Smart Textiles in HCI - Sketch&Stitch

Nur Hamdan

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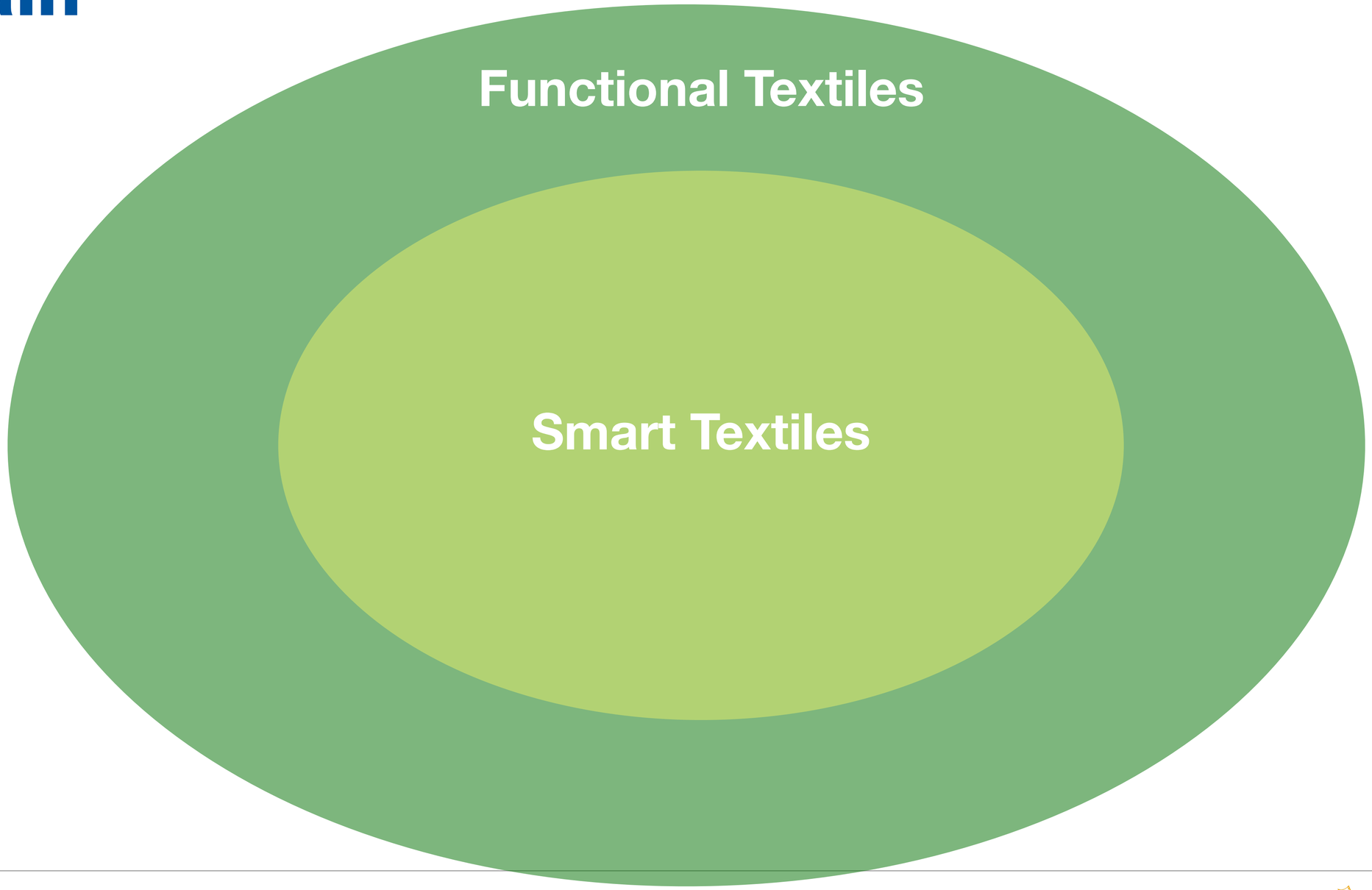
Domain



