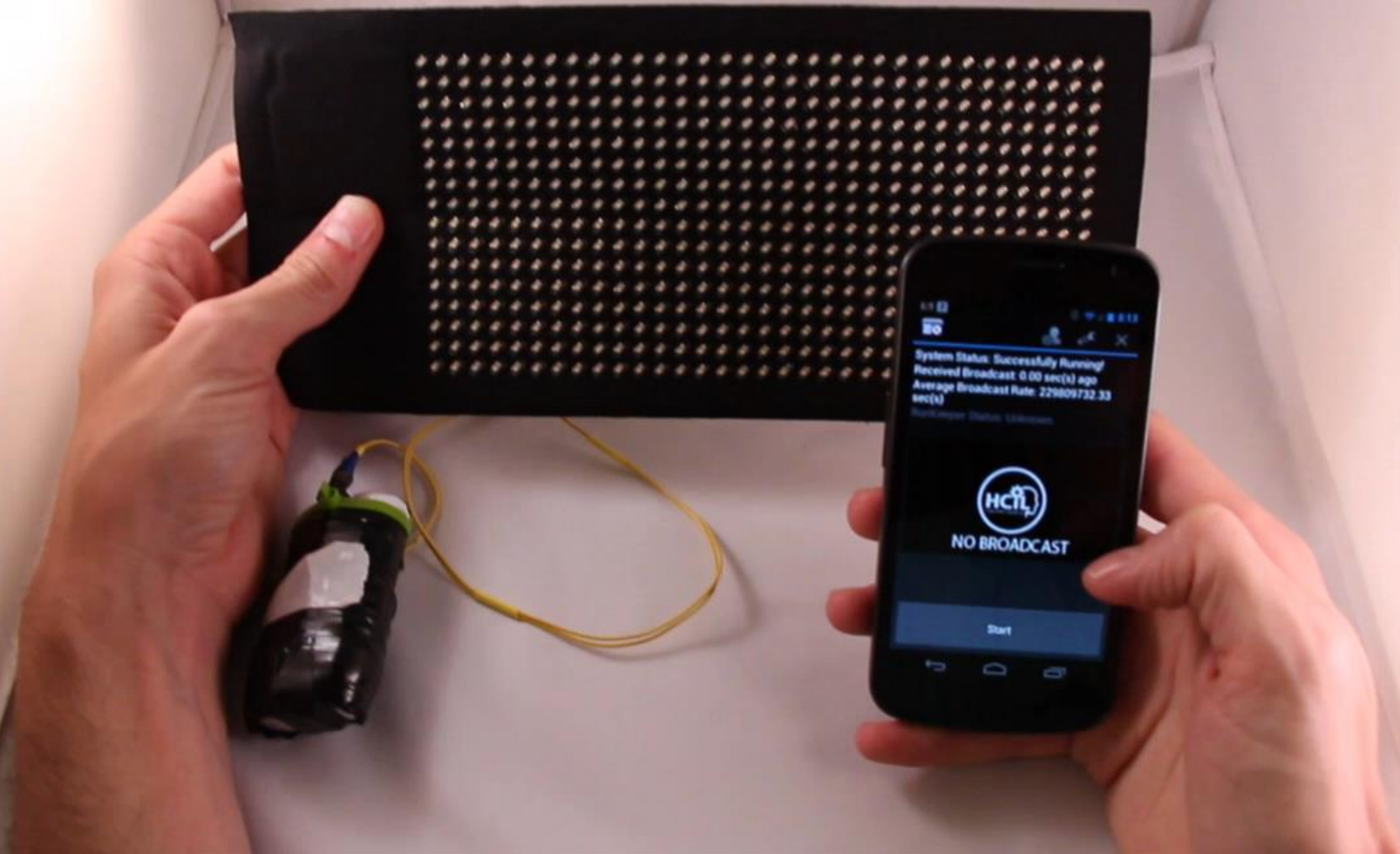
Wearable



1. Sense & process running/HR data. Wirelessly transmit to display hardware.

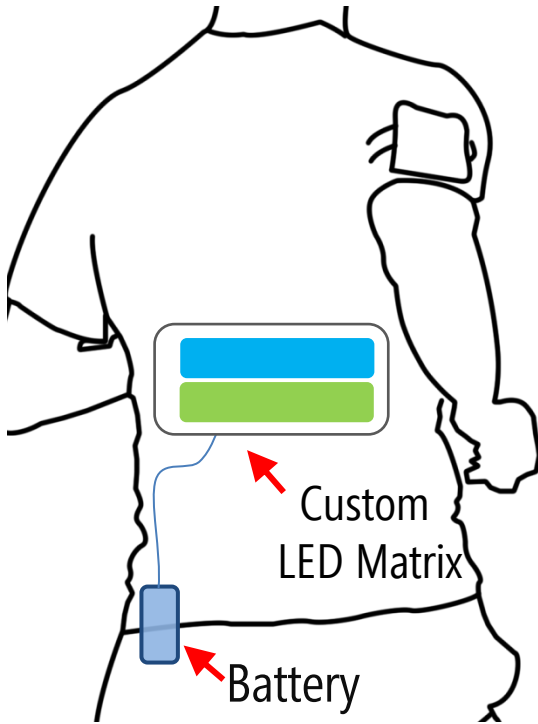
2. Receive running data; process & send to the display via hard wire link.

3. Visualize running data on the wearable display

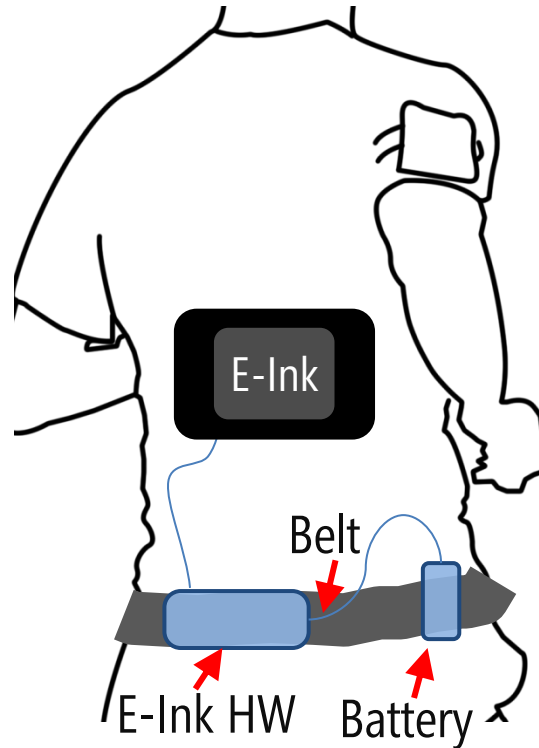


SFF: Three Prototypes

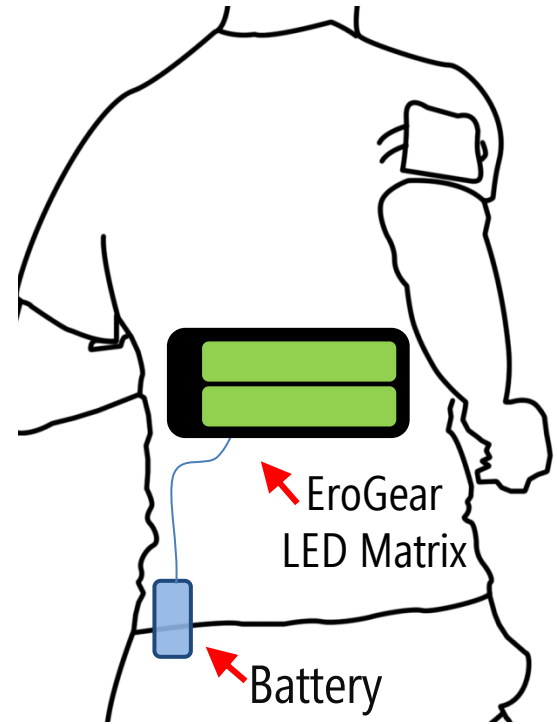
Prototype #1



Prototype #2



Prototype #3



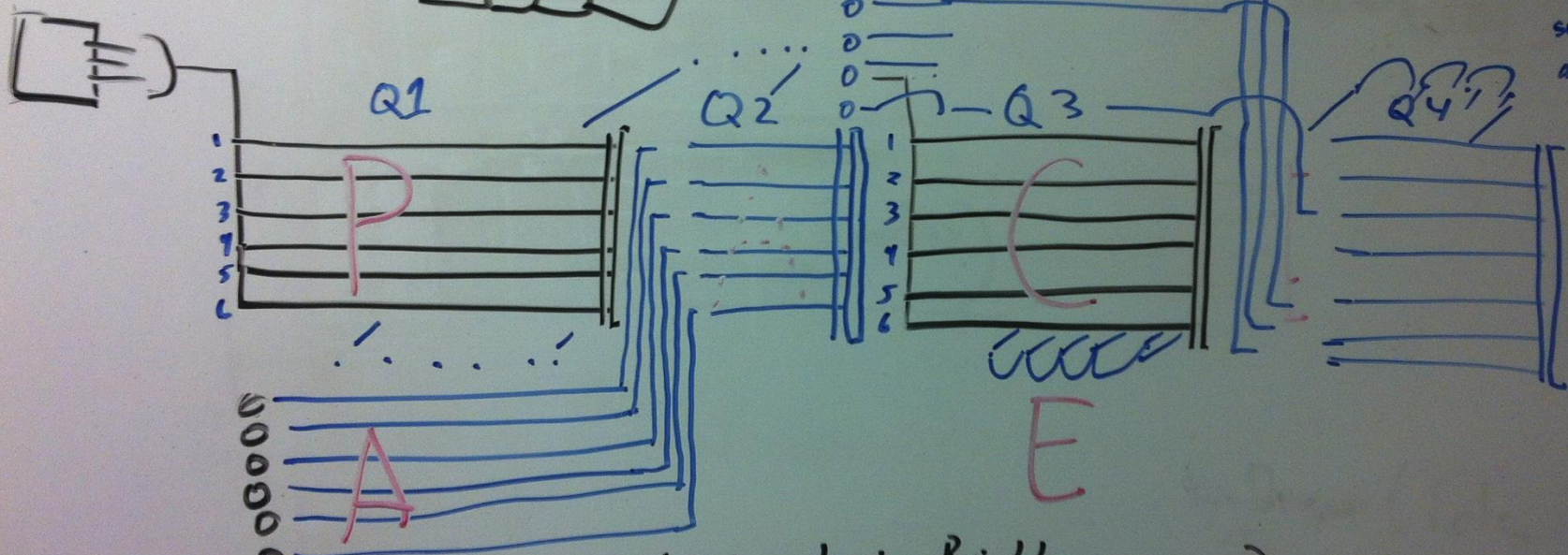
Prototype #1

Custom Flexible PCB Solution



First Step: Prototyping LED Matrix Approaches

2:00.5



- i) Can we solve Charlie plexing Brightness issue?
- ii) Abandon Charlie plexing?
- iii) Parts list?

DisplayMessageActivity

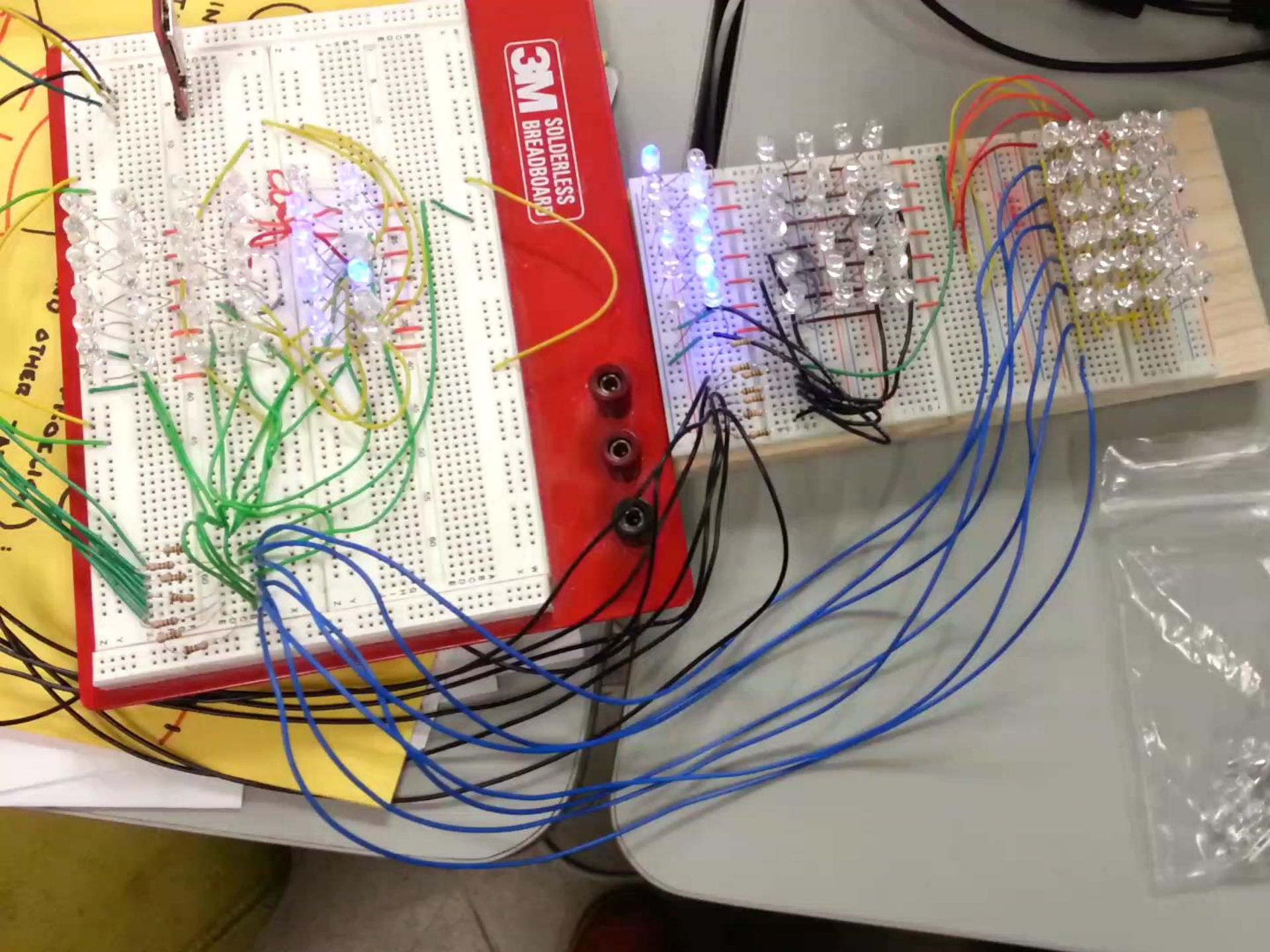
Bluetooth Device (UUID)

