

# MakerWear:

## A Tangible Approach to Interactive Wearable Creation For Children

Majeed Kazemitabaar, Jason McPeak, Alexander Jiao, Liang He, Thomas Outing, Jon Froehlich



COMPUTER SCIENCE  
UNIVERSITY OF MARYLAND





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“

“...to be **makers of things**, not just consumers of things.”

”

**Former President, Barack Obama**

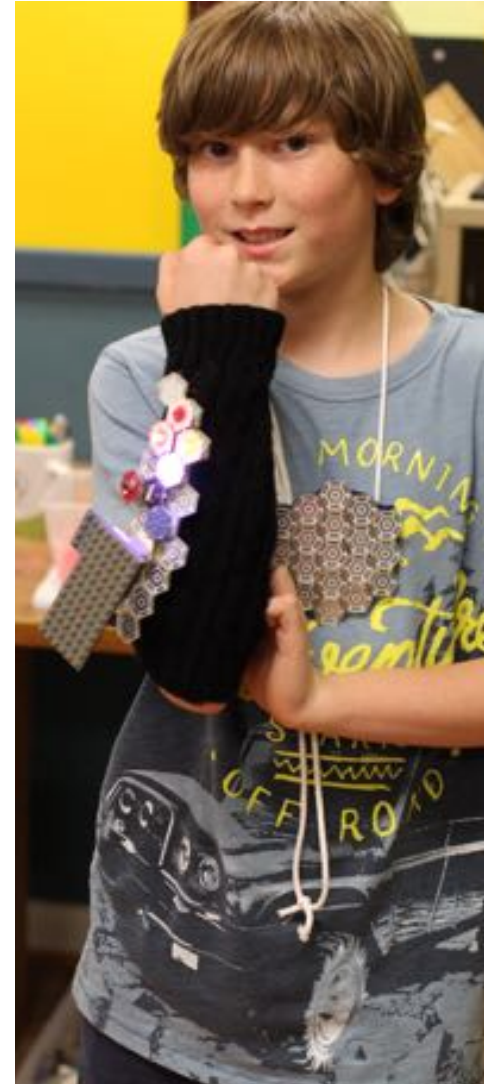
Remarks to the National Academy of Sciences, 2009

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**...

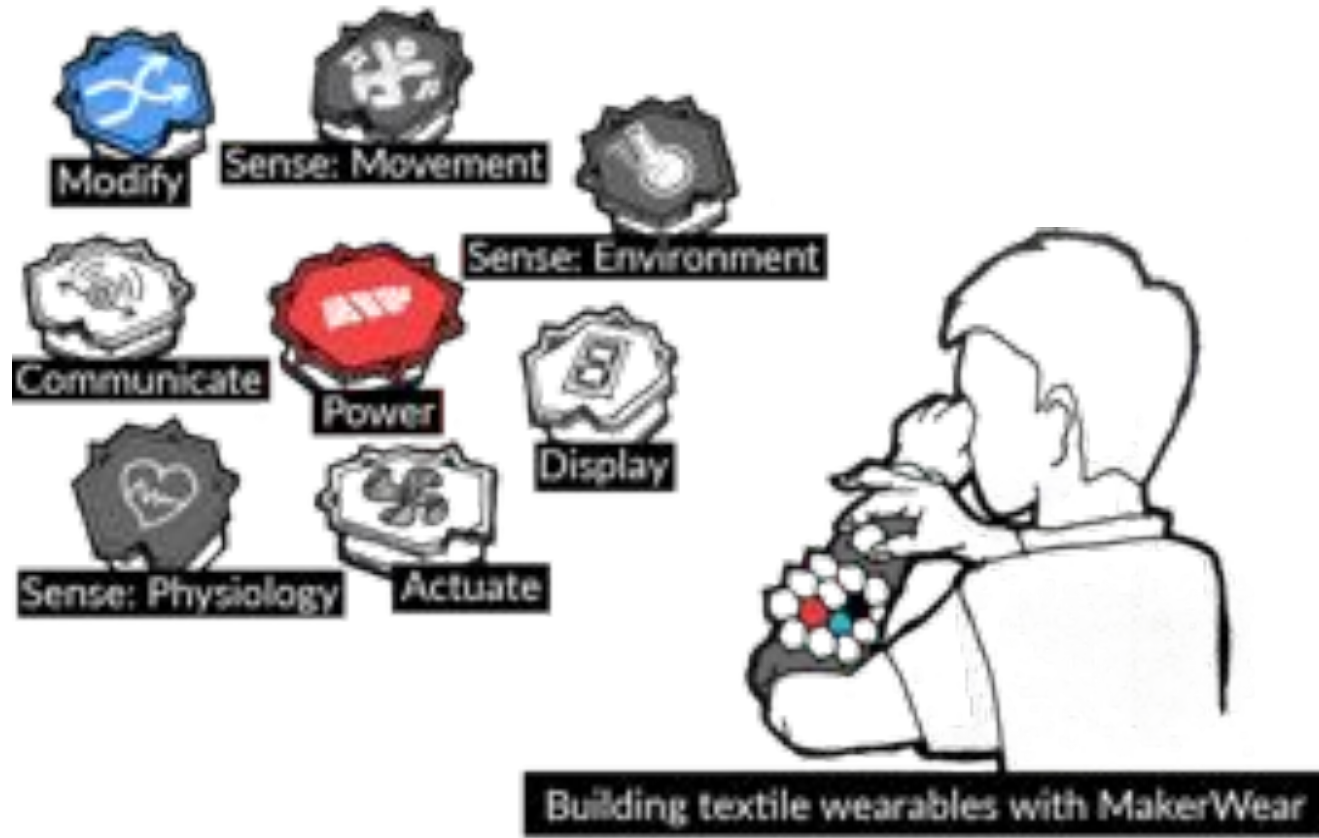


RESEARCH VISION

# 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



All built without the creation of code!

# Research Questions

How can we support **young children** and a **wide-age span** (ages 5-10) in the **creative design** of **interactive wearables**?

What do children **want to build** if given the opportunity?

Can MakerWear be an **introductory pathway to STEAM-related activities** like engineering, design, and computational thinking?

How can we design MakerWear to allow children to build designs that **integrate into their everyday life** (e.g., soccer, theatre)?



RESEARCH VISION

# Constructionism

Our research is rooted in **Papert's theory of constructionism**, which suggests a **strong connection between design and learning**.



**Seymour Papert**

MIT Professor

Pioneer of AI & new learning theories

# Constructionism

Our research is rooted in **Papert's theory of constructionism**, which suggests a **strong connection between design and learning**.

'**Remarkable Learning**' occurs when **children are working with materials to design, create, and invent** external and **shareable artifacts**.



**Seymour Papert**

MIT Professor

Pioneer of AI & new learning theories

# **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

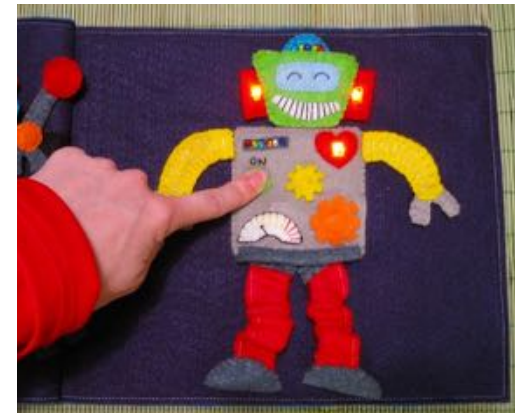
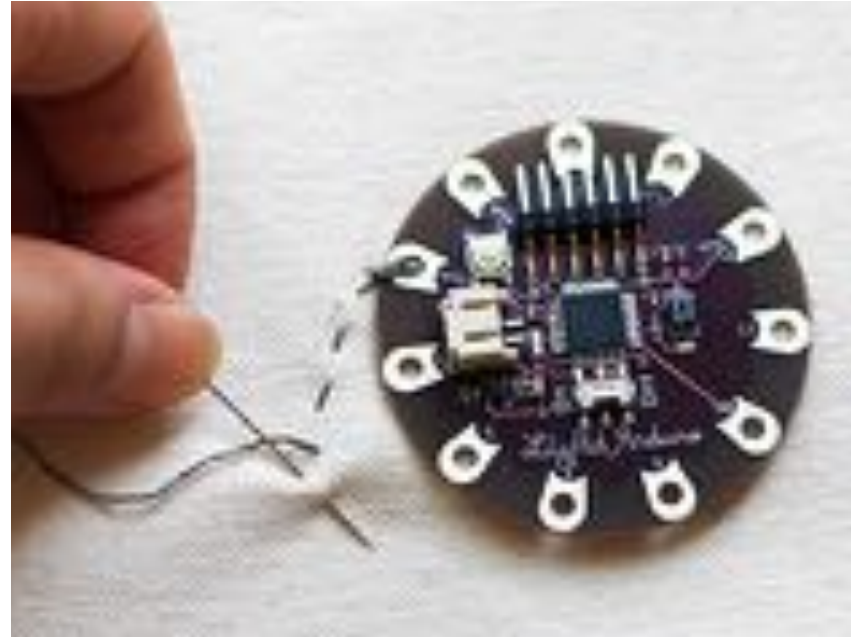
Wearable

Not designed for children

Requires sewing

Requires programming

Requires basic electronics



DESIGN INSPIRATION

# BodyVis

E-textile shirt for visualizing live physiological data

New platform for health and science learning

Fully responsive and interactive

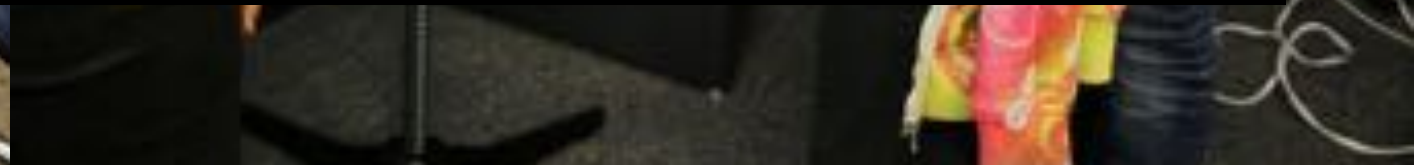


DESIGN INSPIRATION

# BodyVis Provoked Curiosity



Children constantly asked **“how does it work”** and wanted to **explore the “insides”** of the BodyVis shirt. This was unexpected!