Functional textiles are enhanced with special materials for a specific purpose

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Smart textiles are enhanced with digital functionality

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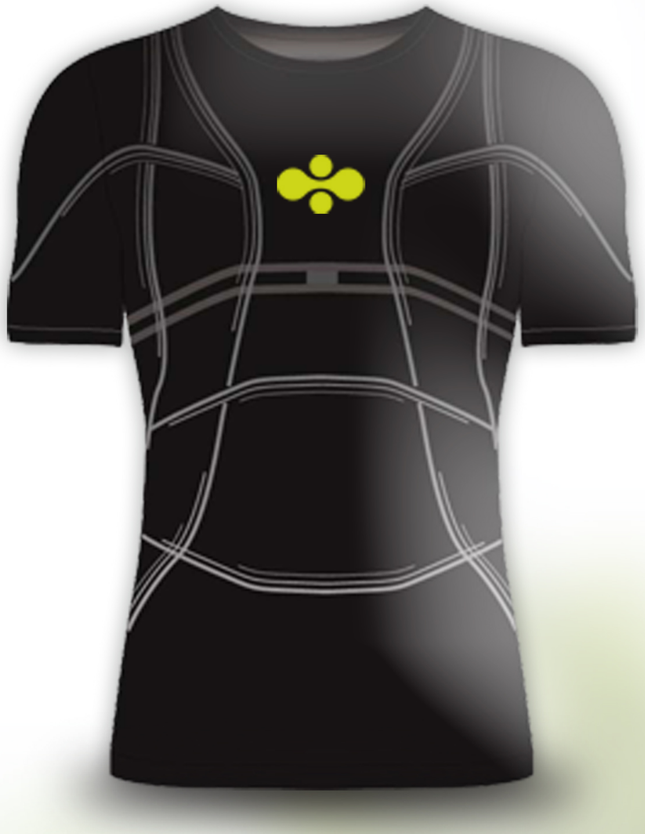

Smart textiles applications:

Bio-sensing

E.g., D-Shirt by Smoozi

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Smart textiles applications:

Motion capture

E.g., NADI X Smart Yoga Pants by Wearable X

Smart textiles applications:

Communication and entertainment

E.g., Levi’s Commuter x Jacquard by Google

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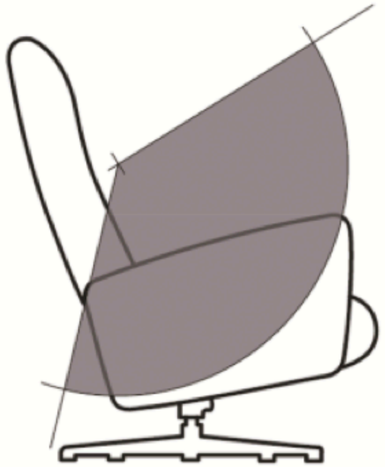
Smart Textile Research

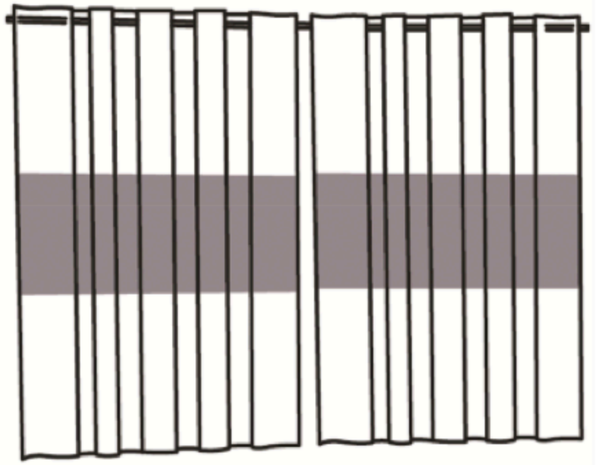
- Smart textiles are composed of a textile substrate and a flexible conductor
- Textile substrates are flexible, stretchable, breathable, durable, scalable, and ubiquitous
- Most common conductors are conductive (piezoresistive) threads, yarns, fabrics, inks and polymers
- Conductors are used to design electrical components (e.g., resistors, capacitors, inductors, sensors, actuators, heat grids, antennas, switches, connectors, power sources), transmission lines, and complete electrical circuits
- Conductors are integrated into textiles using transitional textile techniques (e.g., weaving, knitting, embroidery, printing) as well as modern techniques such as 3d printing
- In HCI we focus on
  - User interfaces, interaction techniques, and applications
  - Tools to design and fabricate textile circuits