Send Message

8N47 27AD

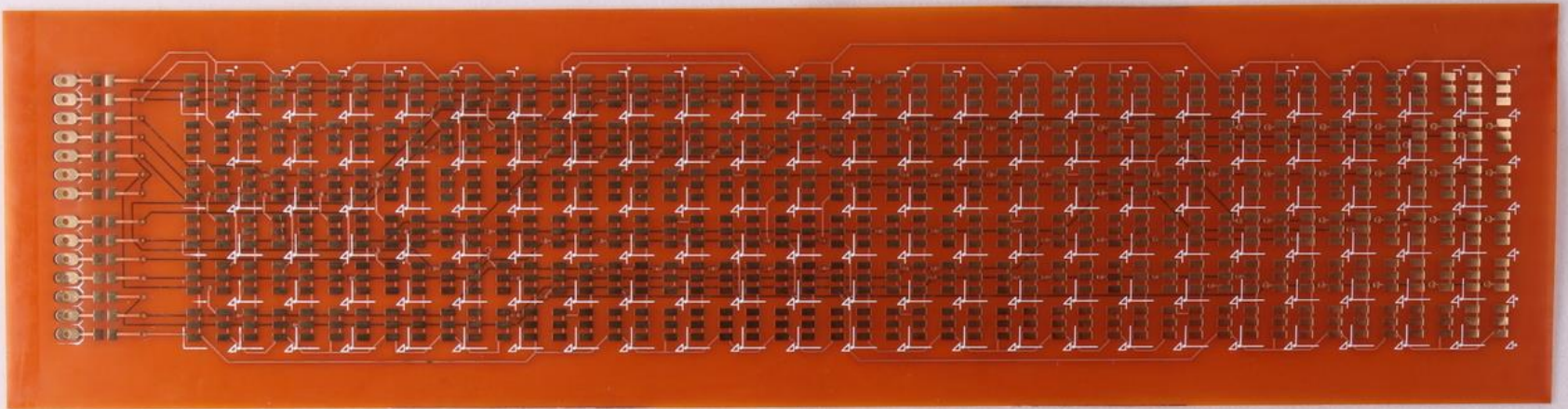
4040404048 27AD

q w e r t y u
s d f g h
x c v

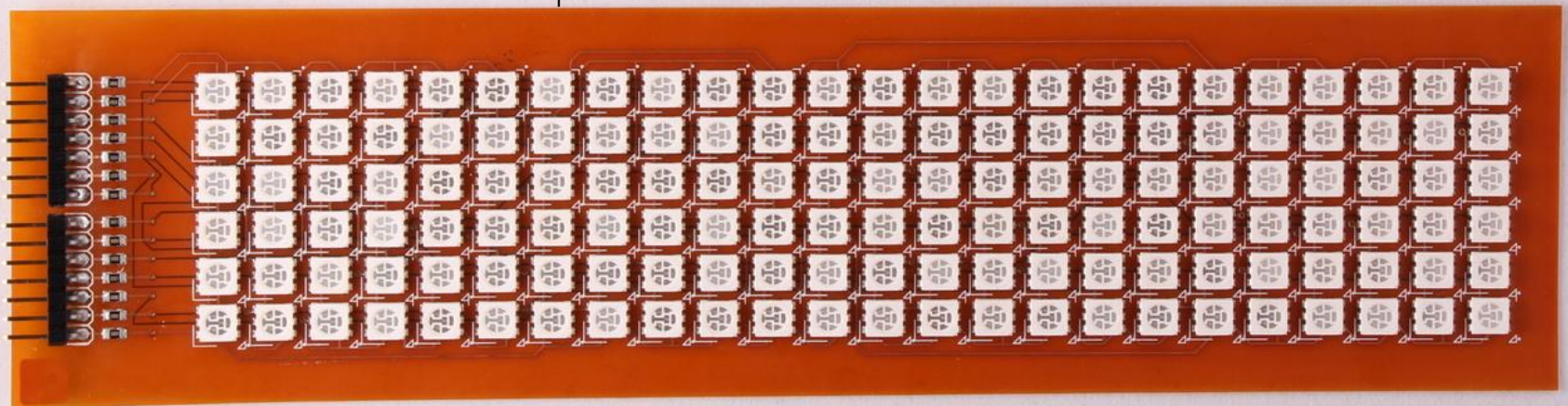


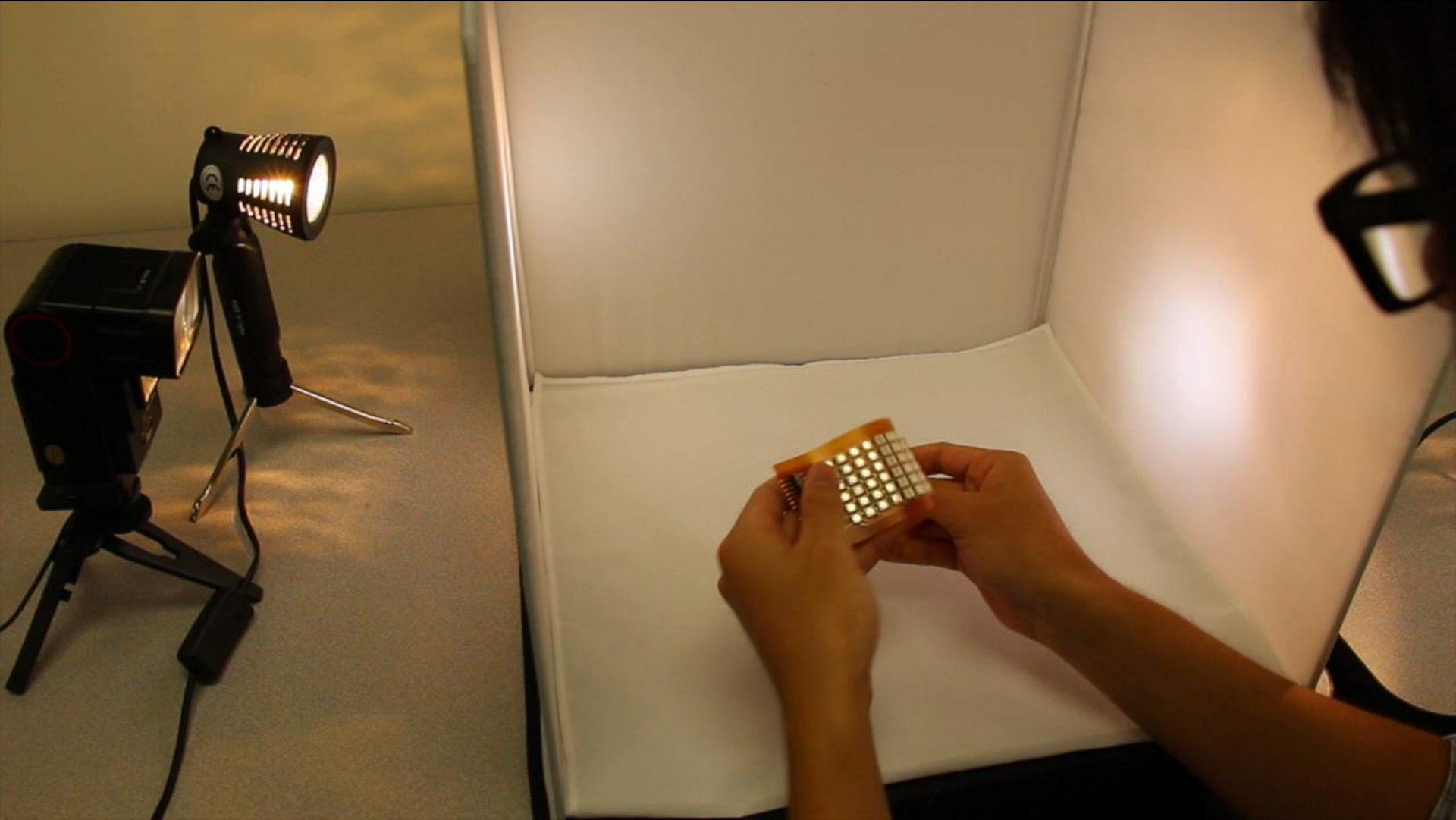
Second Step: Research & Manufacture Flexible PCB Solution