# **Construction Kits**

# Construction Kit Definition

“

Construction kits—like LEGO or Erector Sets—are **creative platforms** that enable users to **design** and **create things** through **interworking components**.

”

CONSTRUCTION KITS

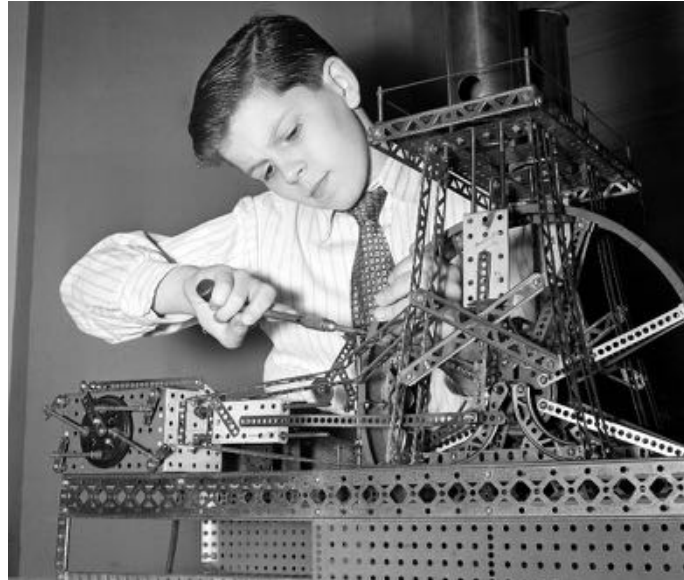
# **Construction Kit** History

# Construction Kit History



## 1<sup>st</sup> Generation Kits

Allowed children to build structures (e.g., towers, buildings)



## 2<sup>nd</sup> Generation Kits

Allowed children to build mechanisms (e.g., pulleys, working ferris wheels, cars with gears)



## 3<sup>rd</sup> Generation Kits

So-called digital-physical kits allow children to build interactive behaviors (e.g., a car that follows a light)

CONSTRUCTION KITS

# Digital-Physical Construction Kits

Robotics (e.g., Cubelets)

Electronics (e.g., littleBits, SAM)

Circuits (e.g., LightUp)

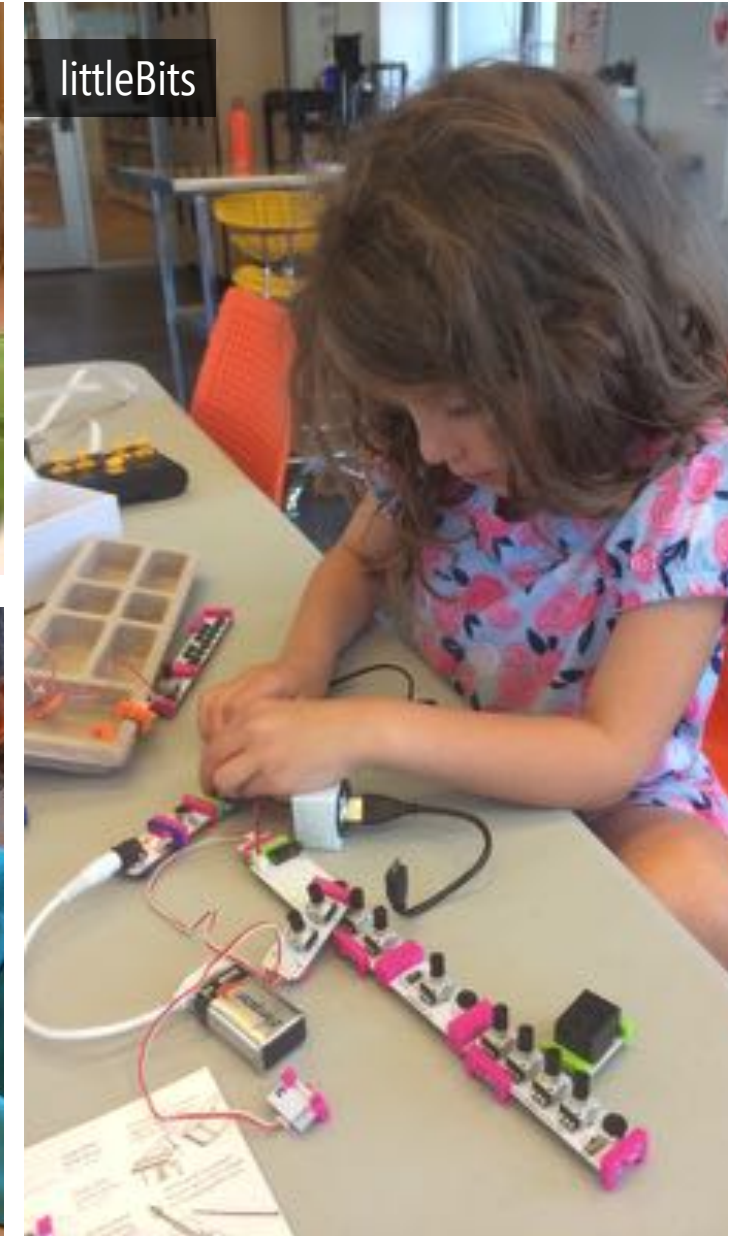
Often programmable

Modular

Snappable (typically magnetic)



Cubelets



littleBits



LightUp

CONSTRUCTION KITS

# Digital-Physical Construction Kits

Robotics (e.g., Cubelets)

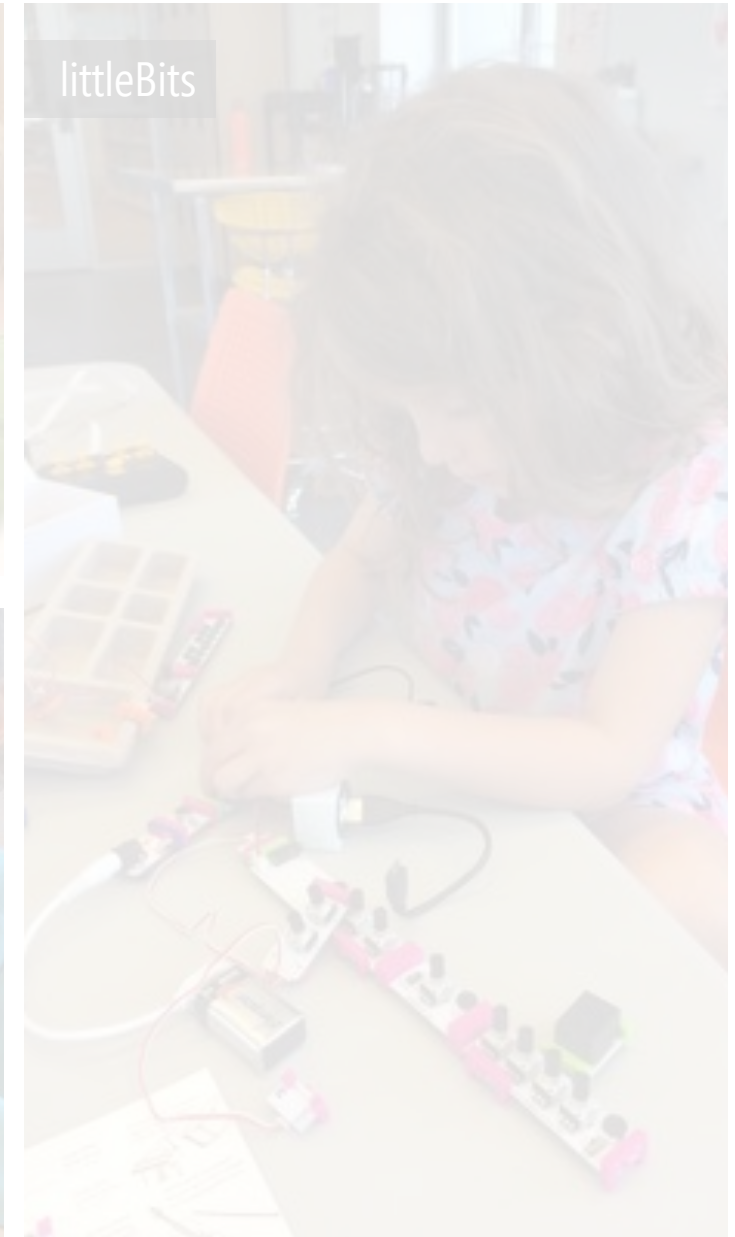
Electronics (e.g., littleBits, SAM)

Circuits (e.g., LightUp)

Often programmable

Modular

Snappable (typically magnetic)



# Modular Robotics Cubelets

## SENSORS



Light Sensor



Distance Sensor



Temperature Sensor

## ACTIONS



Rotating Wheels



Flashlight



Speaker

## "THINK"



Inverse



Maximum



Threshold

## OTHER



Battery



Pass Through



Blocker





# CUBELETS



Modular  
Snappable  
Emergent behavior  
Rapid prototyping  
Highly iterative

CONSTRUCTION KITS

# Digital-Physical Construction Kits

Designed & used in static  
spaces

Not wearable

Not intrinsically shareable

Children not designing for  
the self, their changing  
contexts



WHY CLOTHING?