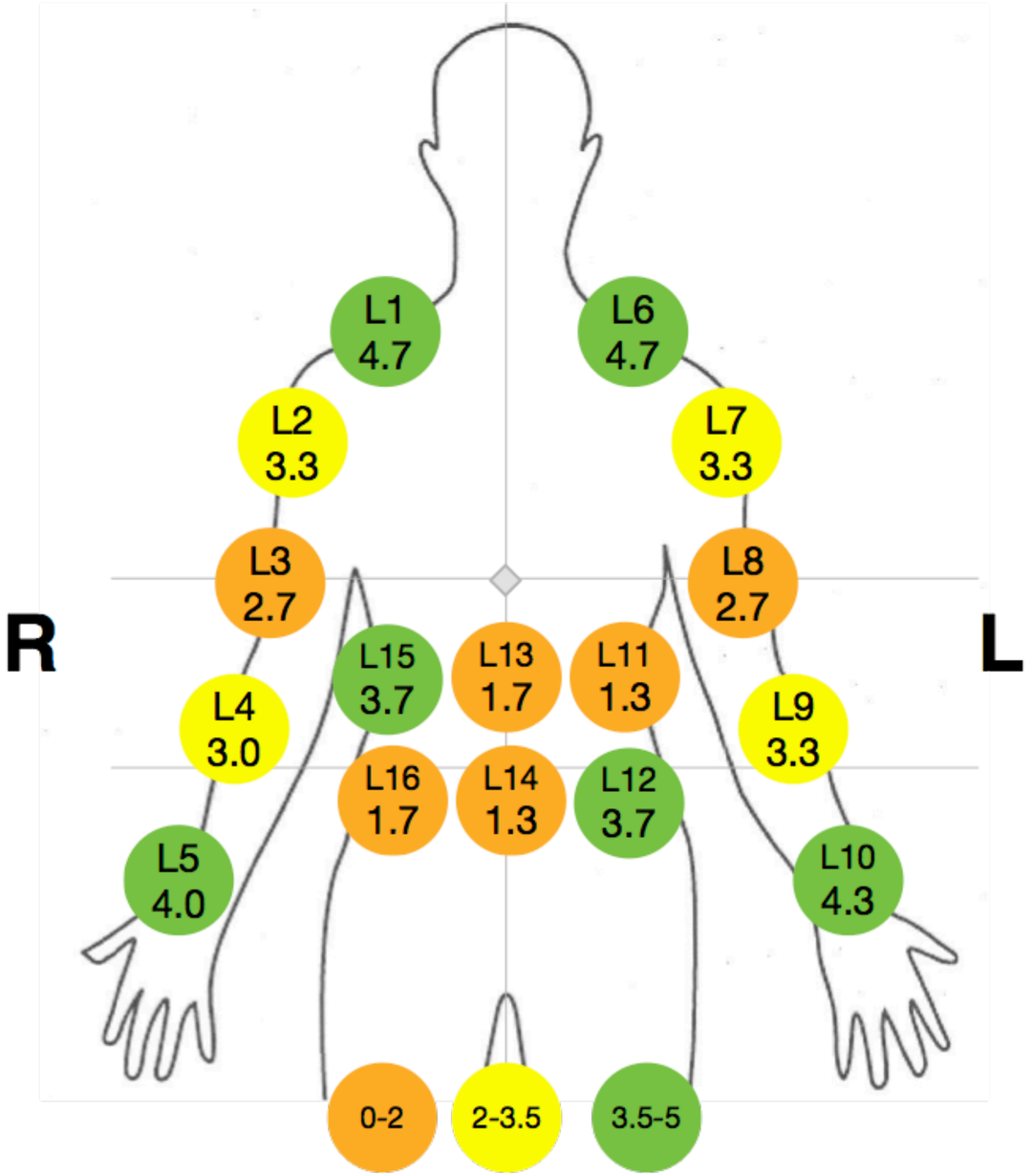
CHAPTER 4

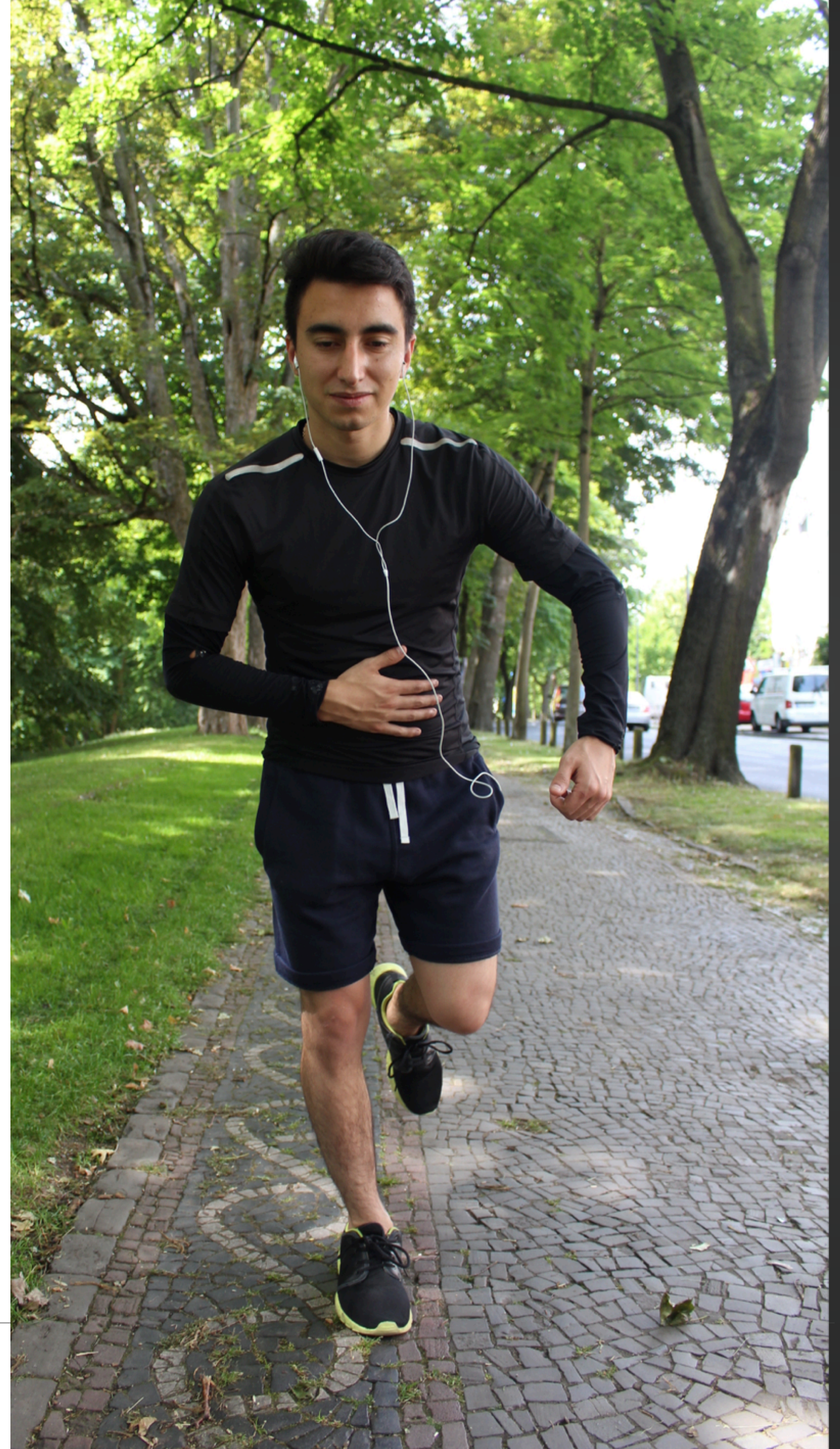
Conductive Embroidery Research Projects