Naked Flex PCB

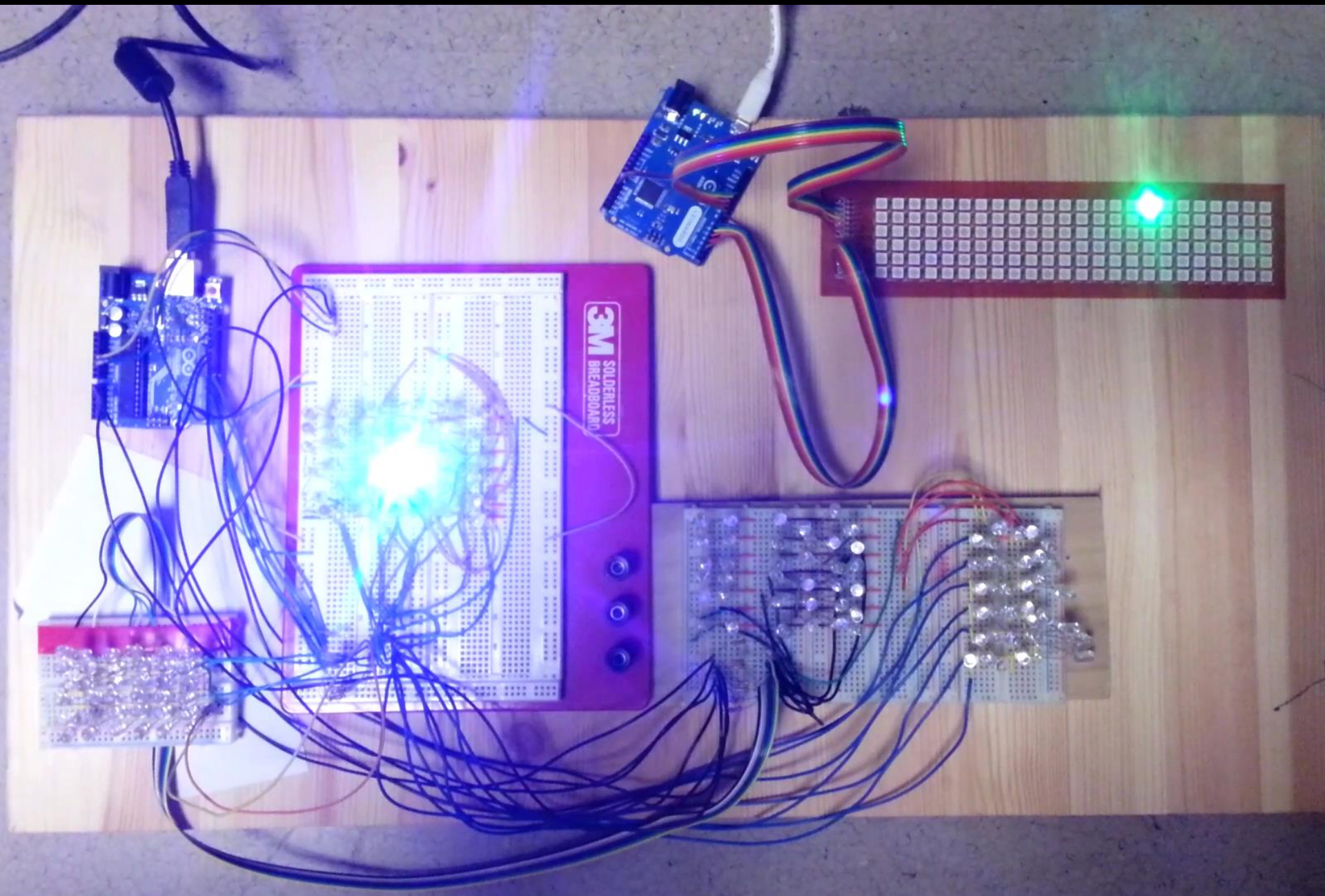


Flex PCB with Mounted Components

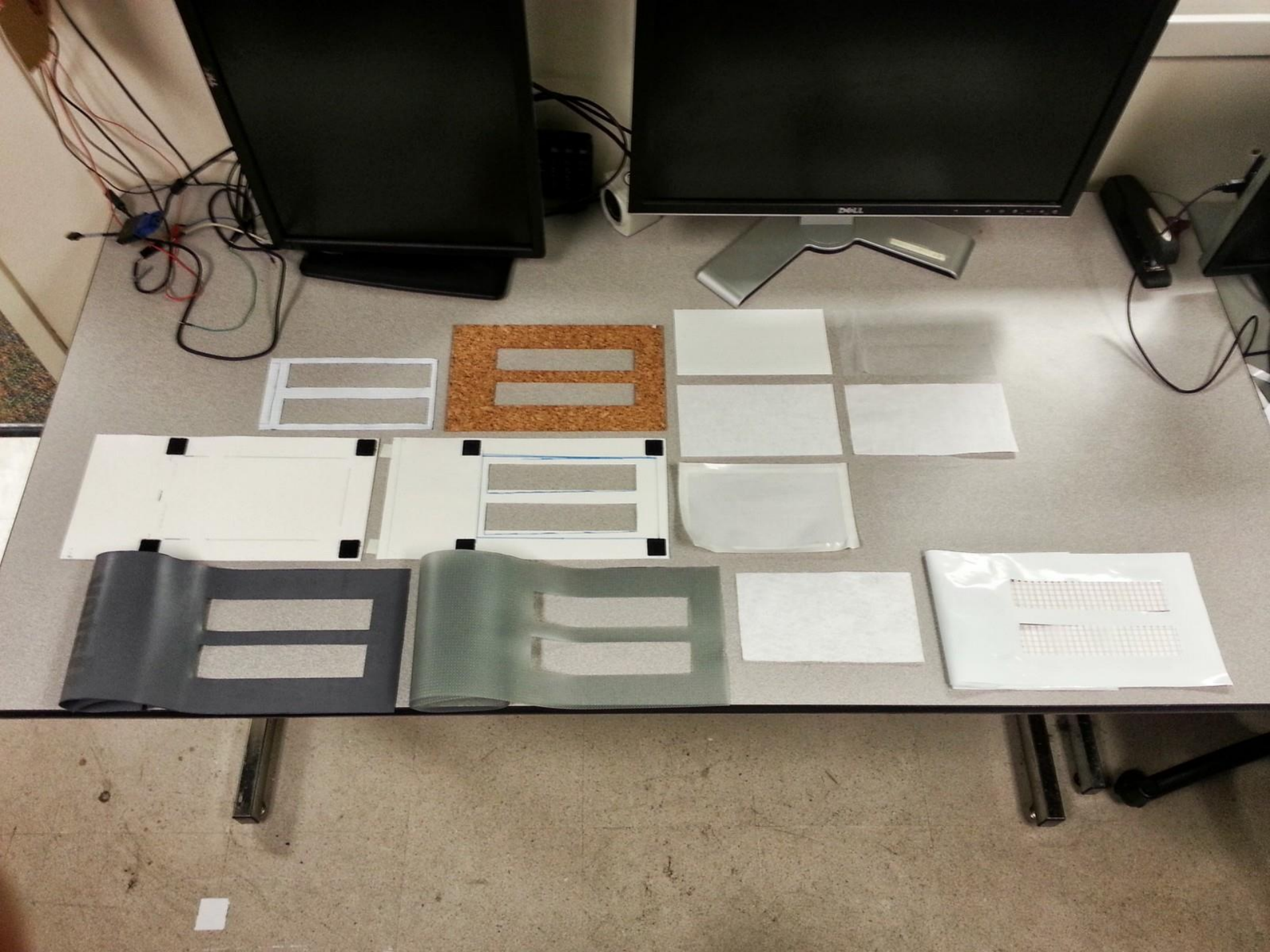


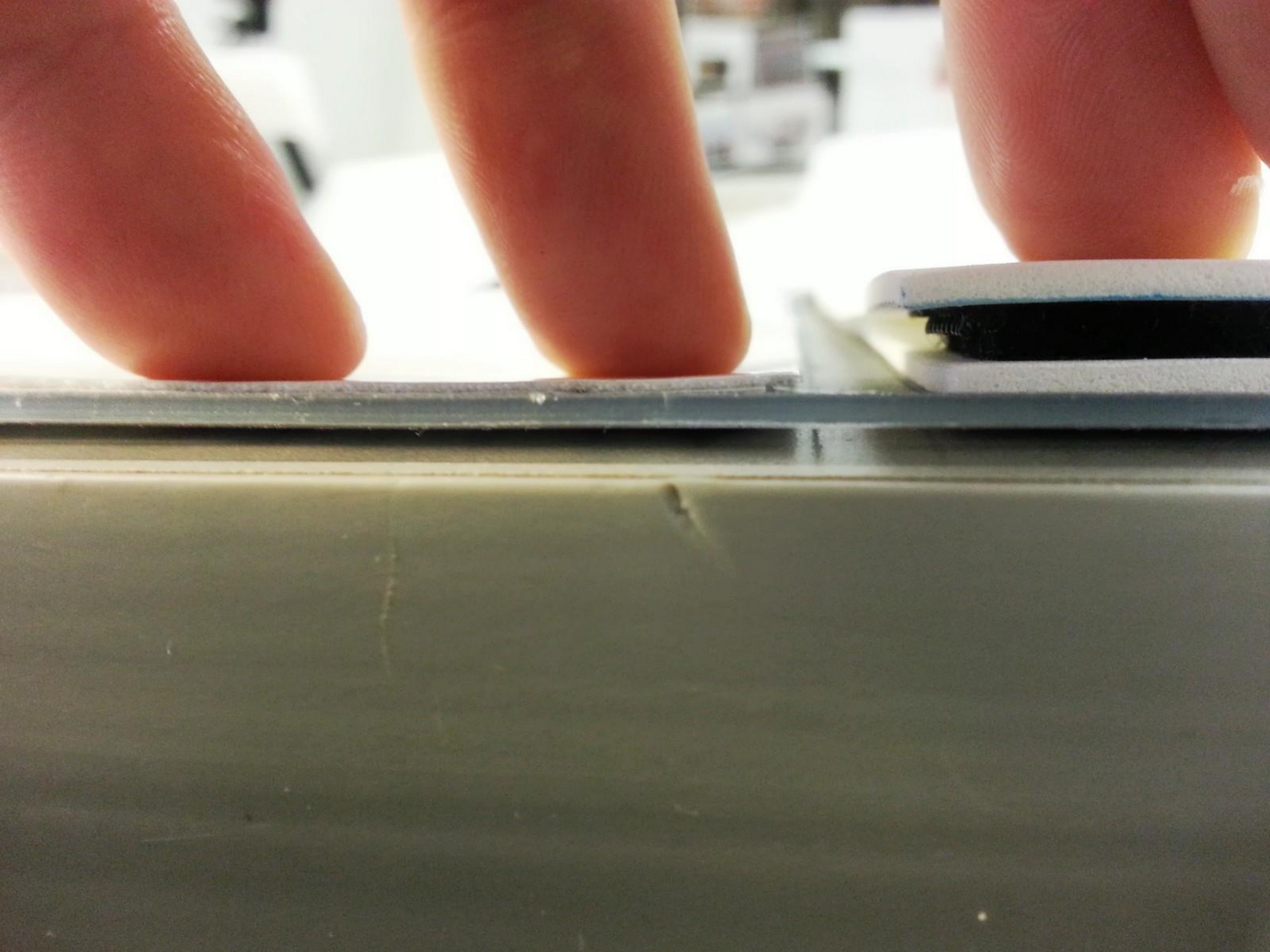


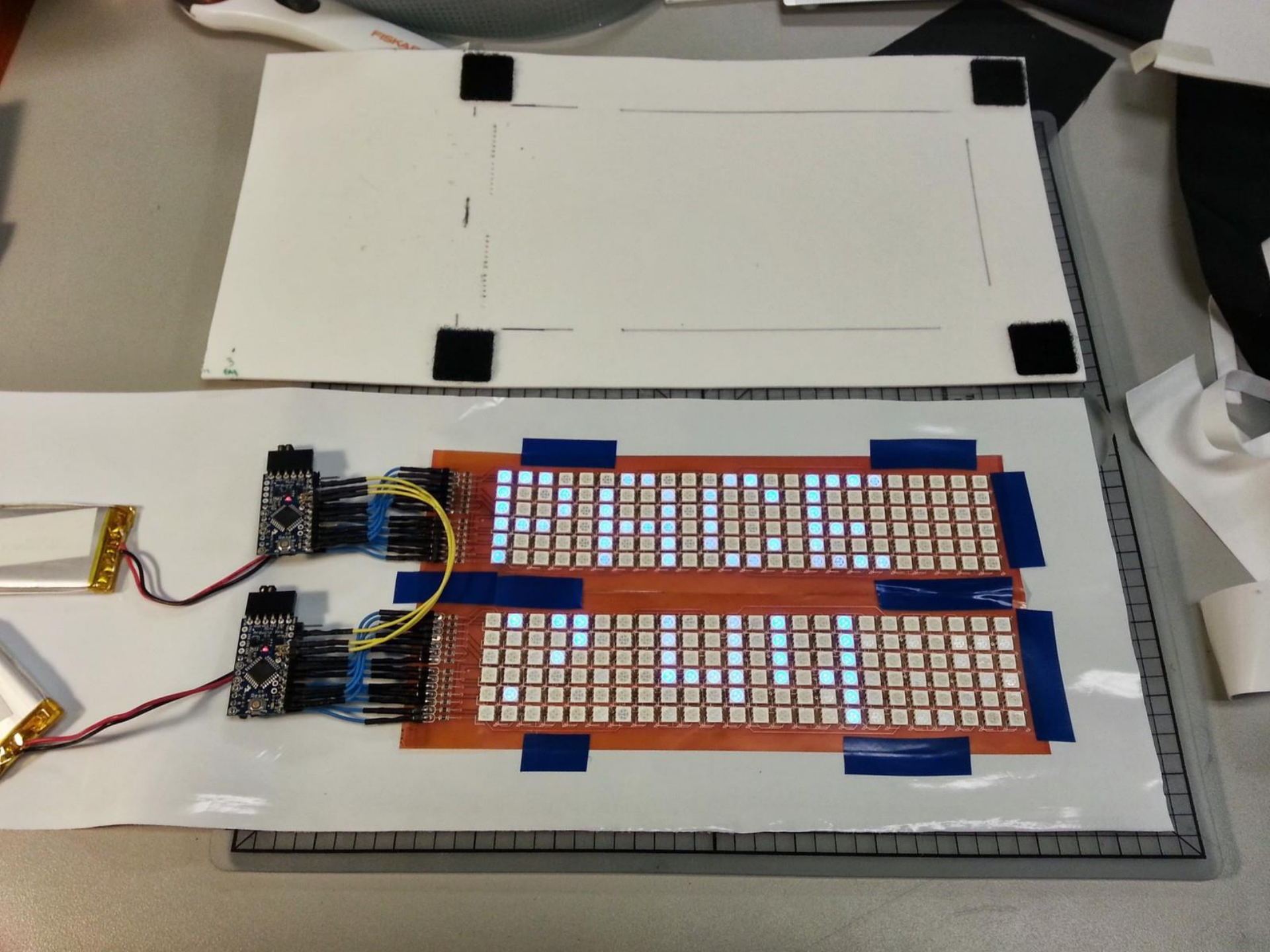
Third Step: Test Flexible PCB with Arduino Code



Final Step: Investigate Enclosure and Diffusion Material Approaches

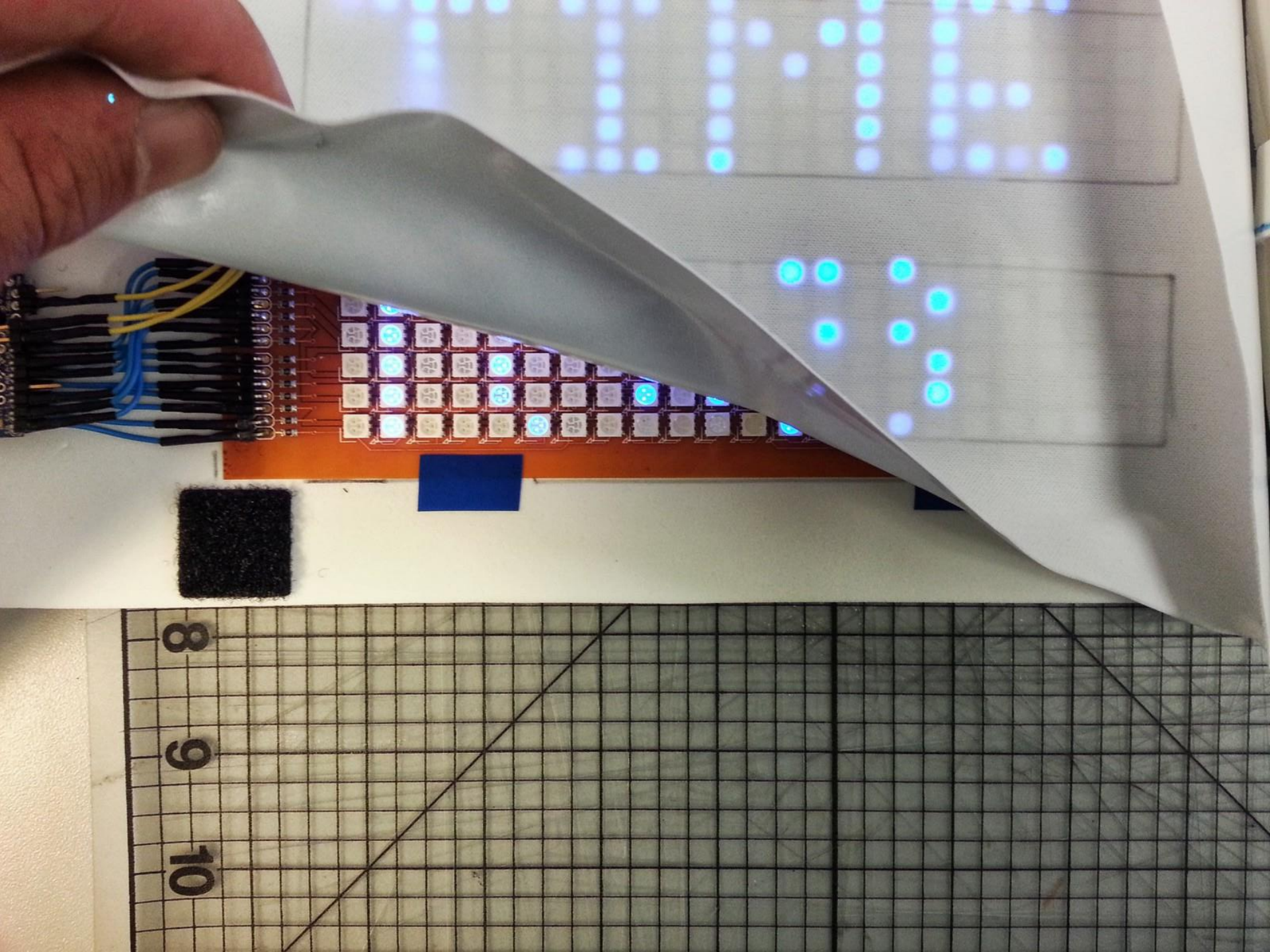






PAUSE

4.11



Final Prototype #1 Design

2 x Arduino
Pro Minis

Cotton
Diffusion Layer

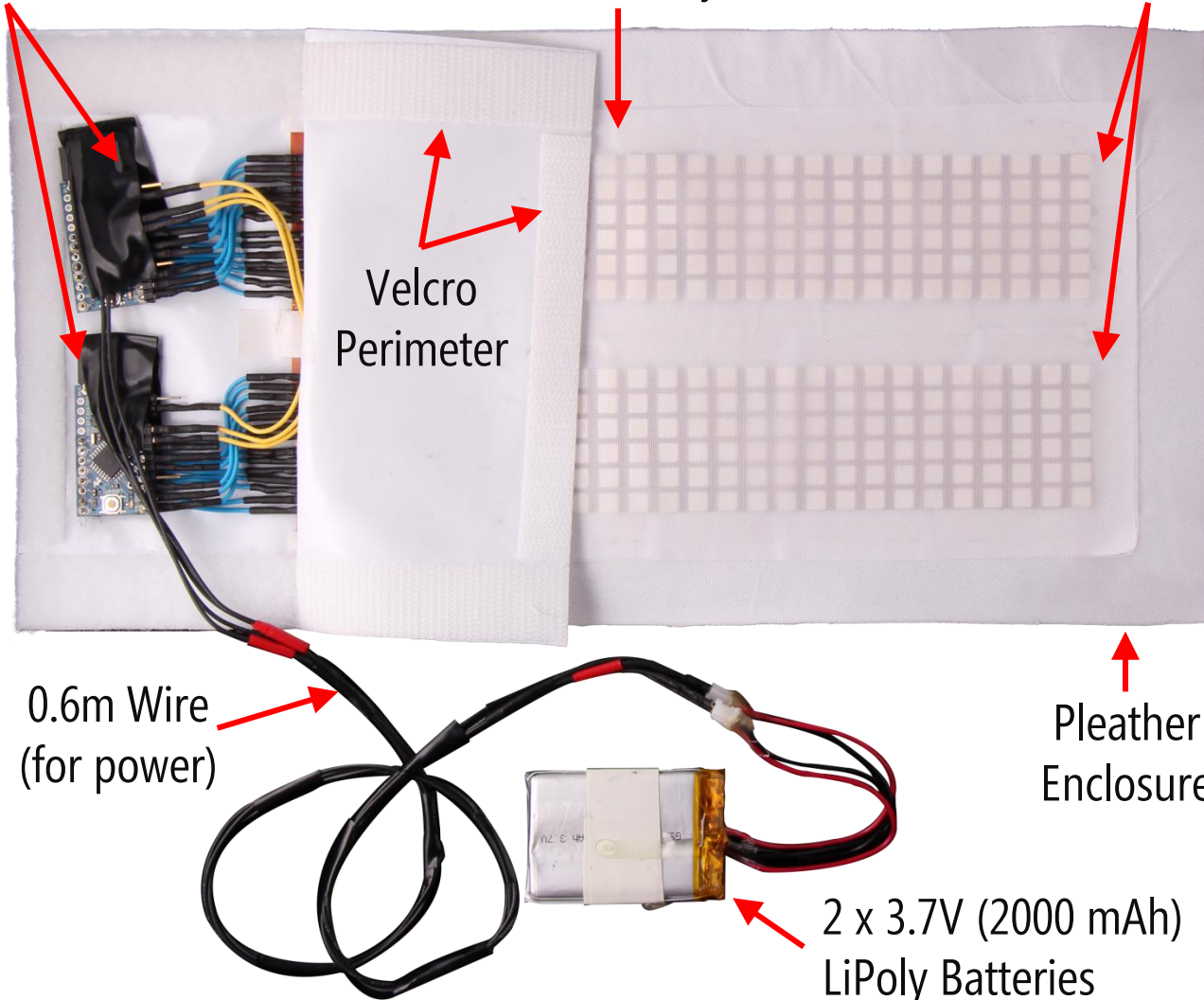
Custom 2 x 24x6 LED
Matrices on Flexible PCB

Velcro
Perimeter

0.6m Wire
(for power)