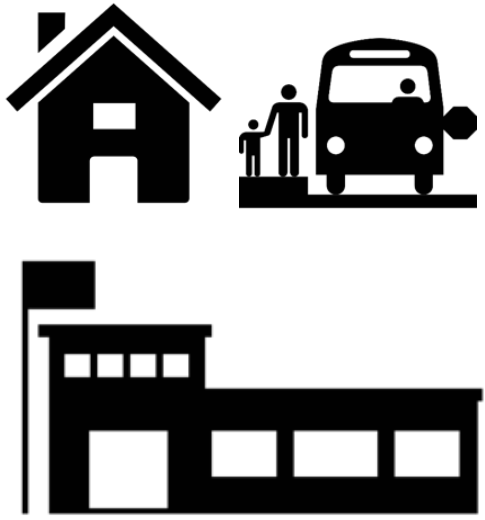
# **Clothing is a Unique Design Context**

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

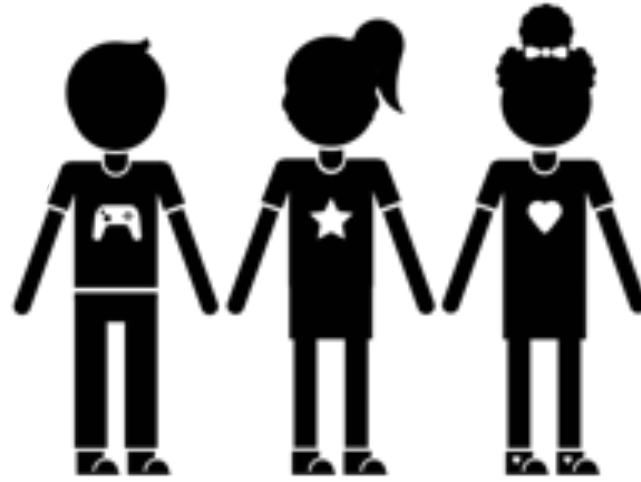
WHY CLOTHING?

# Clothing is a Unique Design Context

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



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

Test

technology for children!



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



DESIGN PROCESS

# 1<sup>st</sup> Co-design session

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

Shoes  
adhesive cardboard  
large post-it pads  
markers



DESIGN PROCESS

# 1<sup>st</sup> Co-design session

Themes and Design ideas:

Personalization

Gestures

Achievements

Communication

Programming



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

DESIGN PROCESS

# 2<sup>nd</sup> Co-design session

Rapid prototyping session with:

littleBits

Velcro

Shoes

Sticky Notes

5 children + 5 adults



# MORSE CODE SHOES

2<sup>nd</sup> Co-Design Session: Rapid Prototyping



# 2<sup>nd</sup> Co-design session Outcomes

Shoes that would:

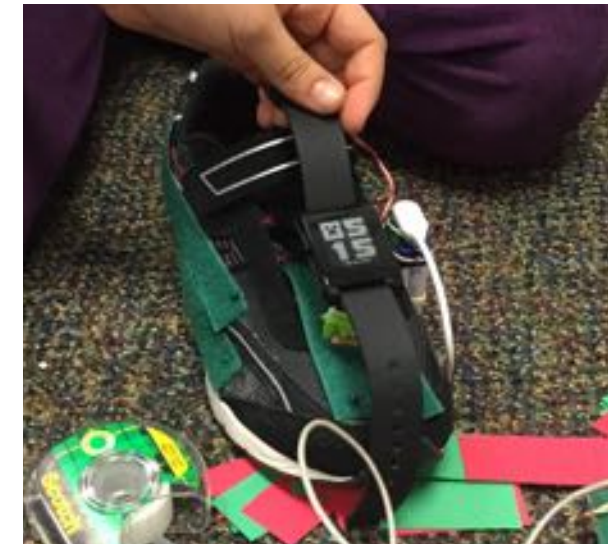
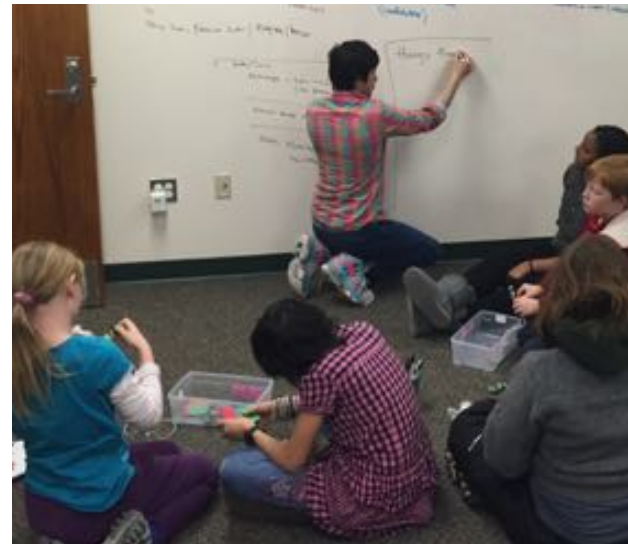
Make noise when walk

Shoelaces that light-up in the dark

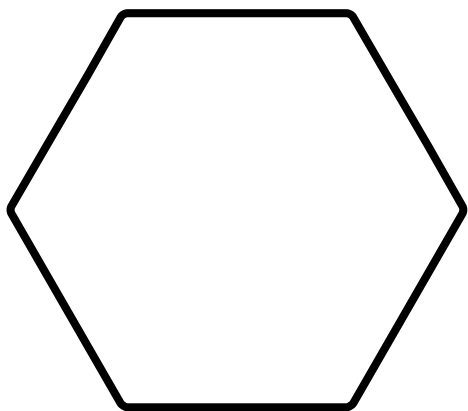
Sound Activated Foot-massage

Air-Conditioner Shoes

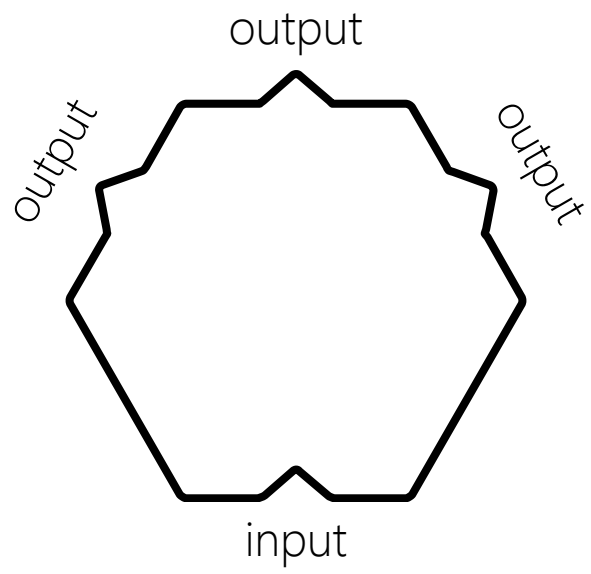
Major Problems: power,  
connections, attachment, ...