Intuitex: Wearables and Furniture









Run&Tap: Investigation of On-Body Tapping for Runners

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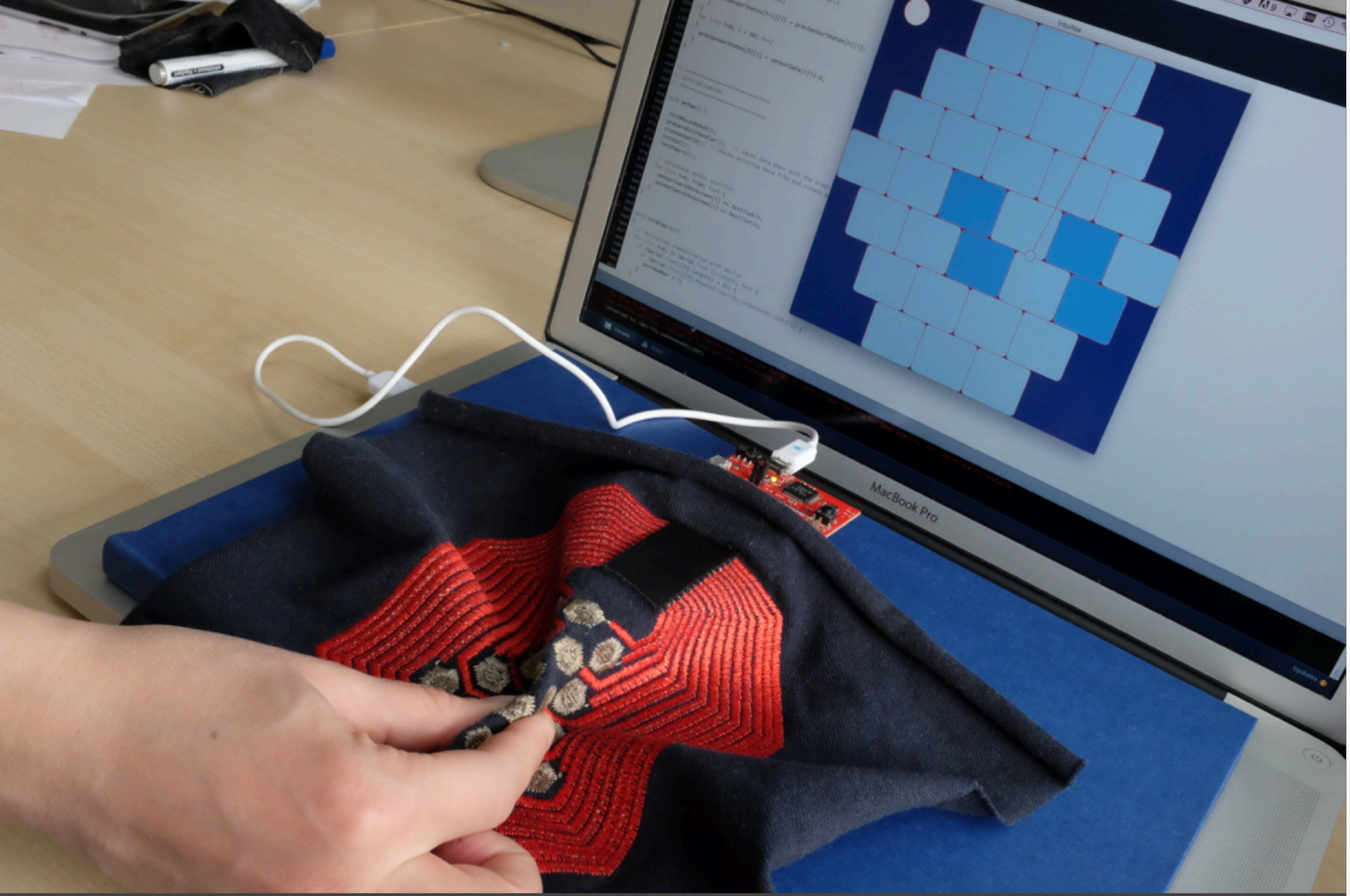
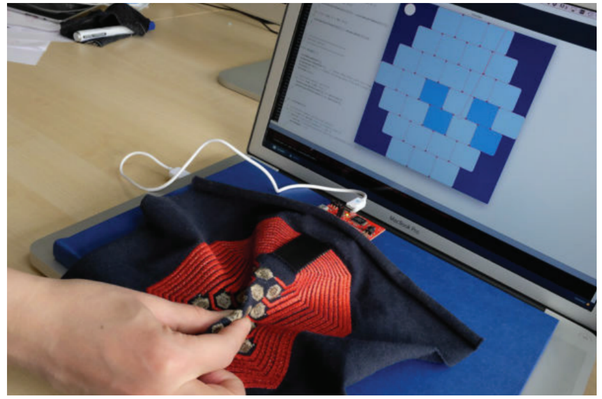
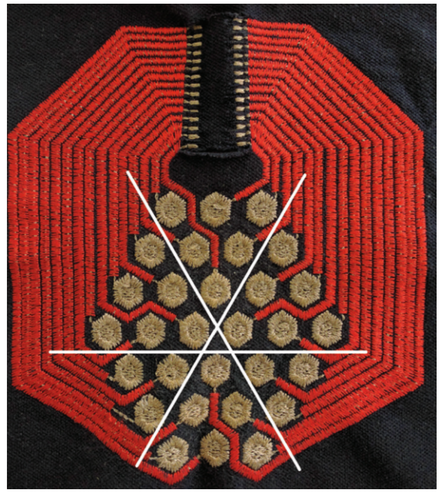