Pleather
Enclosure

2 x 3.7V (2000 mAh)
LiPoly Batteries



Prototype #2

E-Ink Display





YOU'RE LOOKING AT THE

WORLD'S 1ST

PRODUCTION-READY

PLASTIC DISPLAY

PLASTIC LOGIC

093



PLASTIC LOGIC
Z1 MPWB rev1.1

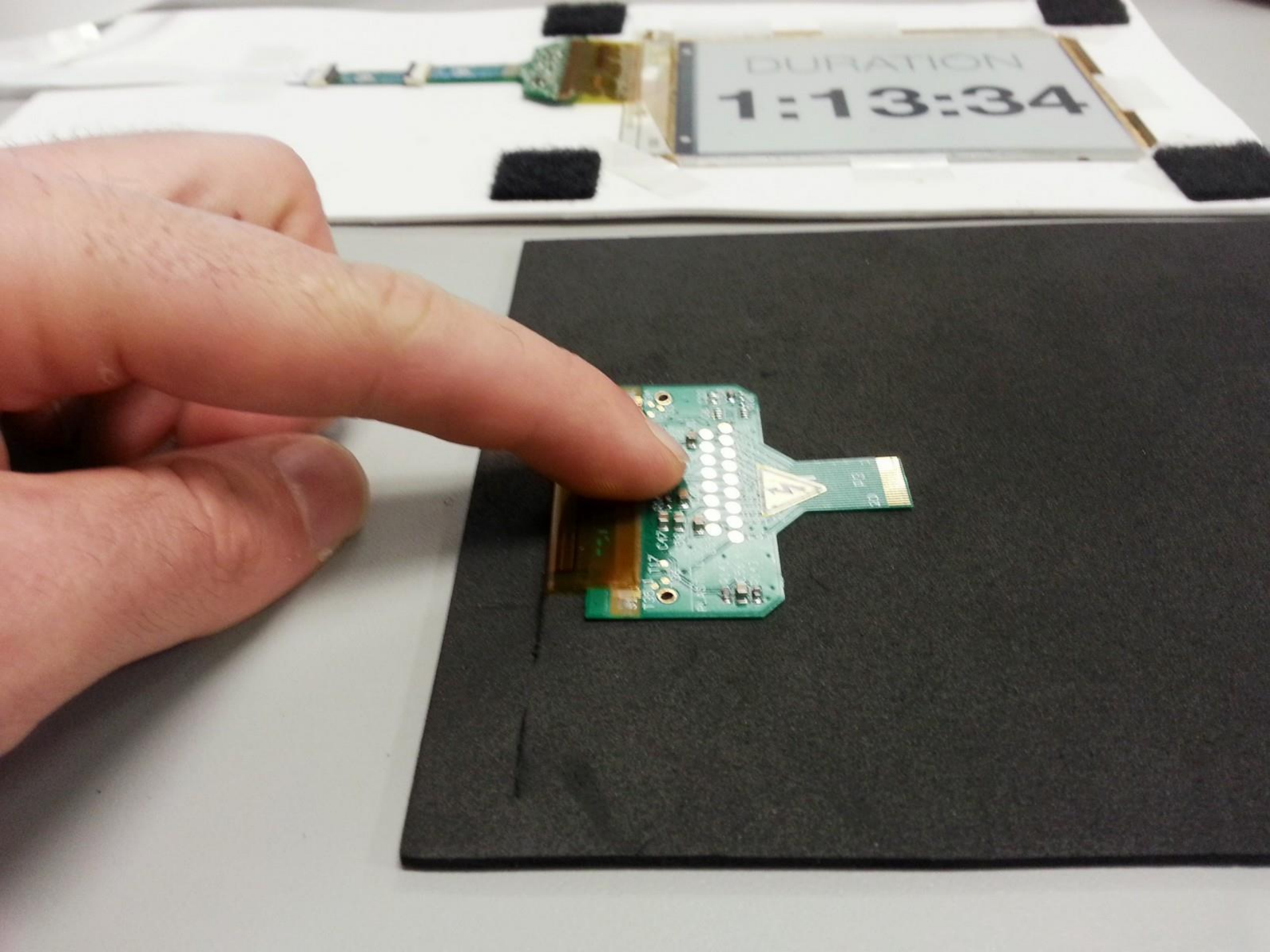
PLASTIC LOGIC
Z1 MPWB rev1.1

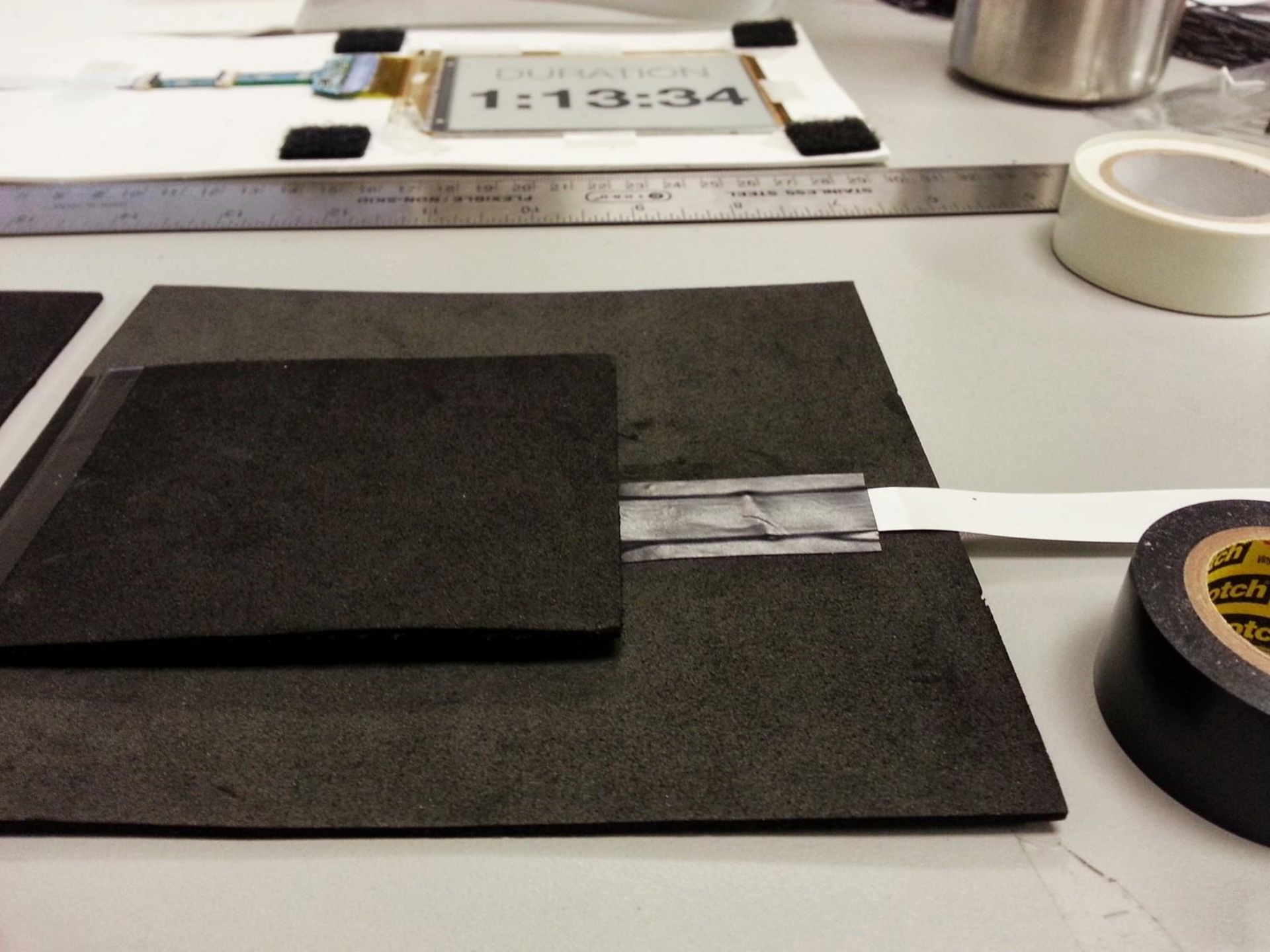
DURATION

1:13:34

D33



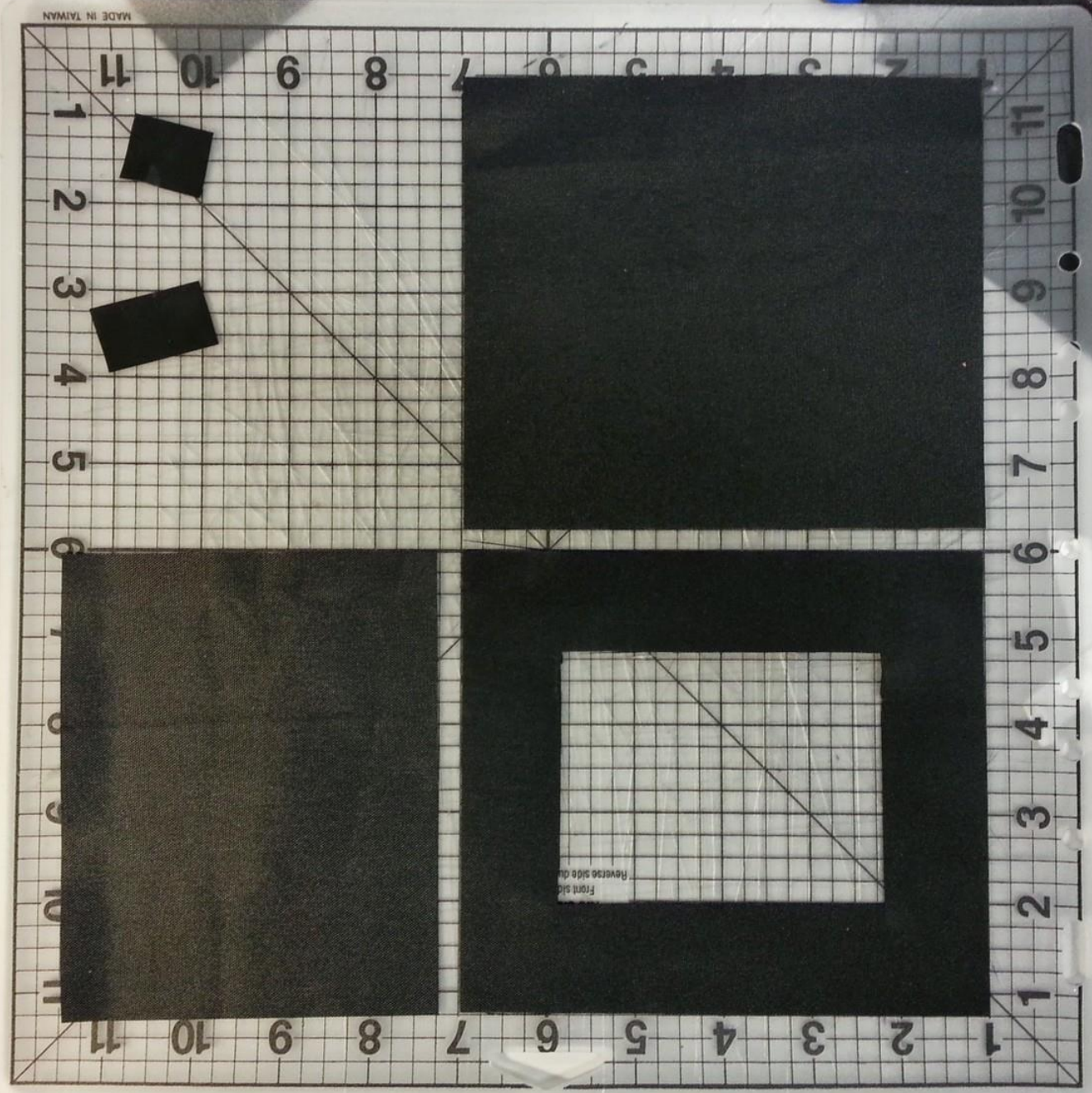


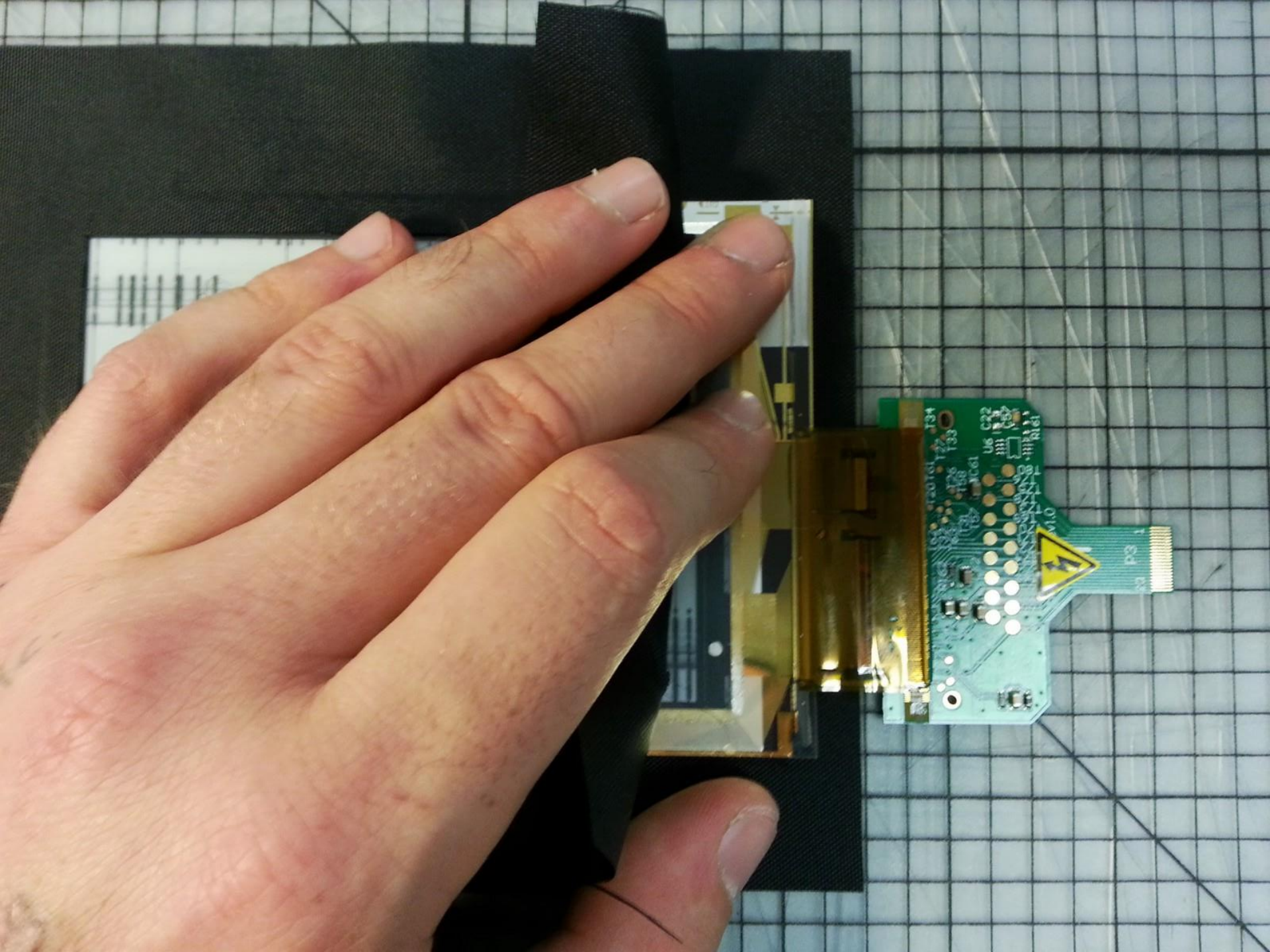


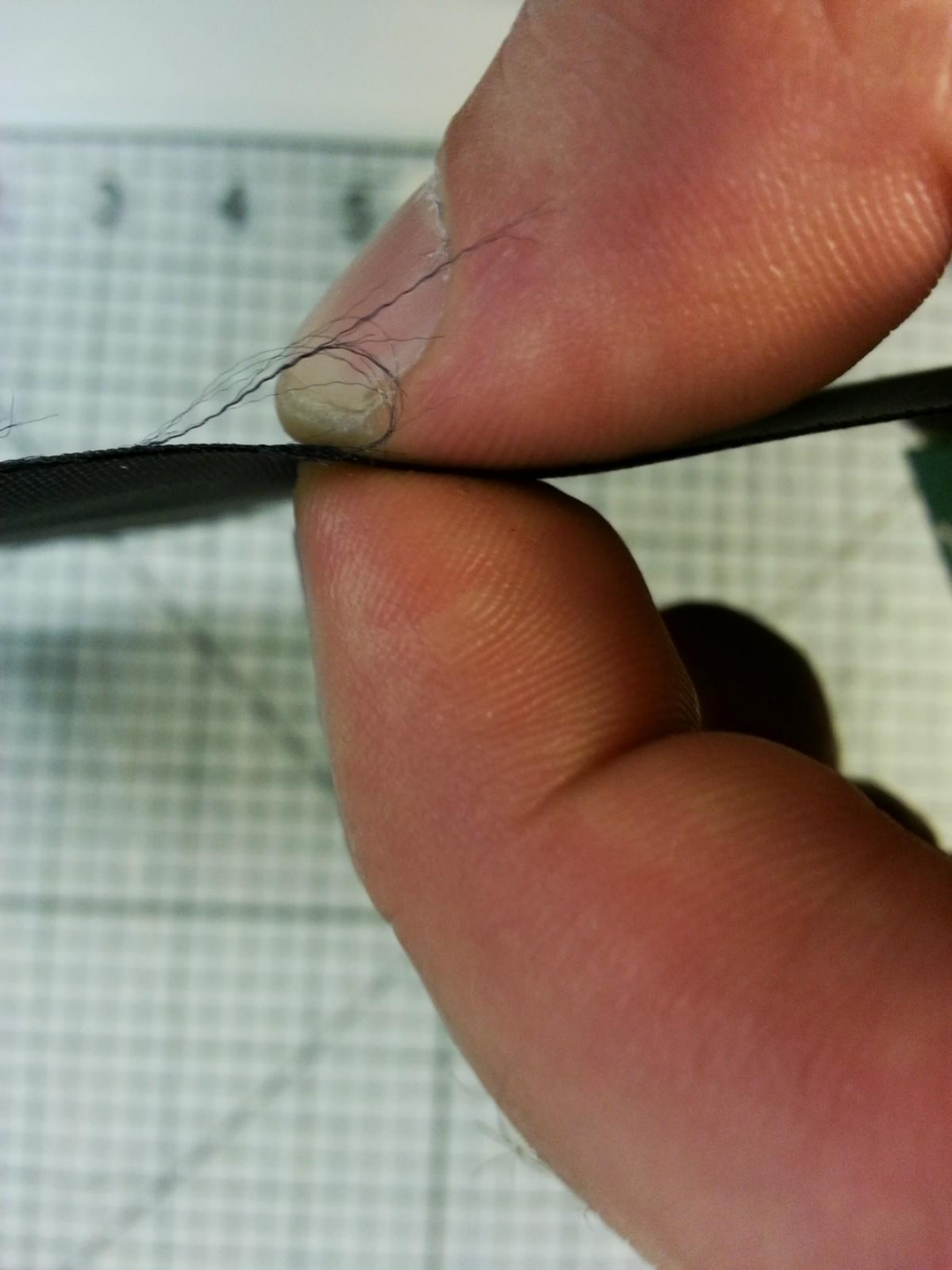


DURATION

1:13:34









A person's hands are holding a black, rectangular pouch. In the center of the pouch is a white rectangular label. The label has the word "DISTANCE" in a small, sans-serif font at the top. Below it, the number "10.4" is printed in a large, bold, sans-serif font. To the right of the number, the word "miles" is printed in a smaller, sans-serif font. The background is a plain, light-colored surface.