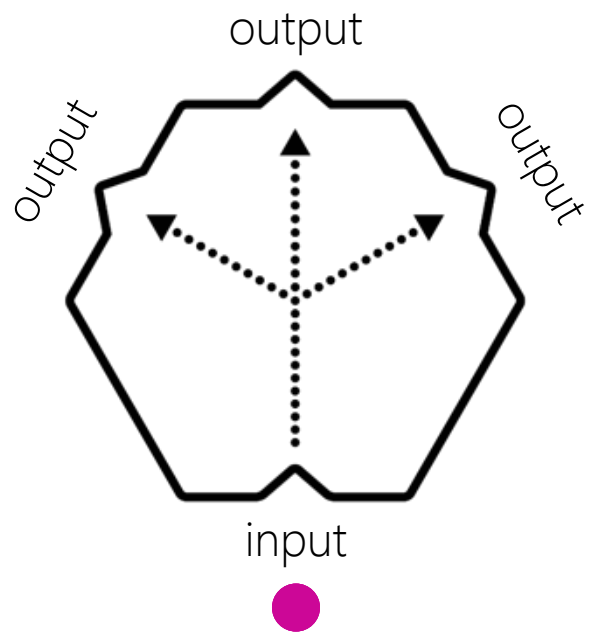


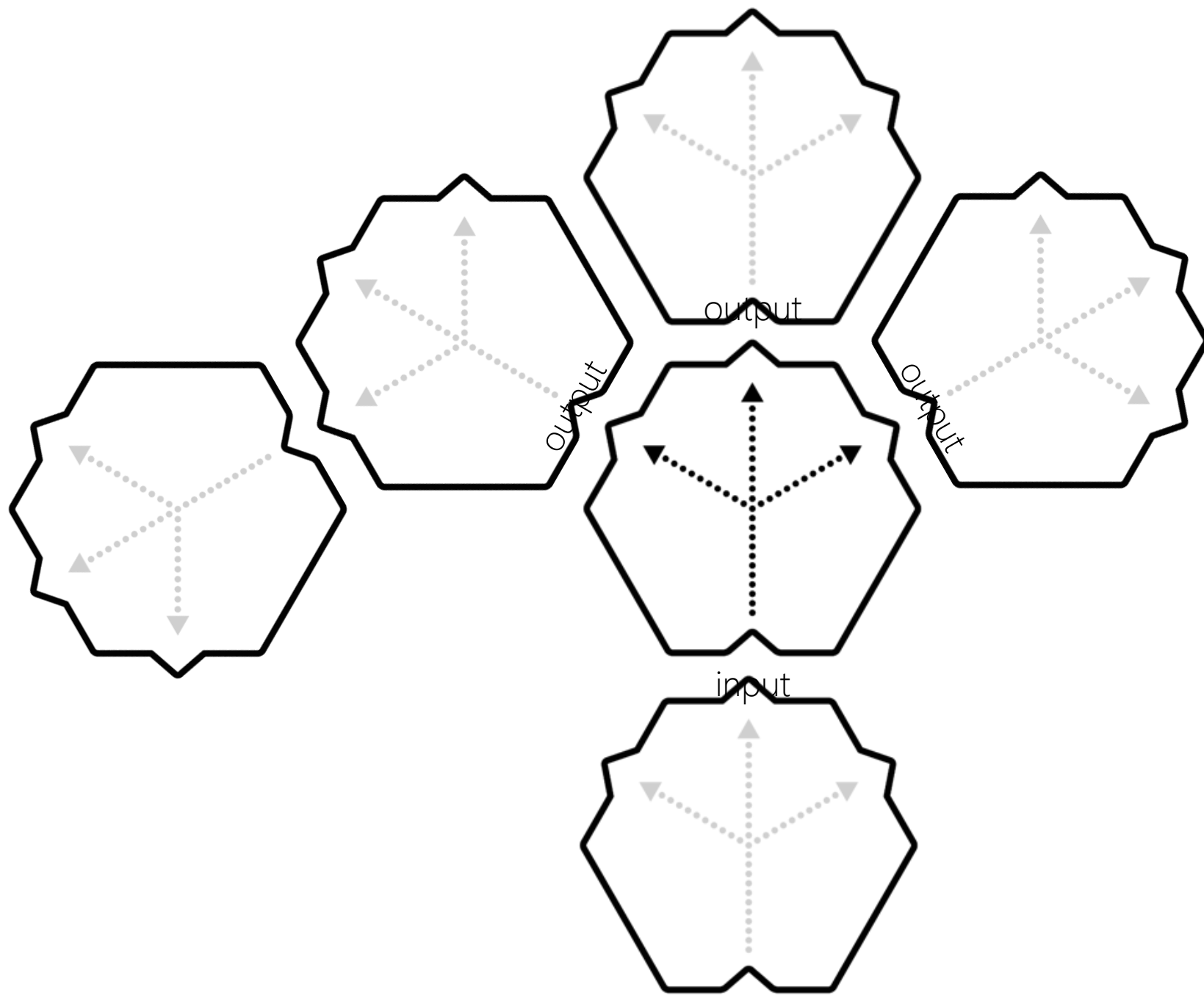
# **MakerWear Design**



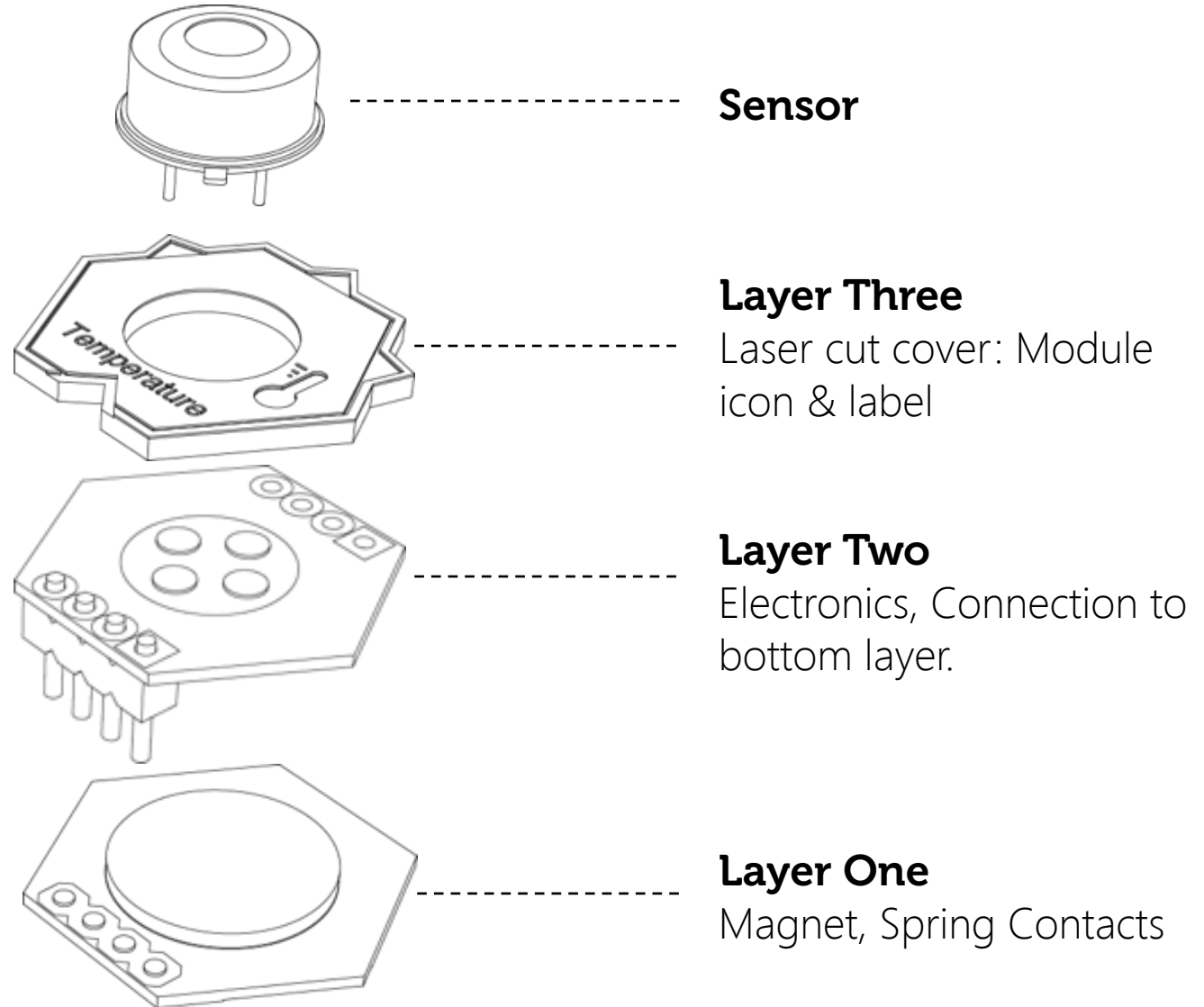




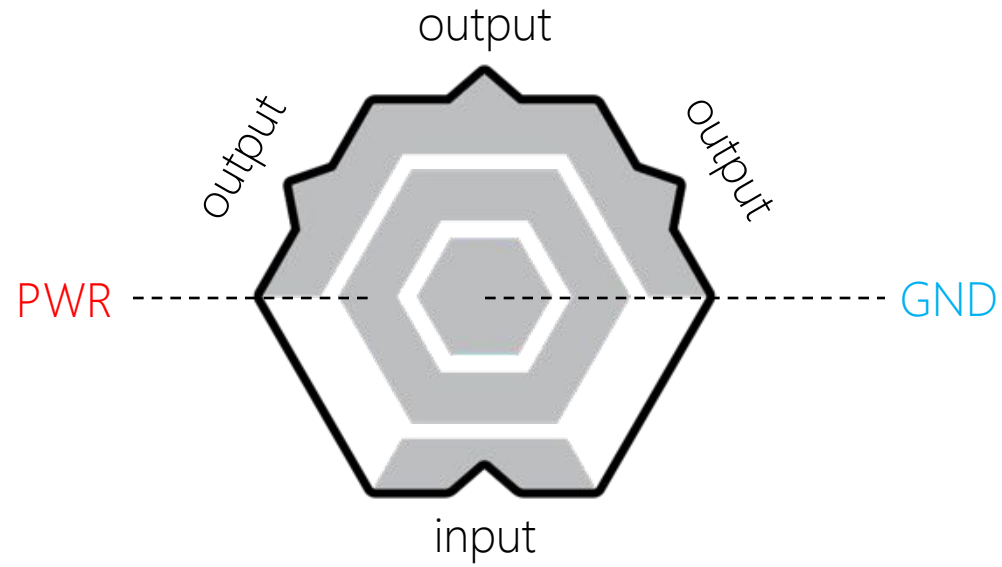




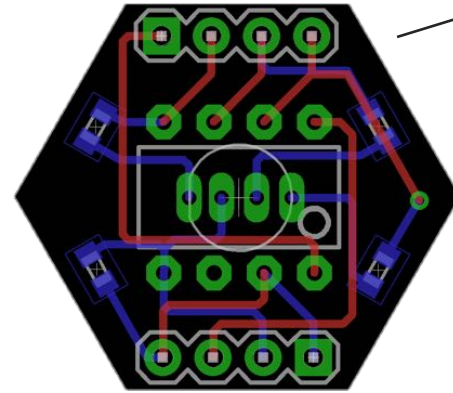
# Module Layers



# Module Layer One



# Module Layer Two



Custom PCB with pre-programmed electronics for given module

# Module Layer Three



Laser cut top shows iconography & label representing module behavior

# **Example Module:** MultiColor Light





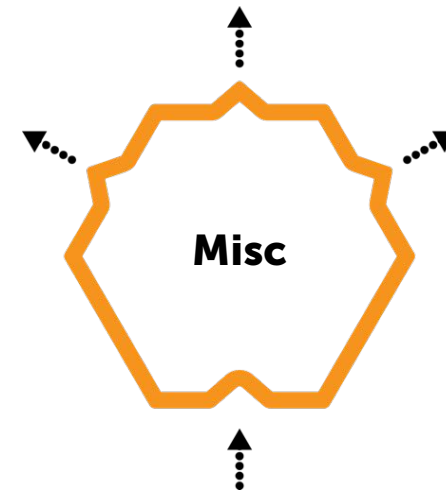
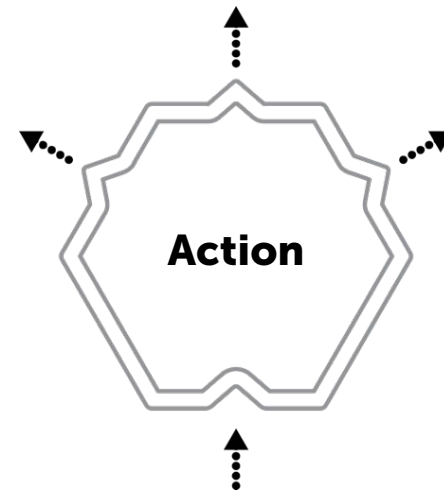
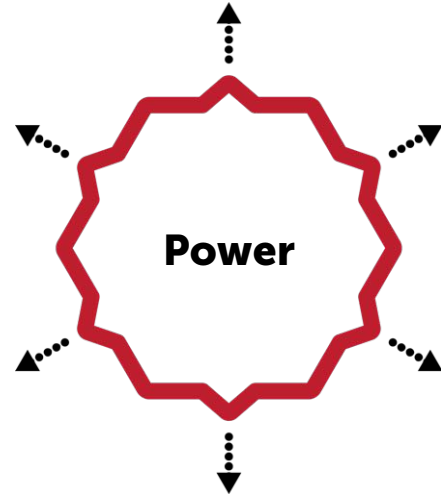
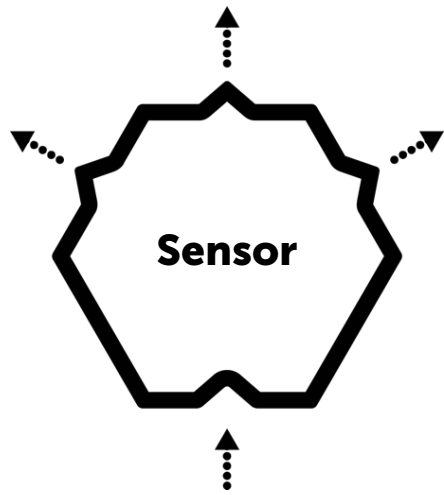
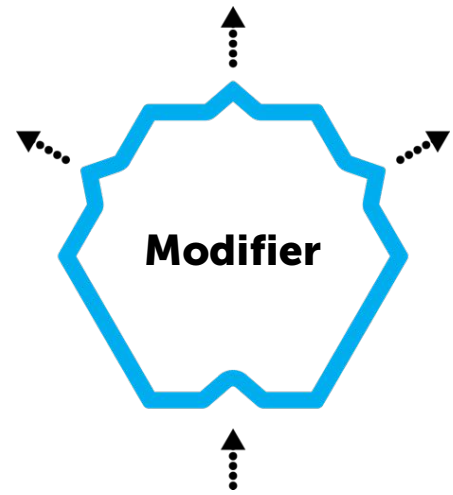
# Example Module: Inverter