Grabbing at an Angle: Menu Selection for Fabric Interfaces

Grabbing at an Angle Experiments



- **Technique**: pinch angle; **interface**: pie/marking menu
- Experiment 1: Human performance: *how many angles can people distinguish eyes-free?*
  - IV: 5 angles, 6 fabrics; DV: deviation from angle, TLX, easiness and comfort
  - Result: 45 degree spacing, any of the fabrics, many ways o pinch
- Experiment 2: Sensor performance
  - Using random forest 85% accuracy rate (4 angles) 91% (2 angles)
  - Haptic affordances (can we increase the number of angles with physical textures?)



Whispering Neckless

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CHAPTER 4

Sketch&Stitch: Interactive Embroidery for E-Textiles - CHI2018

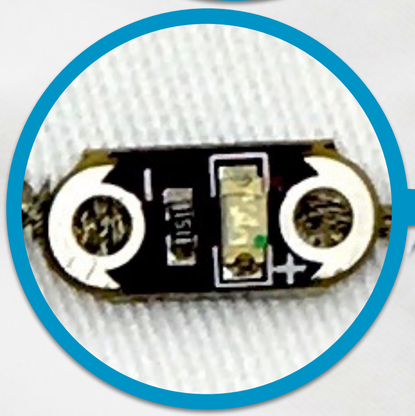
www.videoblocks.com

(The SoundShirt - CuteCircuit)