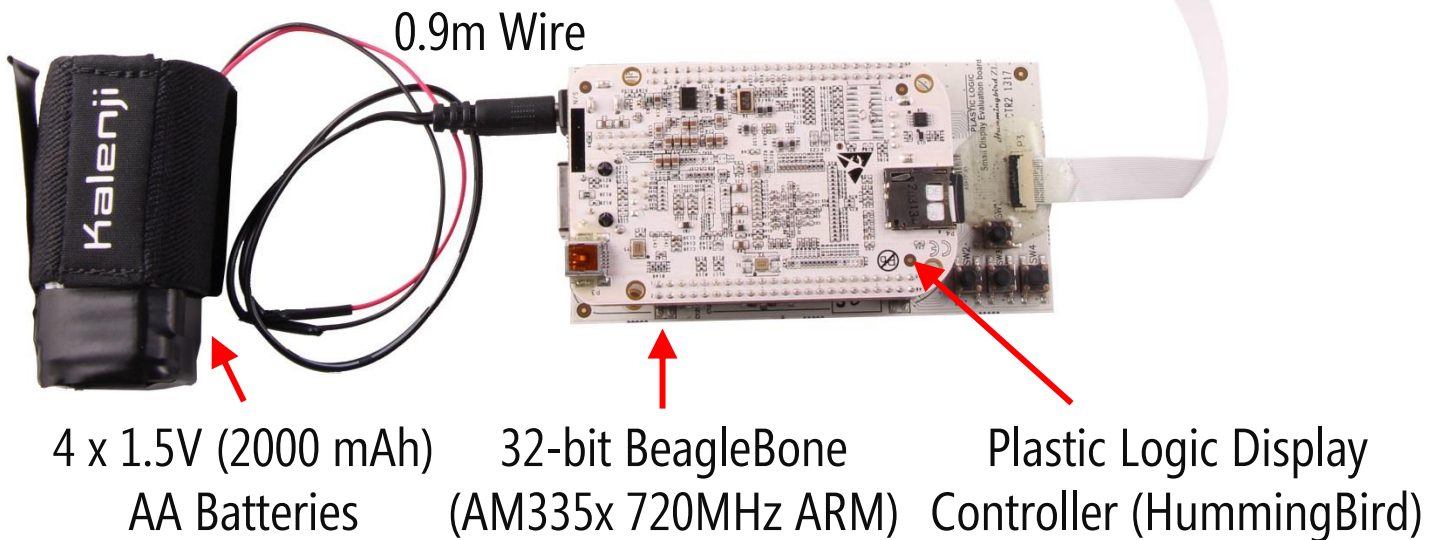
DISTANCE
10.4 miles

Final Prototype #2 Design

Plastic Logic Flexible e-Ink
Display 4.7" (320 x240)

Nylon
Enclosure

0.95m Ribbon Cable
(for power and data)



Prototype #3

Pre-Release Erogear Displays





62 of 62



is registere...



John Fraser



Stevie Chancellor



David Nguyen



Michael Gubbels
Okay, cool. Than...



Joseph Owen
i'm in the hacker...



Danny Muscoplat



Kotaro Hara

to me, mattm401

5/20/13 ☆



Google Drive: create, share, and keep all your stuff in one place.

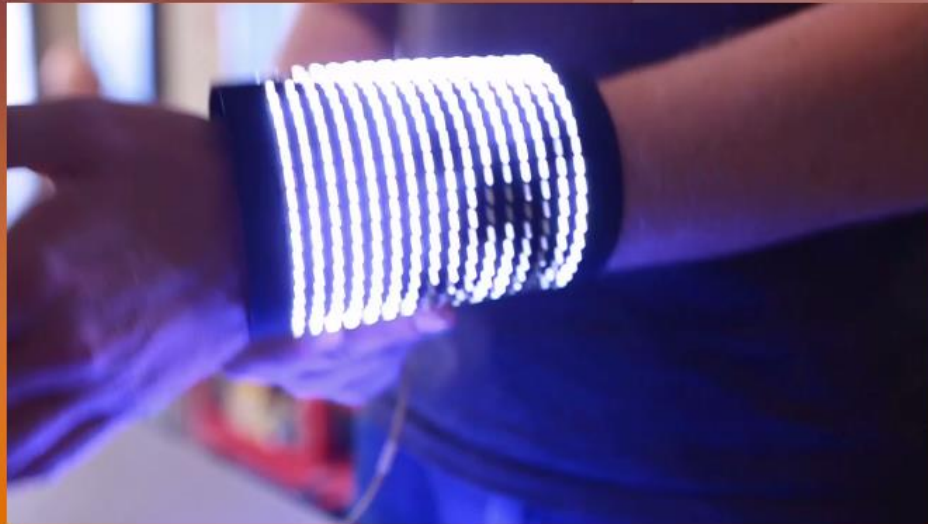


- **Writing the Business Plan**
 - **Executive Summary**
 - **Executive Summary** is the first section of the business plan. It should be **concise** and **catchy**. It should **highlight the key points** of the plan and **provide a brief overview** of the business.
 - **Business Description**
 - **Business Description** is the second section of the business plan. It should **provide a detailed overview** of the business, including its **mission statement**, **goals**, and **values**.
 - **Market Analysis**
 - **Market Analysis** is the third section of the business plan. It should **provide a detailed overview** of the market, including its **size**, **growth**, and **competition**.
 - **Financial Projections**
 - **Financial Projections** is the fourth section of the business plan. It should **provide a detailed overview** of the business's **financial performance**, including its **revenue**, **expenses**, and **profit**.
 - **Conclusion**
 - **Conclusion** is the final section of the business plan. It should **provide a brief overview** of the business and **reiterate the key points** of the plan.

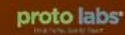


[Learn](#) [Team](#) [Contact](#)

Wearable.
Connected.
Revolutionary.