# **Example Module:** Distance Sensor

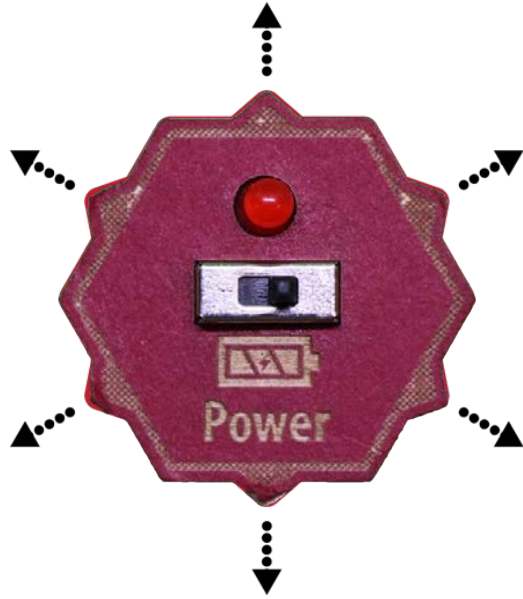


# 5 Module Types

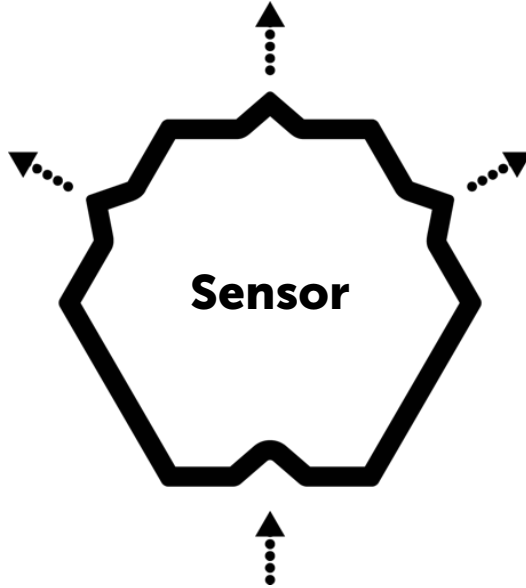


DESIGN OVERVIEW

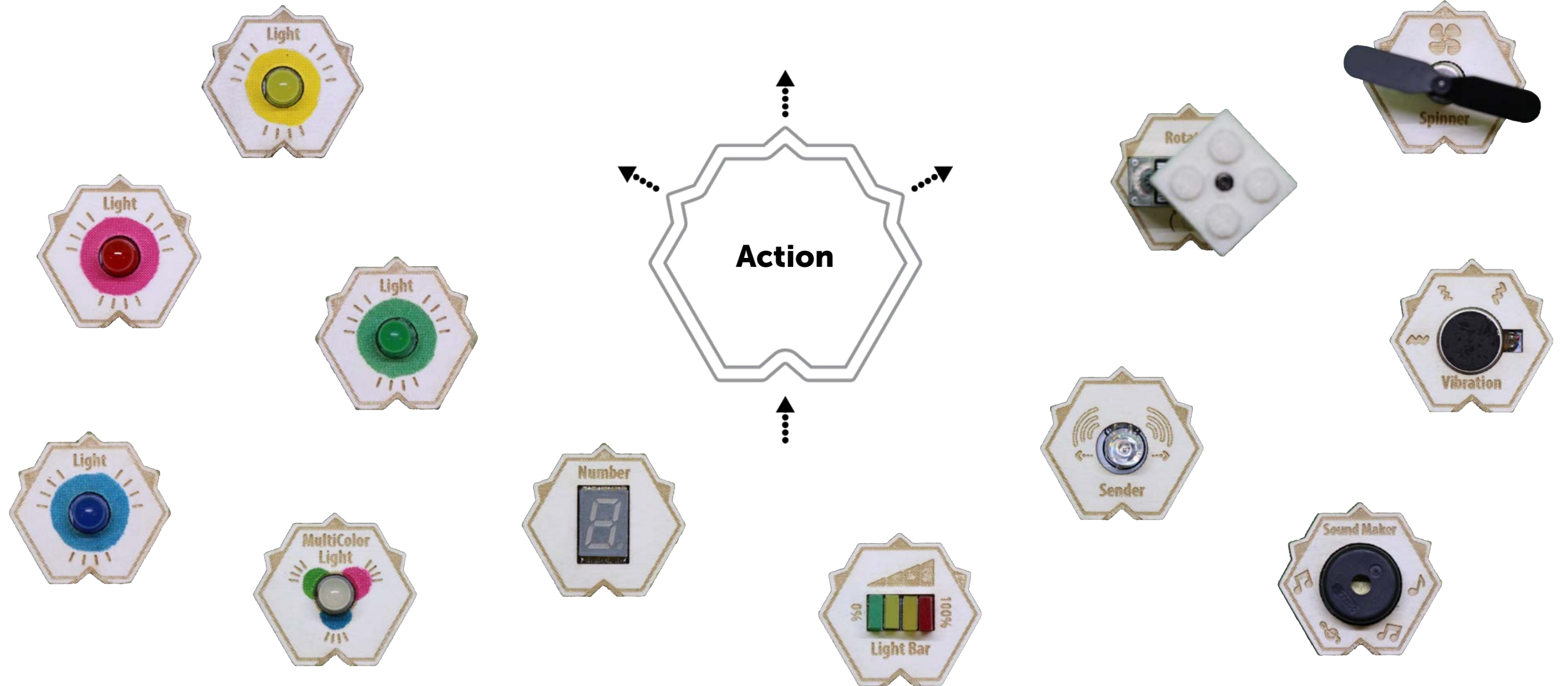
# Module Library



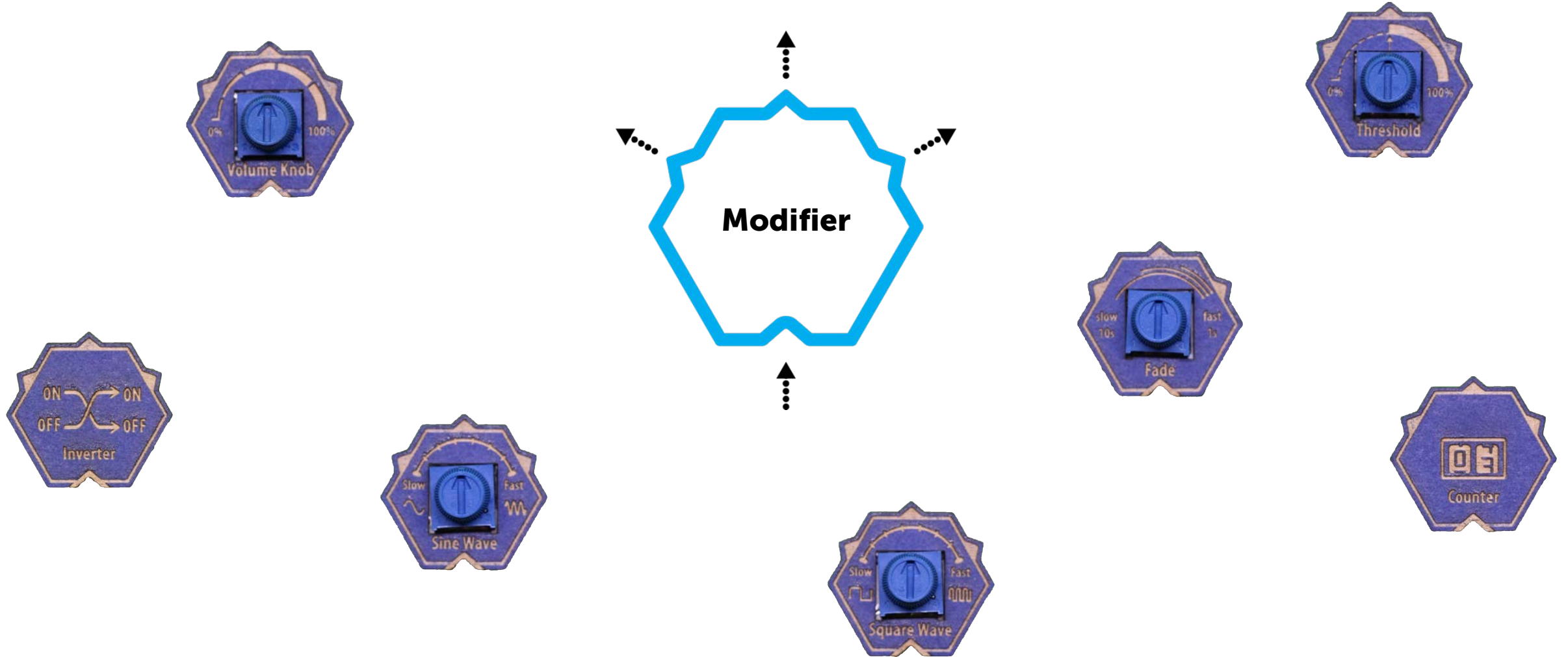
# Module Library



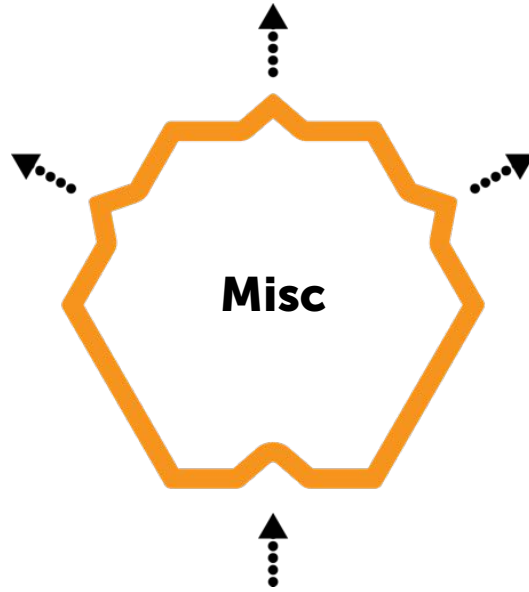
# Module Library



# Module Library



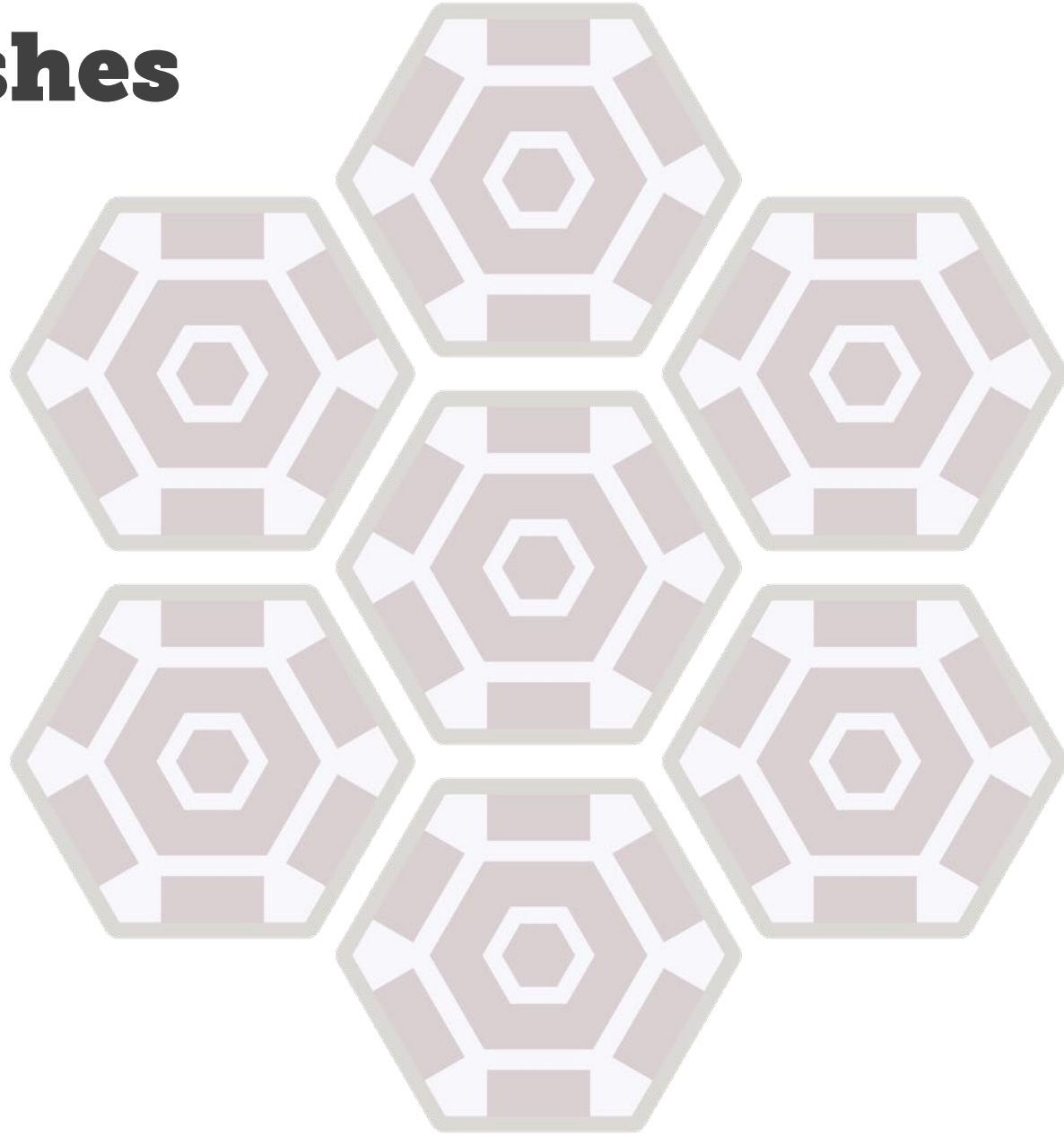
# Module Library





DESIGN OVERVIEW

# Socket Meshes



DESIGN OVERVIEW

# Socket Meshes



Vest