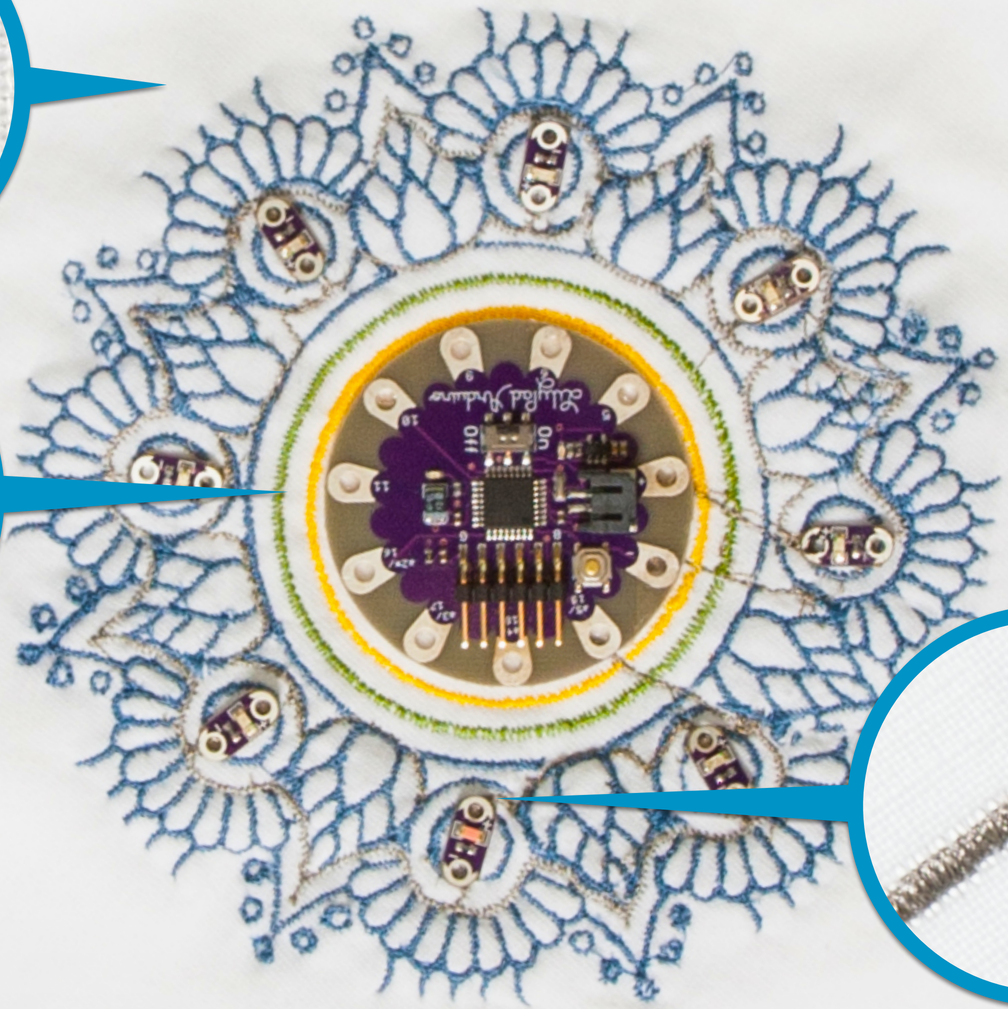
- *Dynamic*
- *Expressive*
- *Interactive*
- *Functional*

E-Textiles

Fabric



Integrated electronics



Conductive Thread

Creating e-textiles is tedious!