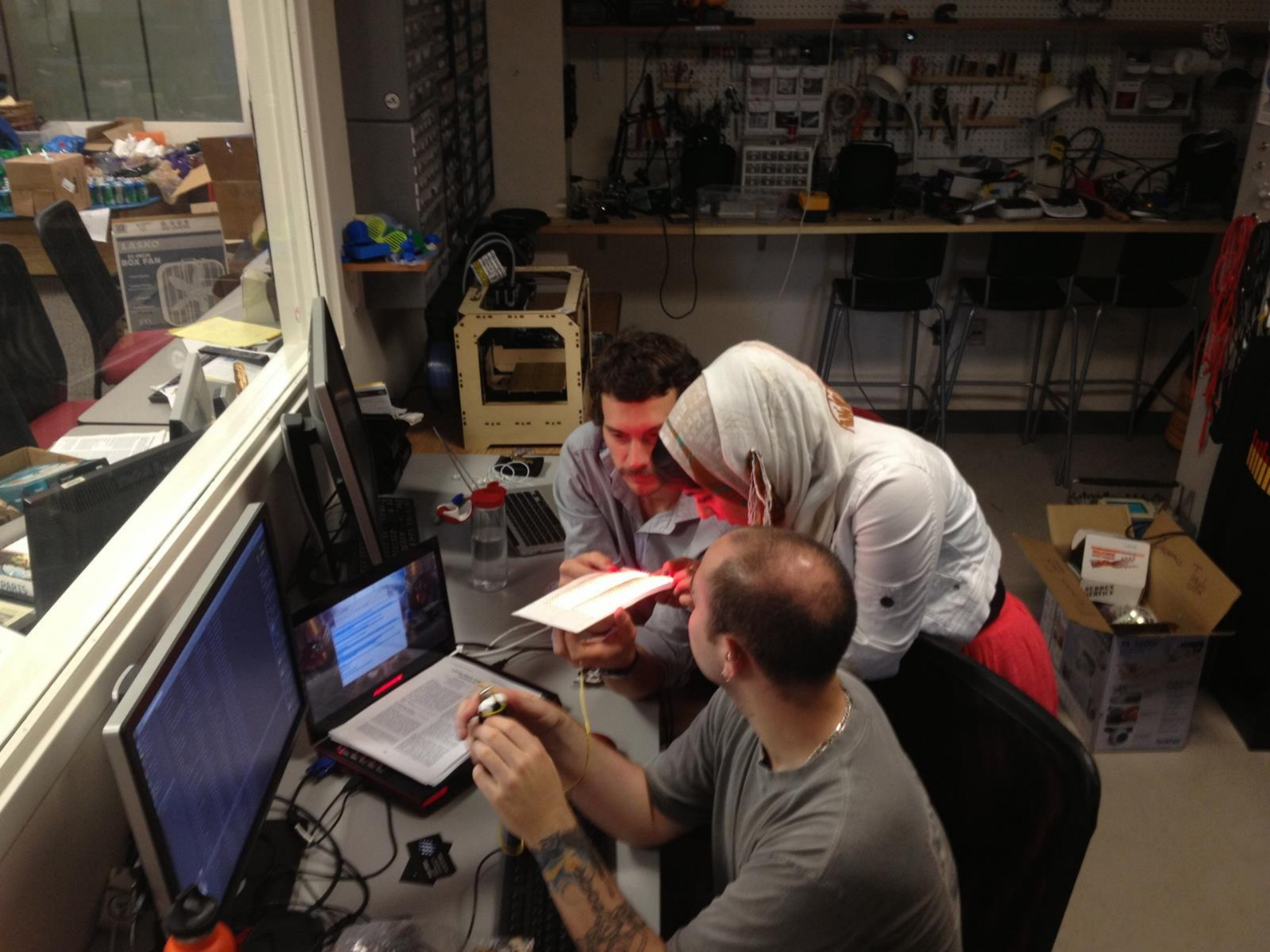


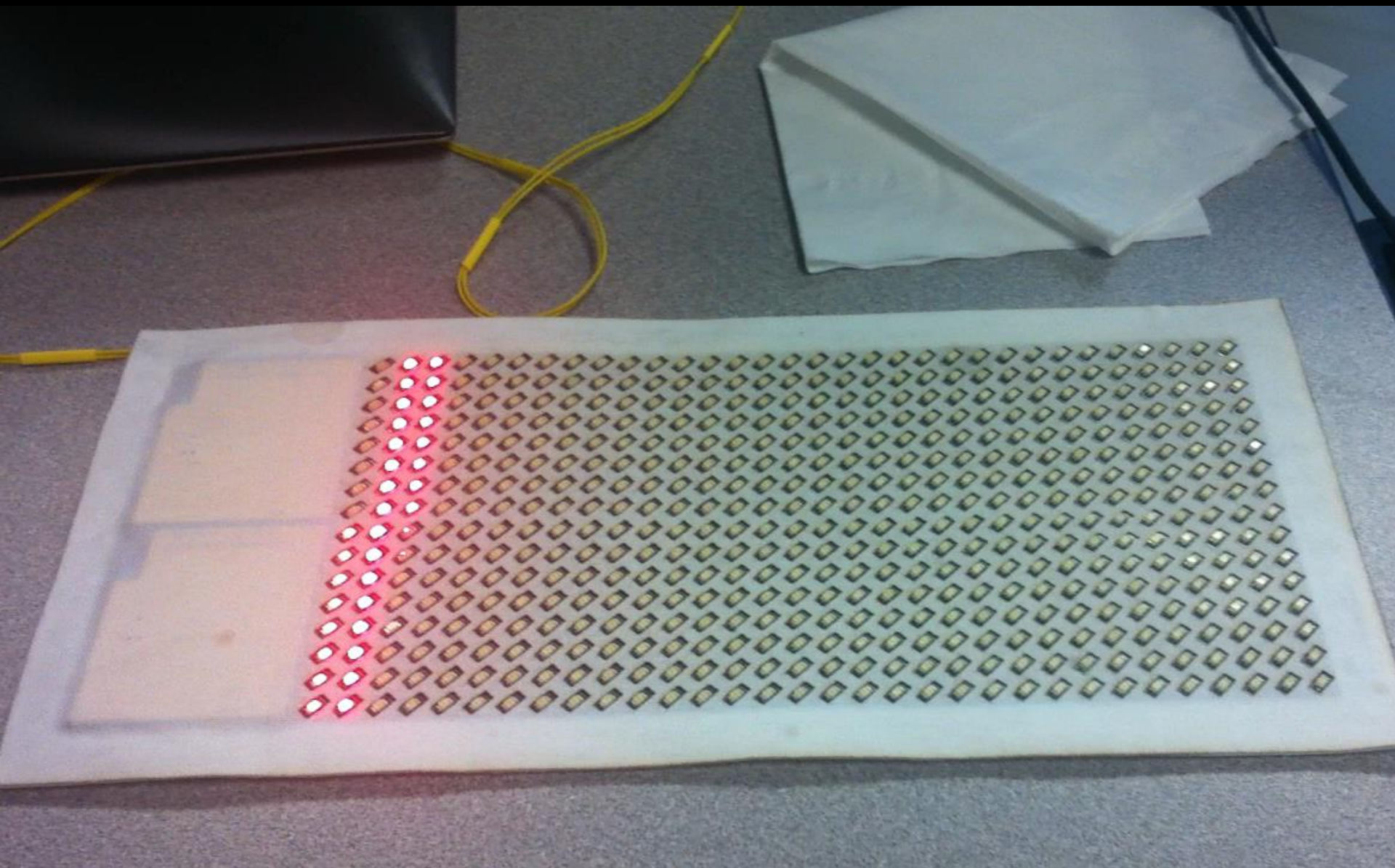
As Seen On





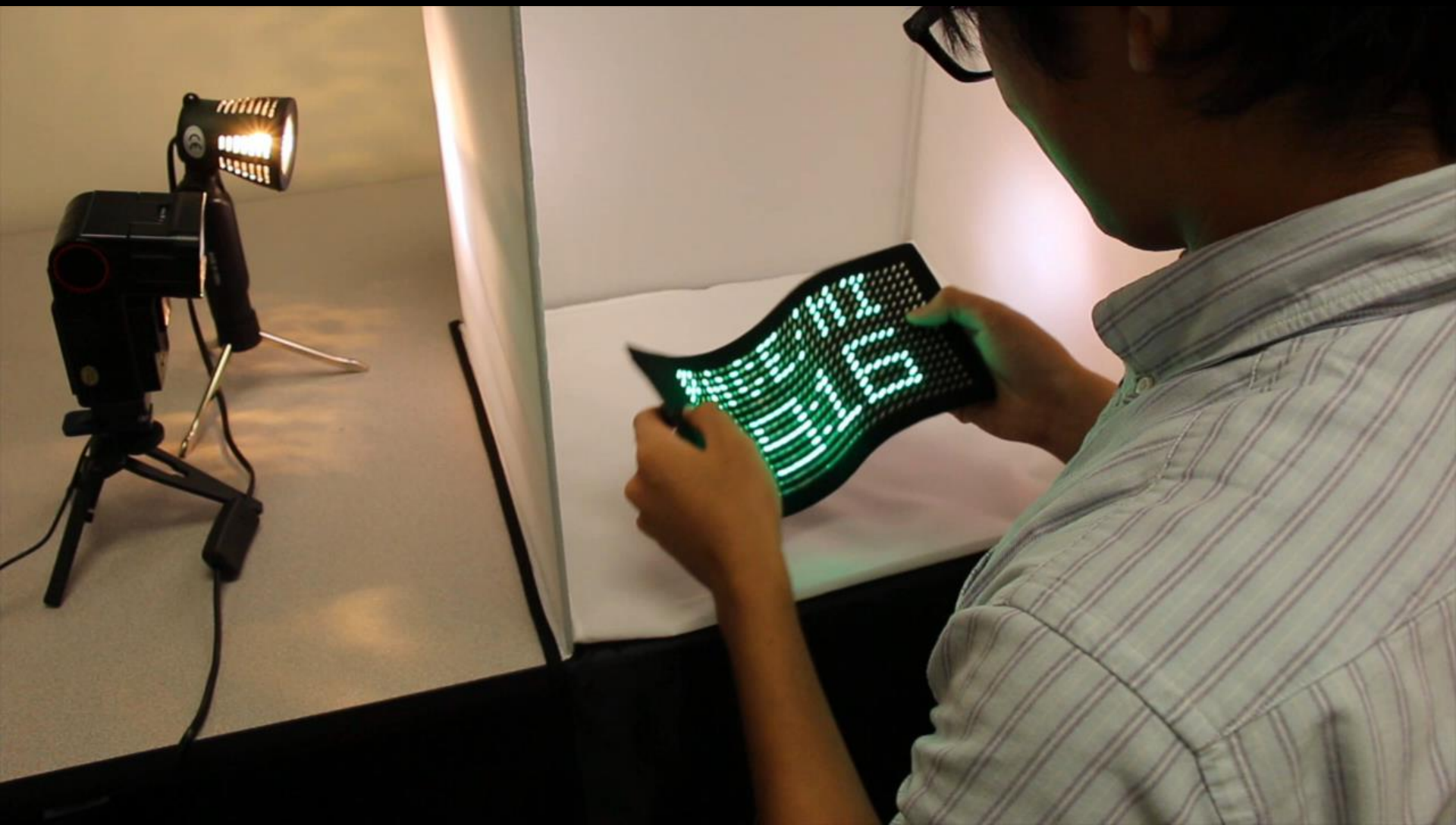








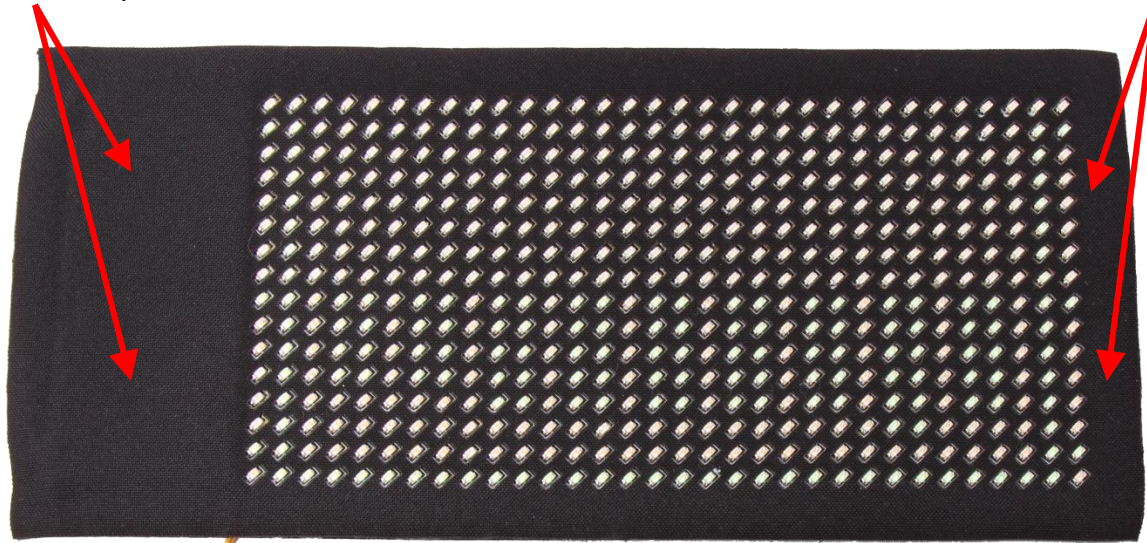
Extremely light-weight and flexible



Final Prototype #3 Design

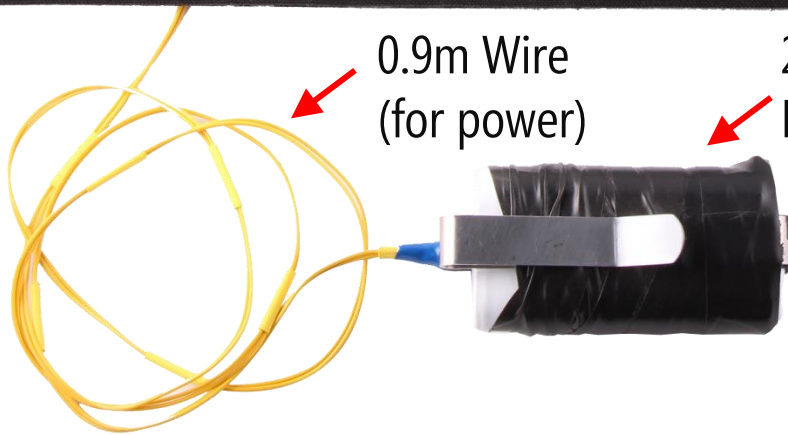
2 x 32-bit MCU; 16-bit LED Matrix
Driver; Bluetooth Modem

2 x 32x8 Erogear
LED Matrices

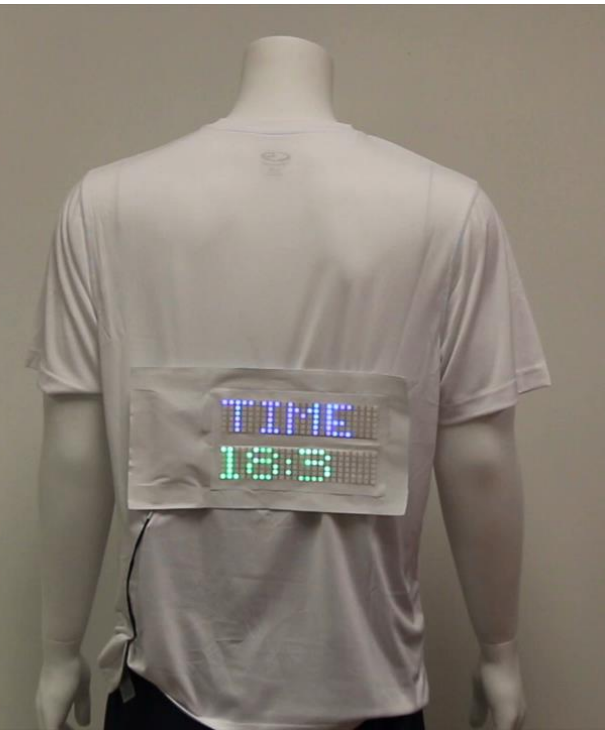


0.9m Wire
(for power)

2 x 3.7V (2200 mAh)
Li-Ion Batteries



SFF: Visual Display Content



We performed dozens of informal pilot studies examining comfort, viewability, and overall user experience













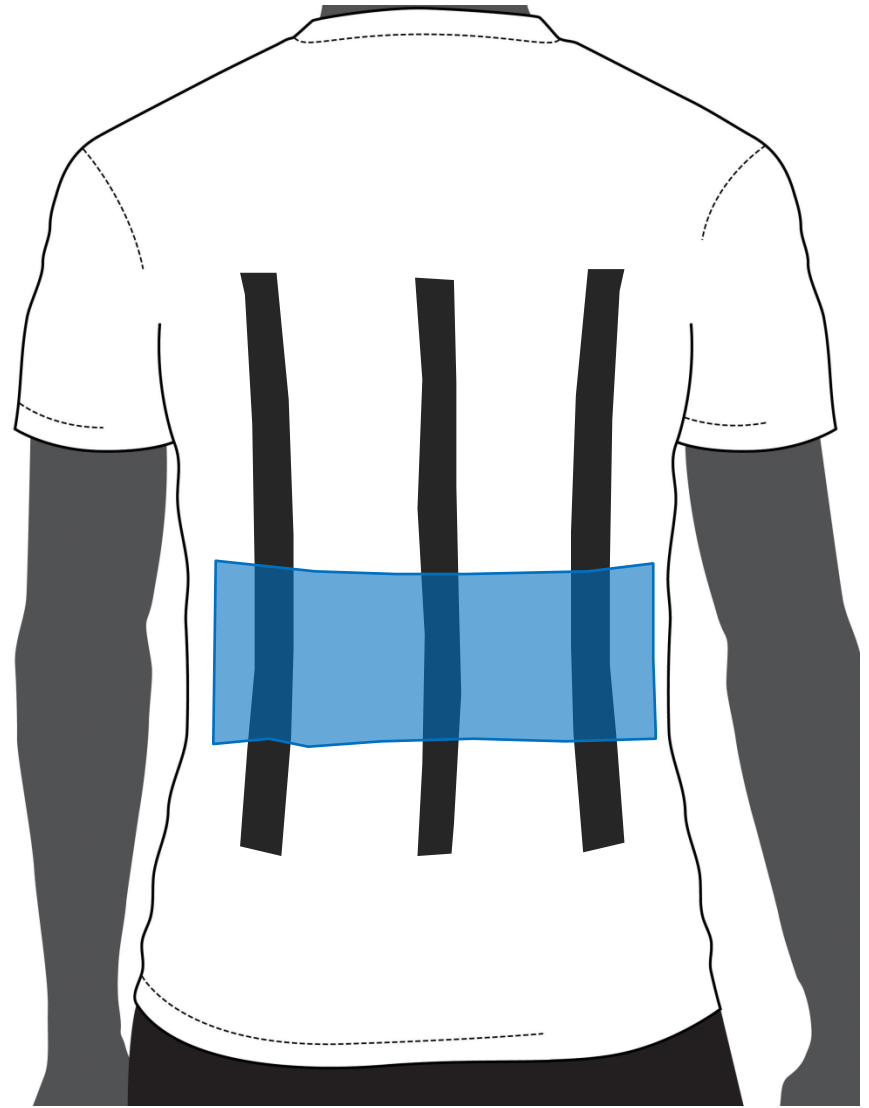
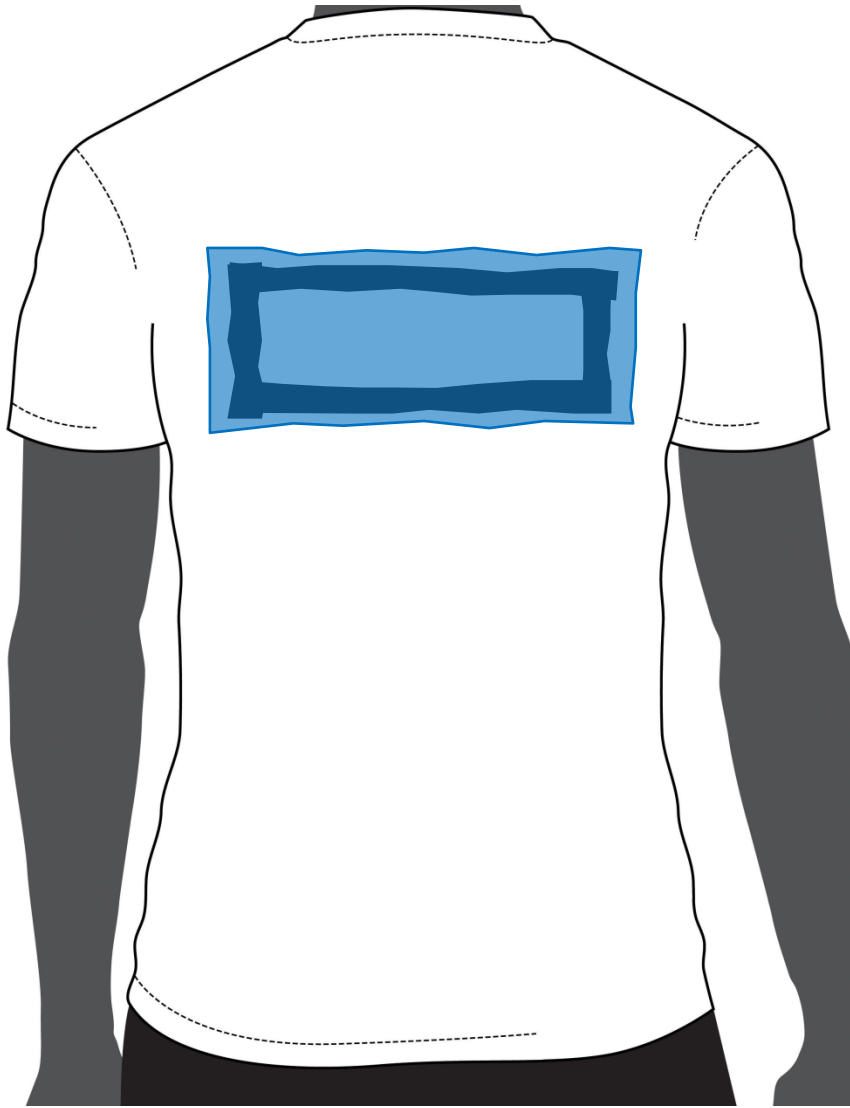












Final Design: Add Bar Graph Pace Visualization



Bar Graph Visualization

Compares 1-min pace averages over time to a target pace collectively pre-set by the group

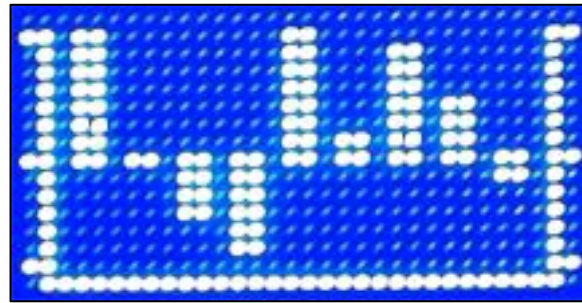
The y-axis is auto-set based on recent pace & target pace

The full bar graph shows 9-mins. Bars above the mid-point are over the target; bars below are under. Under is better.

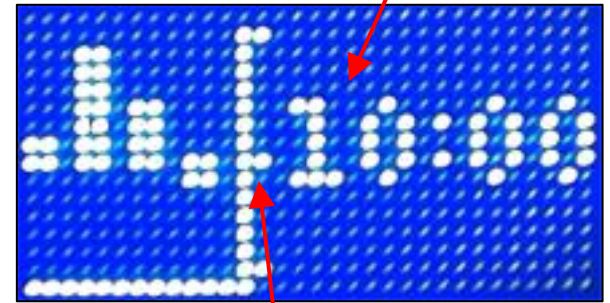
The target pace for the group shows on the first and last bar graph screen



Each bar represents avg pace in 1-min increments



The display scrolls from left to right



The target pace line is at the origin



SFF: Design and Evaluation Process

Ideation &
Lo-Fi
Prototyping

Parallel Prototyping 3 Designs

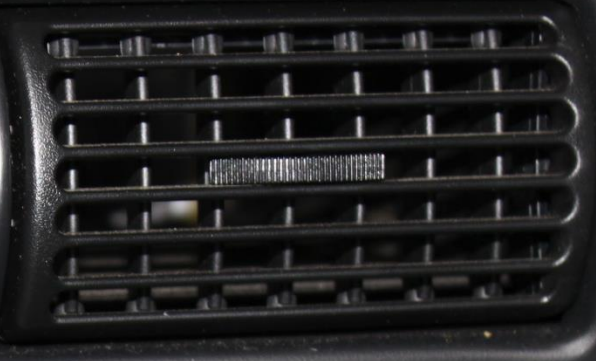
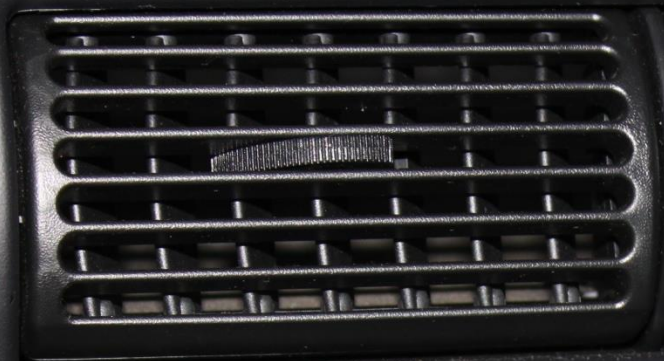
Informal Pilot Studies

Select & Refine
Final Design

Pilot
Testing

Field Study of 10
Pre-Existing
Running Groups

2 Case
Studies
at Races



AM FM CD

CD-6 MP3

LOAD

VOL • PUSH

5:03

CLK
MUTE

SEEK/TRACK

TUNE/DISC

◀ SCAN ▶

◀ MENU ▶

REW 1 FF 2 REPEAT 3 4 SHUFF 5 TEXT 6

#0





Evaluation

We examined the impact of the display on group running dynamics and performance.