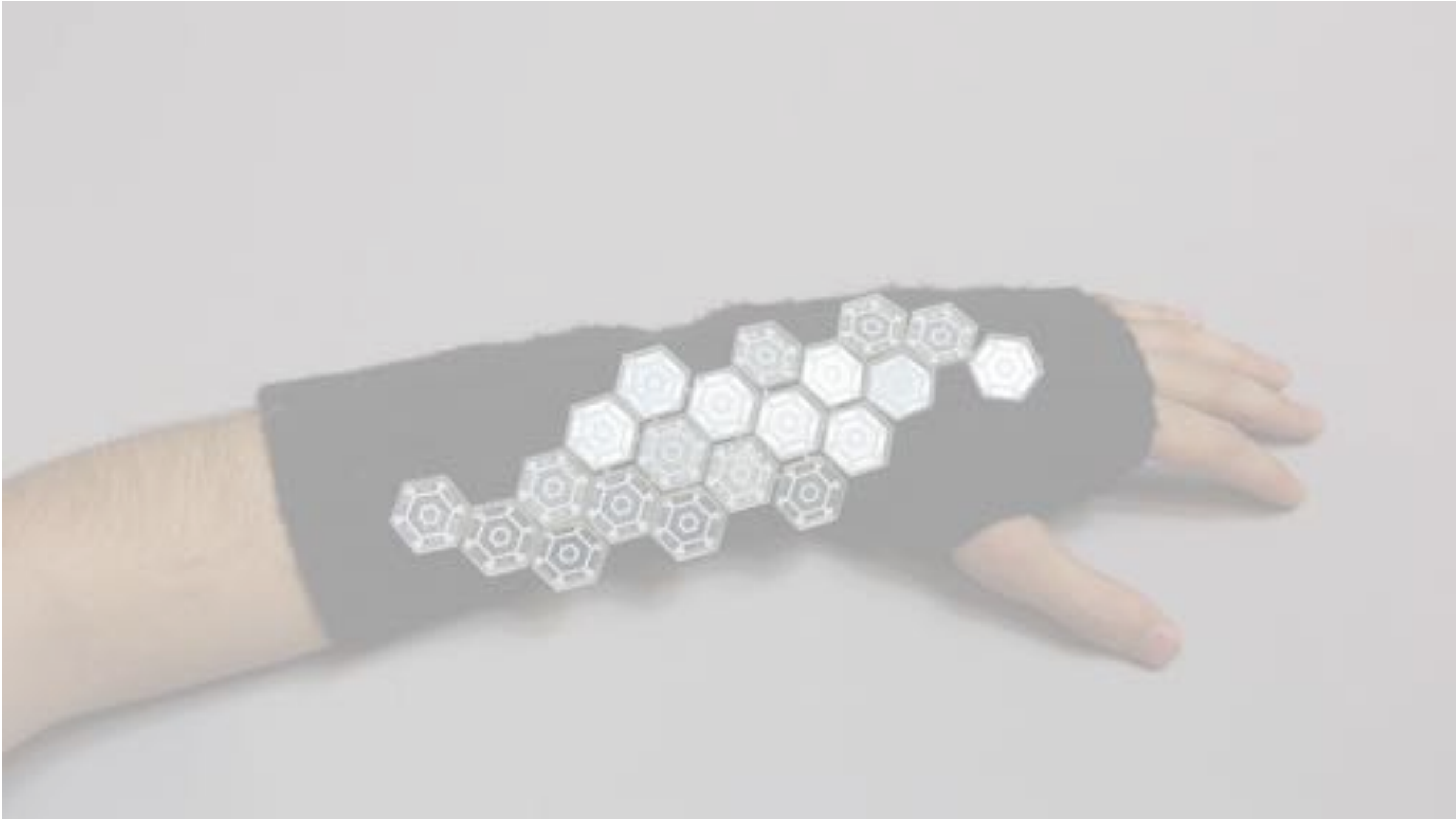


Scarf



Hat

**Demo!**



# **Evaluations**

# MakerWear Studies

Museum  
Exhibit

Co-design  
Session

Pilot  
Workshop

Single-Session  
Workshops

Multi-Session  
Workshops

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**Preliminary**

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**Final**

# Preliminary Studies

# CUSTOM LIGHT OSCILLATOR

Male child maker (~8 yrs old)





# CUSTOM LIGHT OSCILLATOR

Male child maker (~8 yrs old)