“It made me run faster because **my performance was on display**. ”

- Race Participant

“It made **me more aware** of our pacing and **kept me more focused** on the run itself. ”

- Field Study Participant

A photograph of four runners from behind, jogging on a paved path. The runner on the far left wears a yellow t-shirt with a circular graphic and the word 'cine' on the back. The second runner wears a black t-shirt with a digital display on the back showing 'DISTANCE 2.03 MI'. The third runner wears a plain white t-shirt. The runner on the far right wears a black t-shirt with a digital display on the back showing '4.44'. The background is a dense line of green trees. The text 'future work' is overlaid in the bottom left corner.

future
work

SFF Bicycling

Working with EroGear



The Social Fabric Fitness Team!



Matt Mauriello



Michael Gubbels



Jon Froehlich

Follow-up Sources:

Social Fabric Fitness: The Design and Evaluation of Wearable E-Textile Displays to Support Group Running

Matthew Louis Mauriello¹, Michael Gubbels¹, Jon E. Froehlich¹

Manuscript Lab / Human-Computer Interaction Lab Studies/
Department of Computer Science / College of Information Studies/
University of Maryland, College Park
maurim@umd.edu, gubbels@umd.edu, jef@umd.edu

ABSTRACT

Group exercise has multiple benefits including greater adherence to fitness regimens, increased enjoyment among participants, and enhanced workout intensity. While a large number of technology tools have emerged to support real-time feedback of individual performance, tools to support group fitness are limited. In this paper, we present a set of wearable e-textile displays for running groups called Social Fabric Fitness (SFF). SFF provides a lightweight, unobtrusive action on the back of the wearer's shirt to increase awareness and motivation of group fitness performance. We discuss prototyping of three designs—one flexible e-silk and two flexible LED-based displays; the selection and refinement of one design; and two evaluations—a field study of 10 running groups and two case studies of running runs. Our qualitative findings indicate that SFF improves awareness of individual and group performance, helps groups stay together, and improves their motivation. We close with reflections for future athletes e-textile displays.

ACM Classification Keywords:
H.1.1. Information interfaces and presentation (e.g., HCI).

INTRODUCTION
Since the 1960s, running has experienced unprecedented growth in the US [22, 27]. Although typically seen as an individual activity, a growing number of runners are choosing to run in groups and/or joining running clubs [2]. Sports psychologists and coaches cite multiple benefits of group exercise, including greater adherence to exercise regimens, increased commitment to reach shared goals, and more intense workouts [13, 15, 26, 31, 33]. While a large number of tools have emerged to support real-time feedback of individual performance (e.g., Fitocracy, Nike+), we are unaware of existing tools that provide real-time feedback and feedback to support enhanced group fitness activities.

In this paper, we introduce a set of wearable displays called e-textile displays called Social Fabric Fitness (SFF)—designed to increase performance awareness and motivation for group fitness (Figure 1). SFF is worn by one or two per runner. In a running group, the displays wirelessly communicate with the wearer's mobile phone,



Figure 2: The SFF system enables real-time awareness of group fitness performance.

As the first work exploring e-textile information displays for fitness, generally wearable displays to increase group awareness and motivation, we discuss the design and evaluation of three designs and present real-time feedback of the group's activity (e.g., average pace, distance, and duration) based on work in behavioral science on the motivational effects of goal setting and public commitment [15, 26]. SFF also compares recent pace averages to a group's target pace. While a number of projects in ubiquitous computing and HCI have focused on on-body sports sensing (e.g., [4, 8, 26]), only a few have provided real-time real-time feedback [18, 22]. None have explored a unique, wearable display for runners aimed at enhancing group awareness, motivation, and excitement.

As the first work exploring e-textile information displays for fitness, generally wearable displays to increase group awareness and motivation, we discuss the design and evaluation of three designs and present real-time feedback of the group's activity (e.g., average pace, distance, and duration) based on work in behavioral science on the motivational effects of goal setting and public commitment [15, 26]. SFF also compares recent pace averages to a group's target pace. While a number of projects in ubiquitous computing and HCI have focused on on-body sports sensing (e.g., [4, 8, 26]), only a few have provided real-time real-time feedback [18, 22]. None have explored a unique, wearable display for runners aimed at enhancing group awareness, motivation, and excitement.

To examine these questions, we designed, tested, and ultimately evaluated three flexible e-textile prototypes: two LED-based and one e-silk-based. During our iterative process, we focused primarily on usability, usability, ease of use, and group exercise. While evaluating the same prototyping design for further evaluation. We then performed a field study with 10 pre-existing running groups and two small case studies of SFF in race events. For the field study,

In submission to CHI 2014, please do not distribute.

CHI'14 (to appear)

“How many generations in all of human history have had the opportunity to **rise to a challenge that is worthy of our best efforts.** A challenge that can pull from us more than we think we can do.”

Al Gore

Nobel Peace Prize Winner, 2007
Quote from TED Conference, March 2008



Jon Froehlich (jonfroehlich) x

Twitter, Inc. [US] https://twitter.com/jonfroehlich

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Tweets

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Favorites

Lists

Photos and videos

Get in touch: **@jonfroehlich**

Jon Froehlich @jonfroehlich
Assistant Professor at UMD in CS and a member of the Human-Computer Interaction Lab. I make, break, and study stuff for the environment, health, and the city.
cs.umd.edu/~jontf

Edit profile

Tweets

UCP Life Labs @UCPLifeLabs 20h
Only 15 days till the Enabled by Design-athon (enabledbydesignathon.org)! Check out a sneak peek of the venue: pic.twitter.com/8CiCw7dmtV
Retweeted by Jon Froehlich
View photo

Jon Froehlich @jonfroehlich 18h
Cool! MT @HarlanH: Bike shares can be perfect!: buff.ly/1c0Z3MJ < @bikeshare featuring wisdom from @jonfroehlich & @neal_lathia
View conversation

Jon Froehlich @jonfroehlich 23 Oct
Ah, thx Ben! MT @bederson: Love these guys: @jonfroehlich & @kotarohara_en ASSETS best paper award: crowdsourcing to improve transit access
View conversation

Who to follow · Refresh · View all

Samsung Mobile US @Sam...
Follow Promoted

James Caverlee @TheRealCave...
Follow

Doug Pruim @Doug_Pruim
Followed by Kate Starbird and oth...
Follow

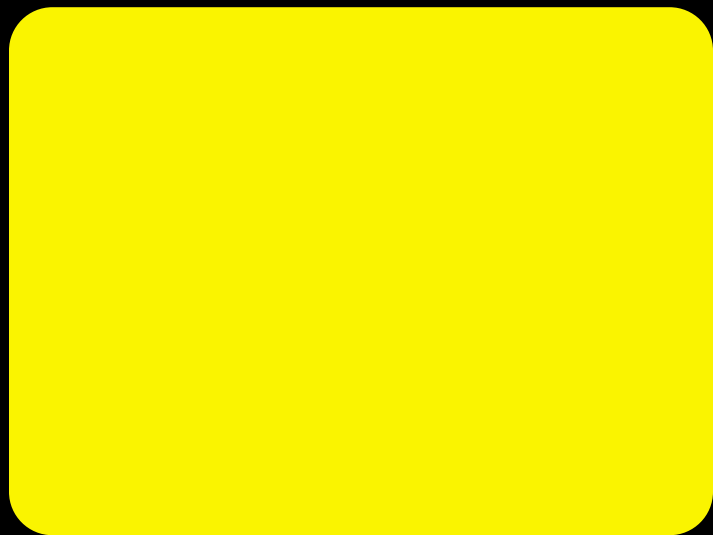
Popular accounts · Find friends

Making with a Social Purpose

@jonfroehlich
Assistant Professor
Computer Science

Segal Institute of Design
Dec 10, 2013





A person is working on a breadboard circuit in a workshop. The breadboard is yellow and has several red LEDs connected to it. The person is using a pair of red-handled pliers to adjust the circuit. The workshop is cluttered with various tools and materials, including a soldering iron, a soldering station, a multimeter, and a breadboard. A white lamp is positioned over the work area. The background shows a pegboard with various tools hanging on it. The text "This sort of activity is enabled not just by space but **ready access to material and tools**" is overlaid on the image.

This sort of activity is enabled not just by space
but **ready access to material and tools**

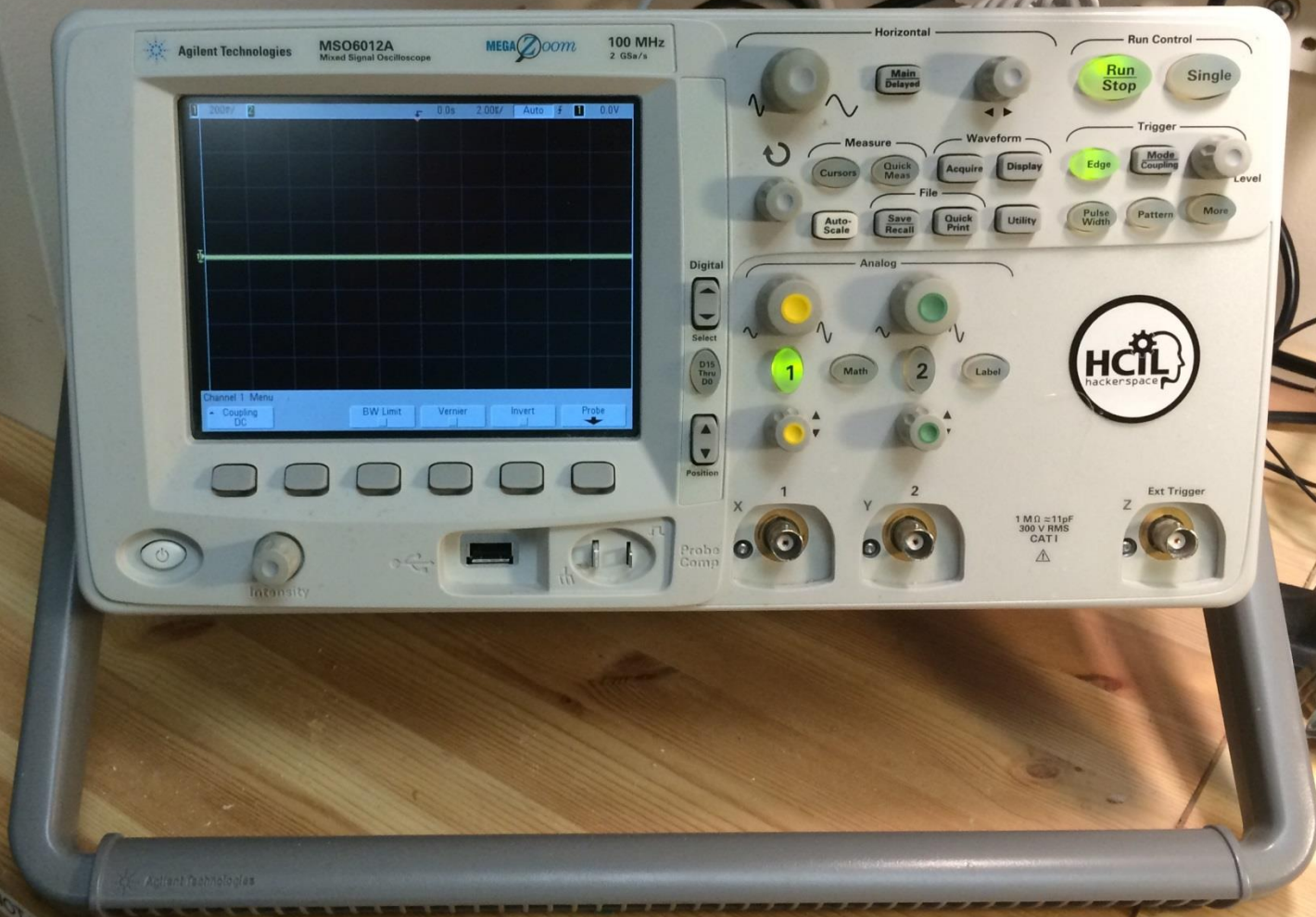
Three Soldering Stations

HCIL Hackerspace



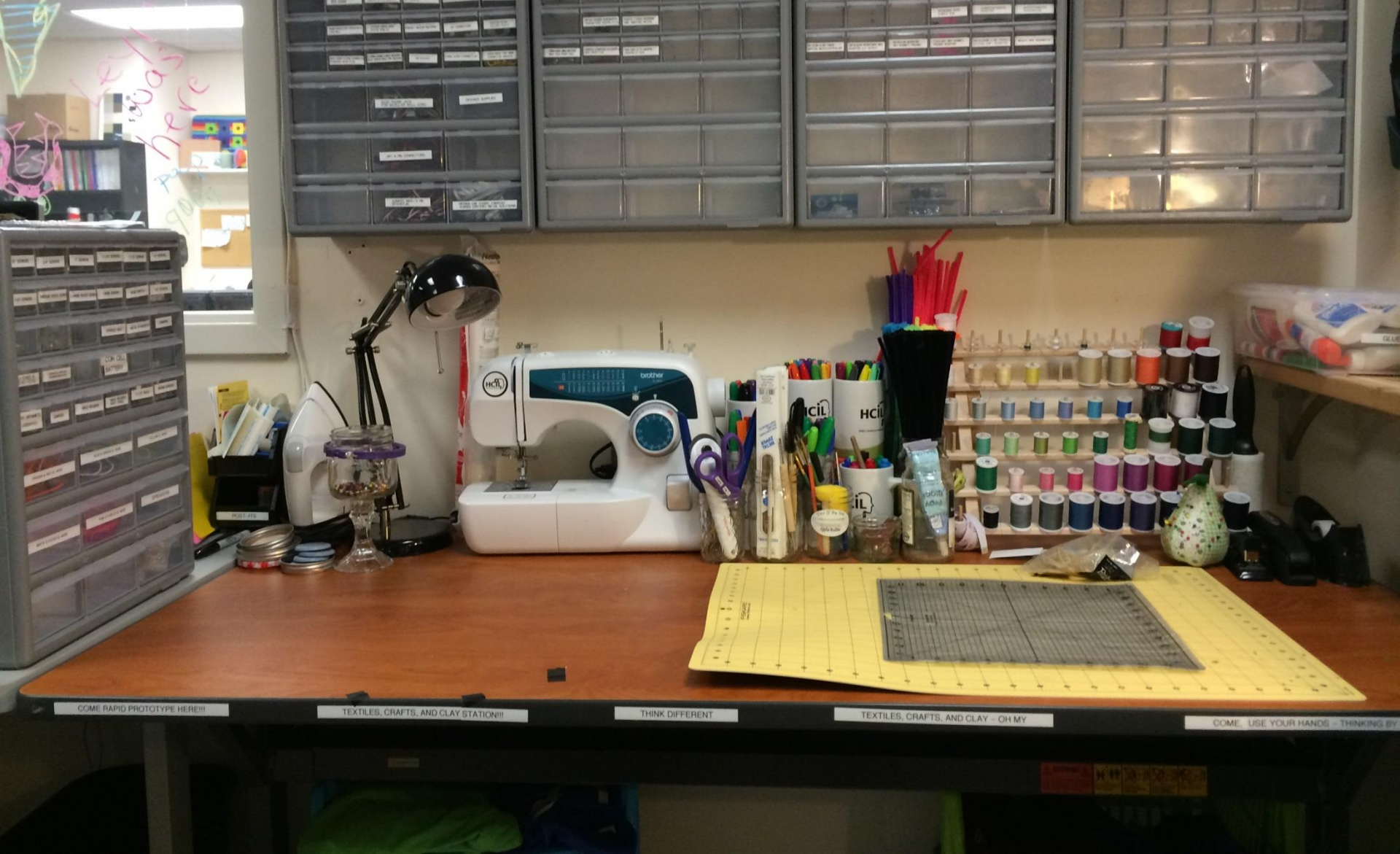
One Oscilloscope

HCIL Hackerspace



Craft/Textile Station

HCIL Hackerspace



HCIL Hackerspace



Basic Electronic Supplies

HCIL Hackerspace

SPARKFUN RESISTOR KITS

WELCOME TO RESISTOR WORLD!



RESISTORS

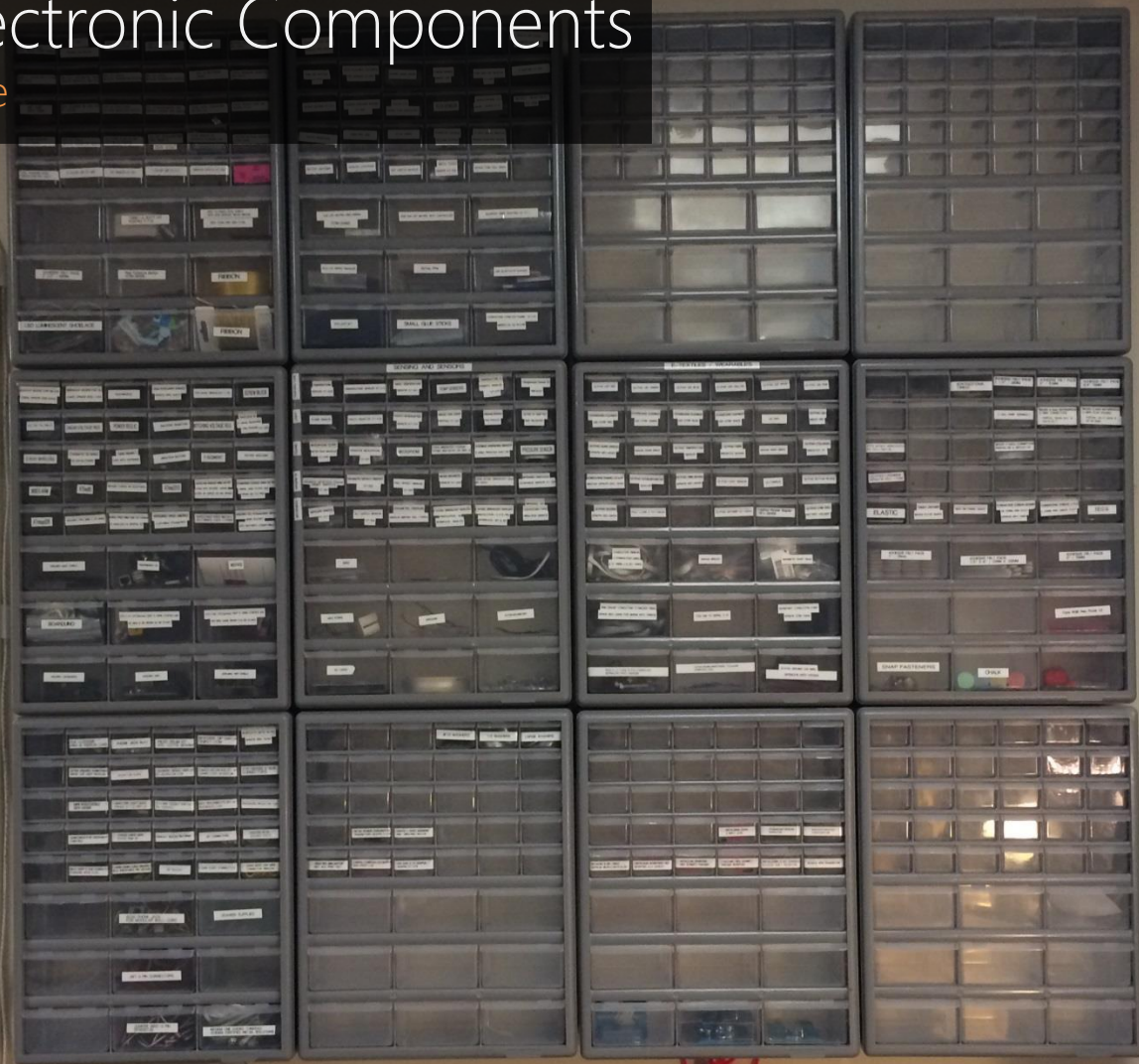
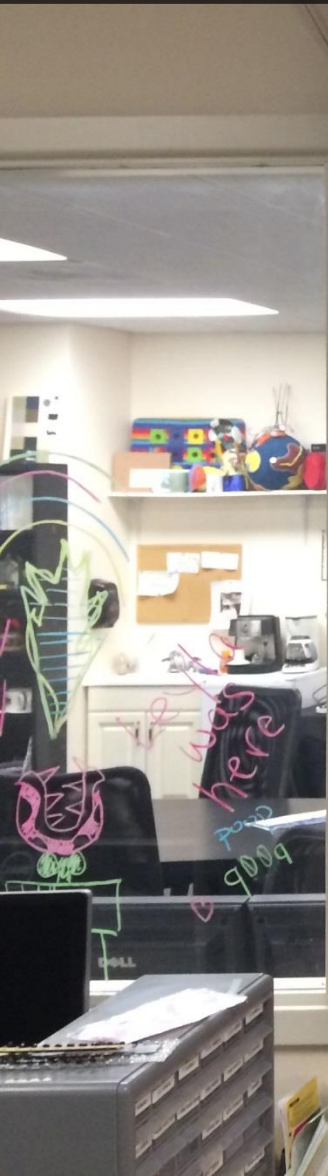
ASSORTED CAPACITORS



CAPACITORS

Wall of Electronic Components

HCIL Hackerspace





Microcontroller Inventory*



3 Beaglebones
<http://beagleboard.org/>



3 Raspberry Pis
<http://www.raspberrypi.org/>



2 .NET Gadgeteers
<http://www.netmf.com/gadgeteer/>



3 ARM Cortex-Ms
http://en.wikipedia.org/wiki/ARM_Cortex-M

And lots of Arduino...

*We have other boards as well but these are the main ones



Arduino Inventory



15 Unos

<http://arduino.cc/en/Main/ArduinoBoardUno>



15 Leondardos

<http://arduino.cc/en/Main/ArduinoBoardLeonardo>



2 Yúns

<http://arduino.cc/en/Main/ArduinoBoardYun>



2 Megas

<http://arduino.cc/en/Main/ArduinoBoardMega2560>



2 Dues

<http://arduino.cc/en/Main/ArduinoBoardDue>



2 Esploras

<http://arduino.cc/en/Main/ArduinoBoardUno>



5 Pro Minis

<http://arduino.cc/en/Main/ArduinoBoardProMini>



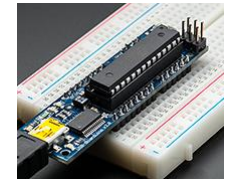
2 Pro Micros

<http://sprkfn.com/12640>



1 Fio

<http://arduino.cc/en/Main/ArduinoBoardFio>



9 Boarduinos

<http://adafru.it/91>



2 LilyPads

<http://arduino.cc/en/Main/ArduinoBoardLilyPad>



2 LilyPad Simple

<http://arduino.cc/en/Main/ArduinoBoardLilyPadSimple>

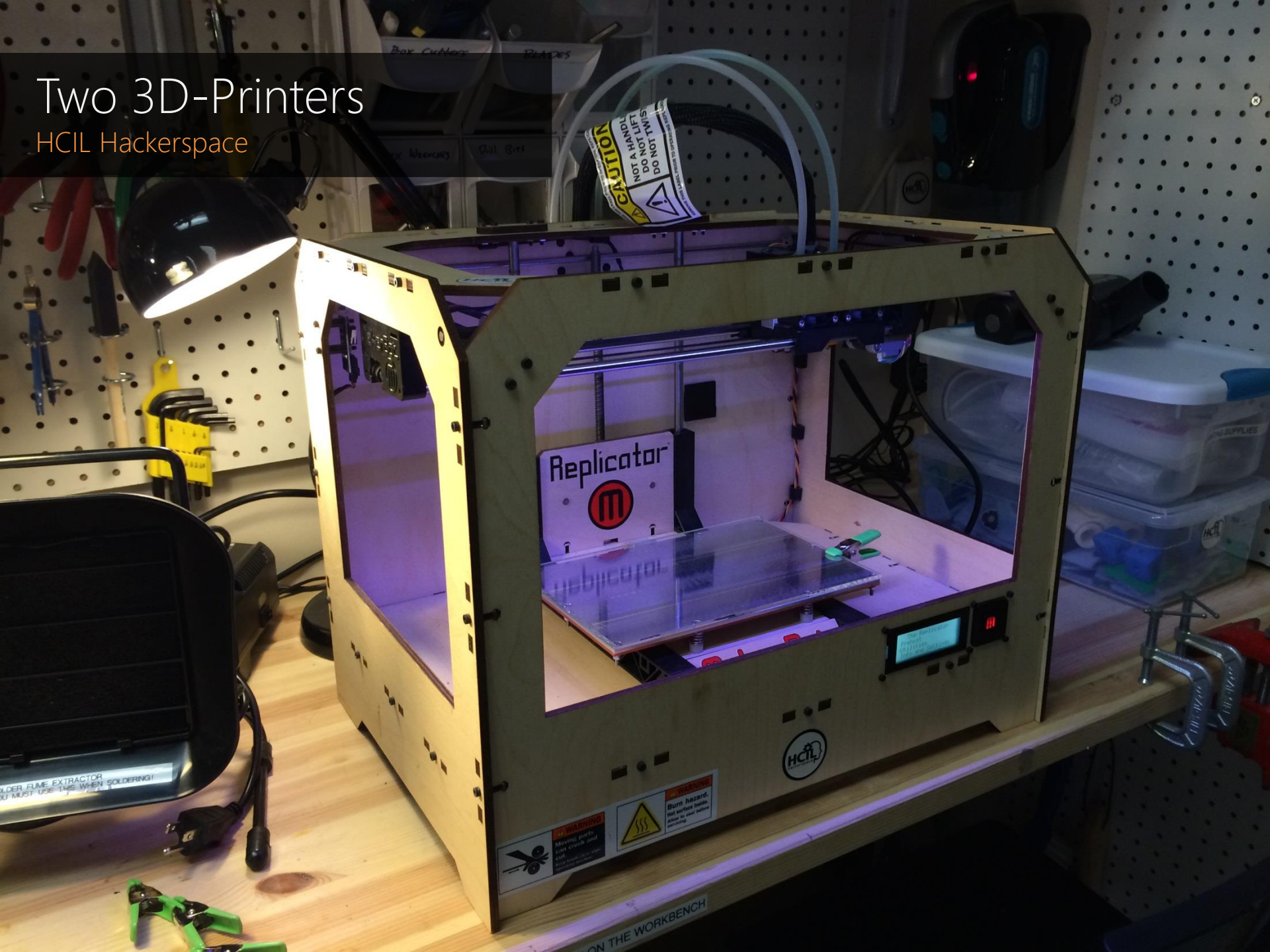
Quadcopters

HCIL Hackerspace



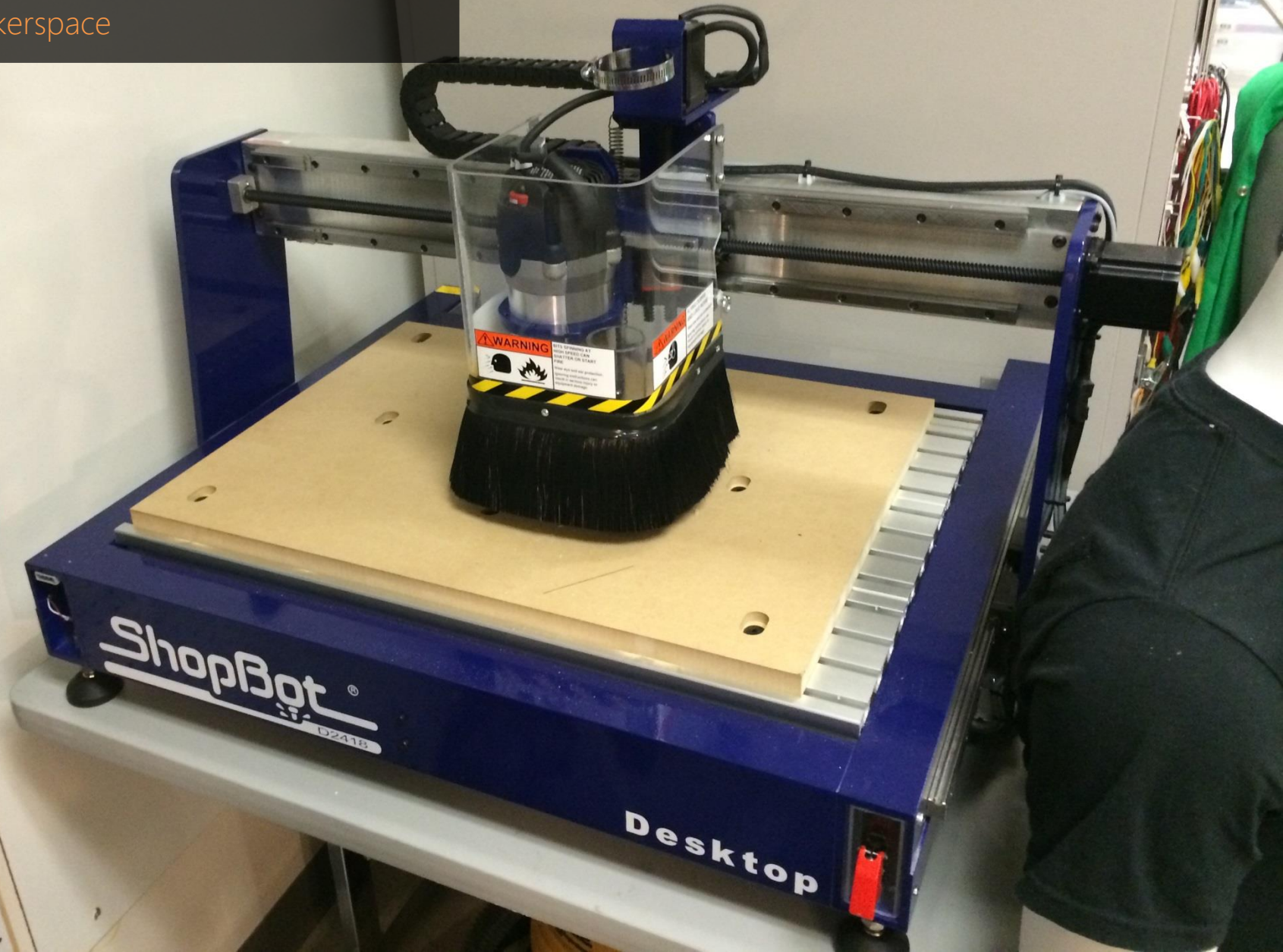
Two 3D-Printers

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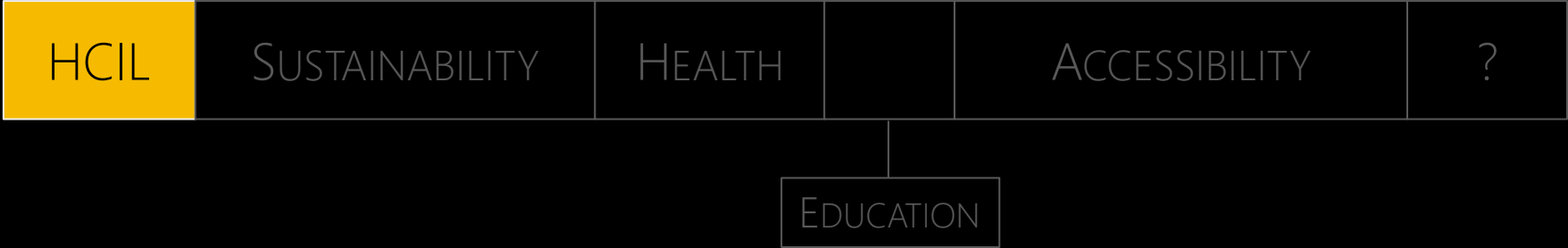
One CNC Machine

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HCIL	SUSTAINABILITY	HEALTH		ACCESSIBILITY	?
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EDUCATION



Making with a Social Purpose