# CUSTOM LIGHT OSCILLATOR

Male child maker (~8 yrs old)



# CUSTOM LIGHT OSCILLATOR

Male child maker (~8 yrs old)



# MOVEMENT-BASED INSTRUMENT W/LIGHTS

2 brothers



# MOVEMENT-BASED INSTRUMENT W/LIGHTS

2 brothers



# Outcomes

Explicit support for lo-fi integration: Rotator / LEGO

Increased number of sockets

Created 12 additional modules



# Final Workshops

# Final Workshops

two single-session (1.5 hour) workshops divided into two different age groups: 5-7 and 8+

Three four-session workshops divided into three age groups: 5-7, 8-9, 10+





EVALUATION

# Final Workshops

Pre questionnaires

Building/Play time

Design challenges

Post questionnaire

Artifact-based interviews



# **MakerWear Creations**

Workshop Design Challenges

# DANCE FREEZE

Day 2: 11 yr old male maker



# DANCE FREEZE

Day 2: 11 yr old male maker



# Dance Freeze



# BUZZ LIGHTYEAR

Day 2: 11 yr old male maker



# BUZZ LIGHTYEAR

Day 2: 11 yr old male maker



# Buzz Lightyear





# LASER TAG

Day 3: 6 yr & 7 yr male makers



# LASER TAG

Day 3: 6 yr & 7 yr male makers



# Laser Tag



**MakerWear Creations**  
Workshop Final Projects

# WRECKING BALL ARMBAND

6 yr old male maker



# WRECKING BALL ARMBAND

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



# JOGGING CLOTHES

10 yr old female maker



# JOGGING CLOTHES

10 yr old female maker



# LIGHT-UP SOCKS

7 yr old male maker



# LIGHT-UP SOCKS

7 yr old male maker



# FITNESS TRACKER

11 yr old male maker



# FITNESS TRACKER

11 yr old male maker





# **Future Work**

FUTURE WORK

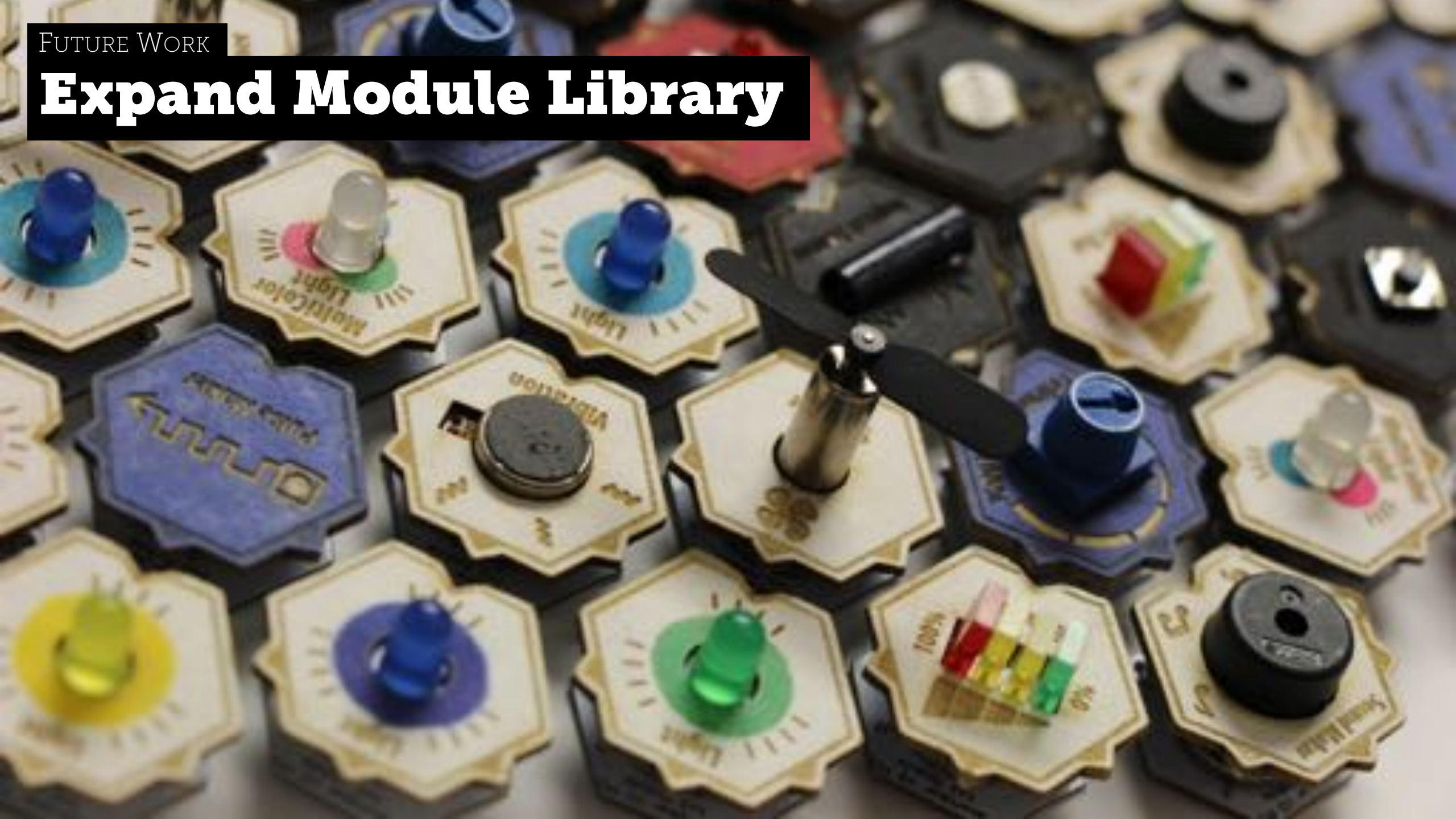
# Form Factor

More flexible  
Reduced weight  
Thinner



FUTURE WORK

# Expand Module Library



FUTURE WORK

# Expand Module Library

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



FUTURE WORK

# Wireless Programming Interface

Modules will be wirelessly programmable via a custom tablet programming interface



**Tickle**

<https://tickleapp.com/>

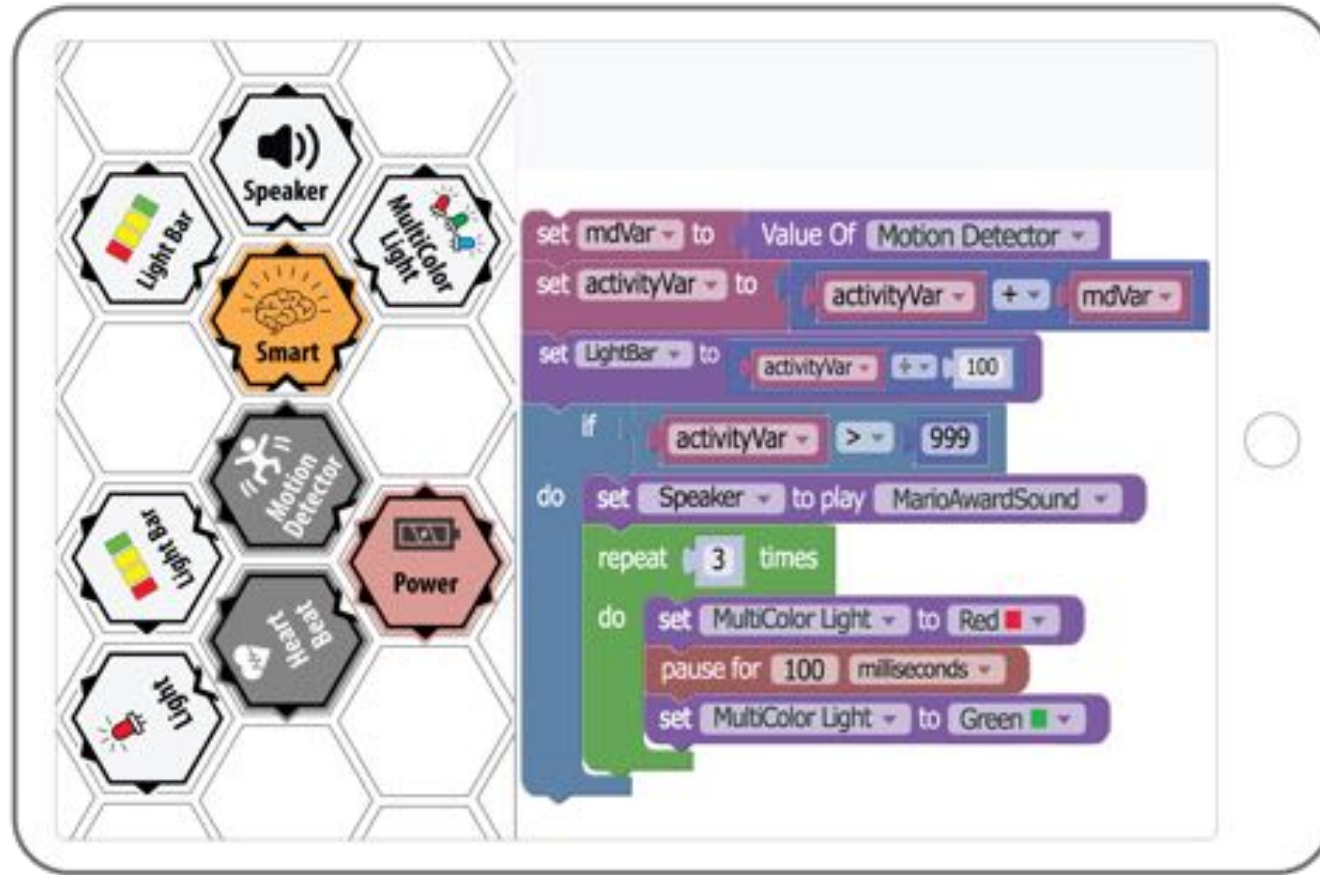


**SAM Labs**

<https://samlabs.com>

# Wireless Programming Interface

Modules will be wirelessly programmable via a custom tablet programming interface



## Sample Application:

Making a fitness tracker using a *Motion Detector* and a *HeartBeat Detector*.

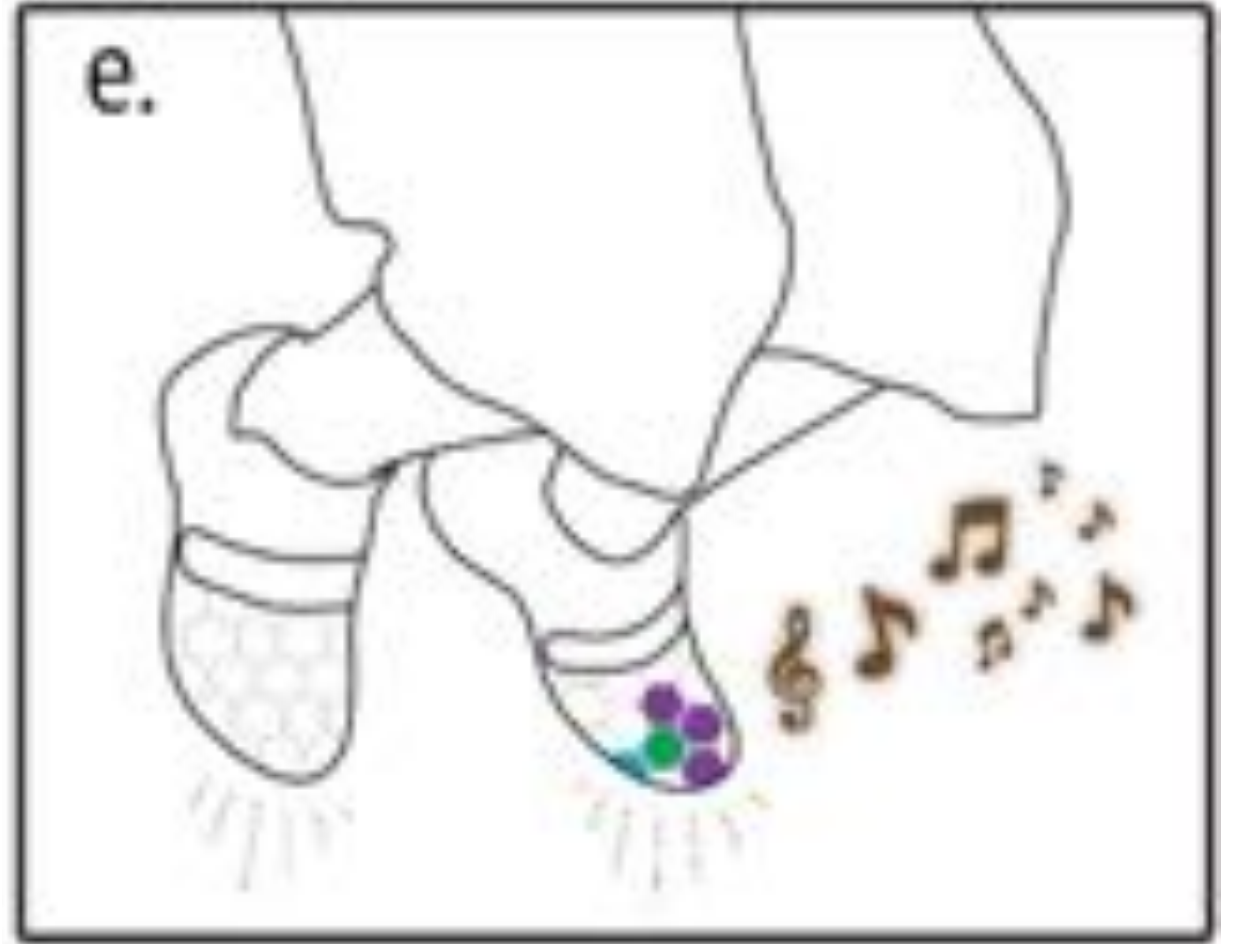
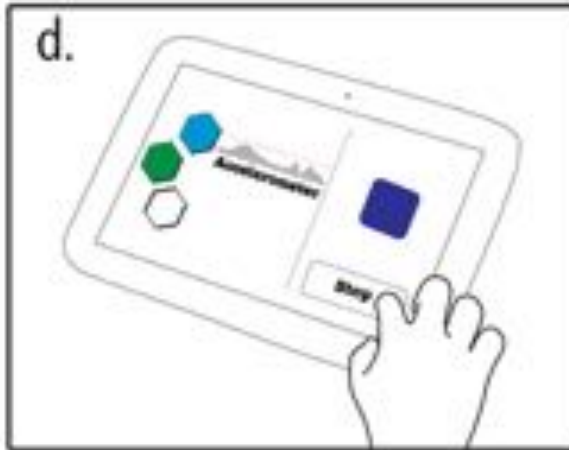
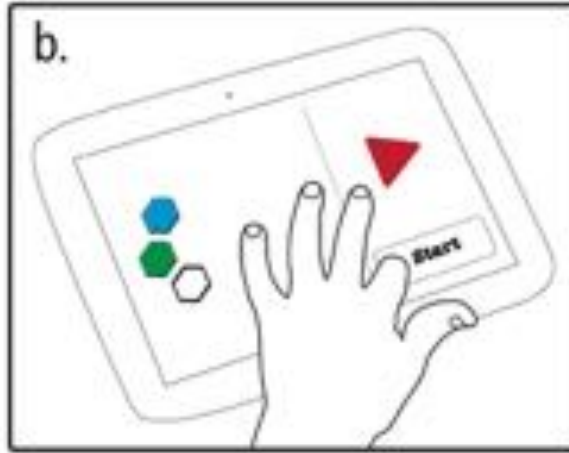
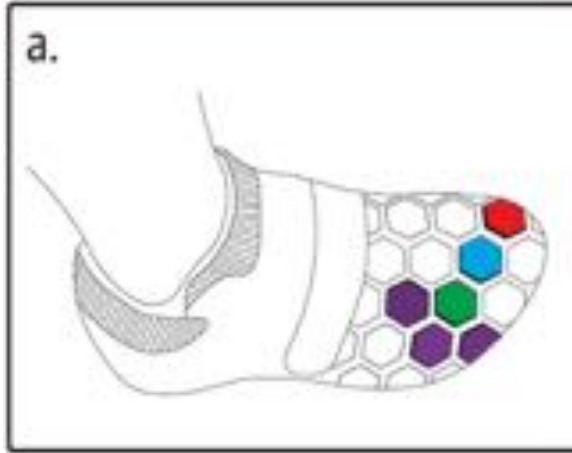
FUTURE WORK

# **Programming by Demonstration**

Children can program complex behavior via a novel interaction machine learning interface

# Interactive Machine Learning

Children can program complex behavior via a novel interaction machine learning interface





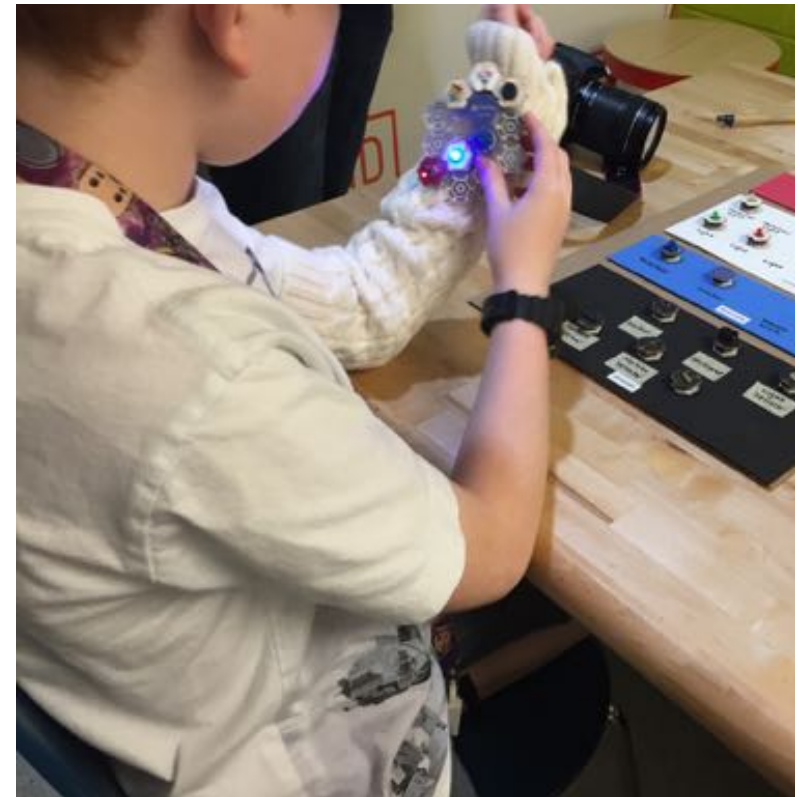
IN SUMMARY


# 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:

## A Tangible Approach to Interactive Wearable Creation For Children

Majeed Kazemitabaar, Jason McPeak, Alexander Jiao, Liang He, Thomas Outing, Jon Froehlich



# Media Acknowledgements



## Dancer

By James Keuning

<https://thenounproject.com/term/dancer/373924/>



## Painting

Juan Pablo Bravo

<https://thenounproject.com/term/painting/17015>



## House

By Paulo Volkova

<https://thenounproject.com/term/house/3966/>



## Trampoline

Juan Pablo Bravo

<https://thenounproject.com/term/trampoline/16998>



## School

By Mike Wirth

<https://thenounproject.com/term/school/23692>



## Children

OCHA Visual Information Unit

<https://thenounproject.com/term/children/4283/>



## Bus Stop

By Iconathon

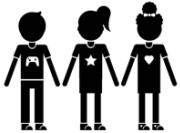
<https://thenounproject.com/term/school-bus-stop/731/>



## Arduino

uizin

<https://thenounproject.com/term/arduino/34403>



## Friends

By Marie Van den Broeck

<https://thenounproject.com/term/friends/235419/>



## Boy

By Carlos Gonzalez

<https://thenounproject.com/term/boy/364826/>