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E-Textile Creation Process

Design
Circuit & Art

Apply
Thread

Insulate
Traces

Attach
Hardware

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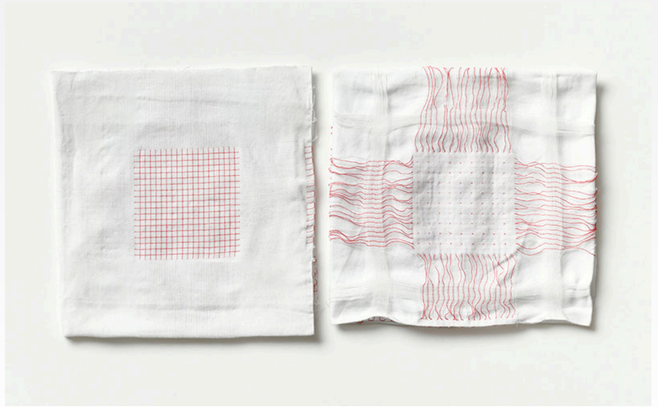
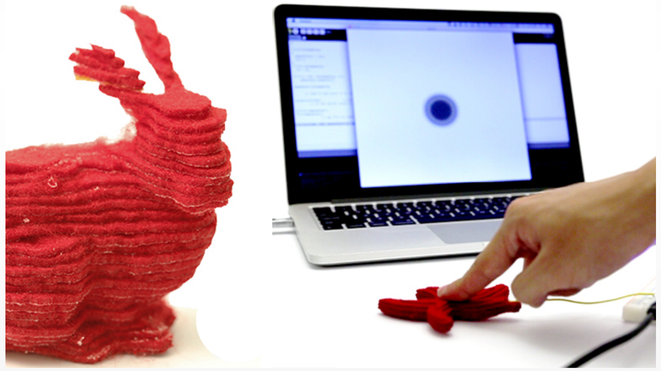
E-Textile Fabrication Techniques

(Post and Orth et al., IBM SYST J '00)



(Poupyrev et al., CHI '16)



(Peng et al., CHI '15)

(Buechley et al., Ubiquitous Comput. '09)

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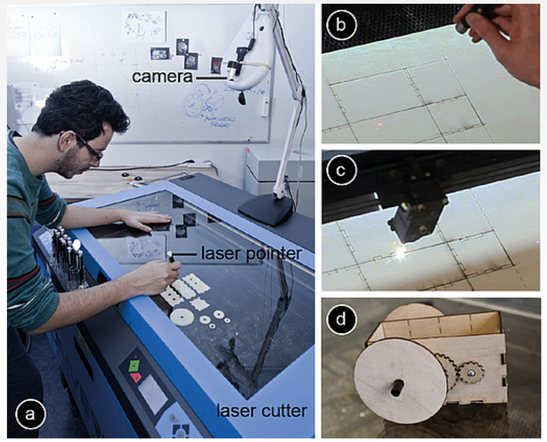
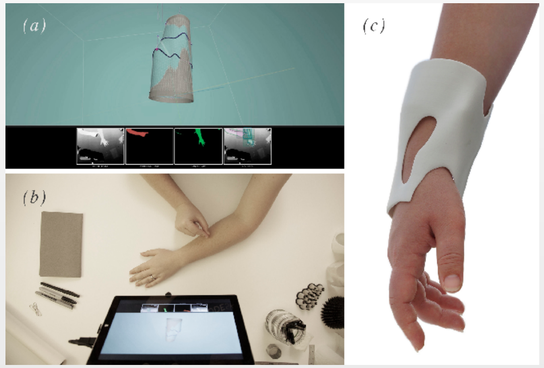
Other Interactive Fabrication Tools

(Willis et al., TEI '11)



(Mueller et al., UIST '12)

(Savage et al., UIST '15)



(Gannon et al., CHI '15)

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Interactive fabrication for e-textile

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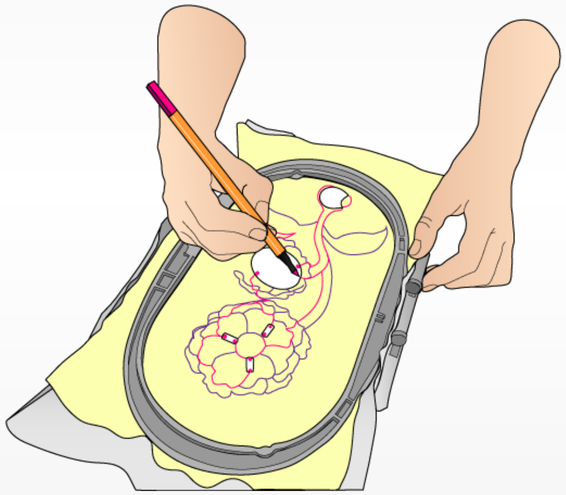
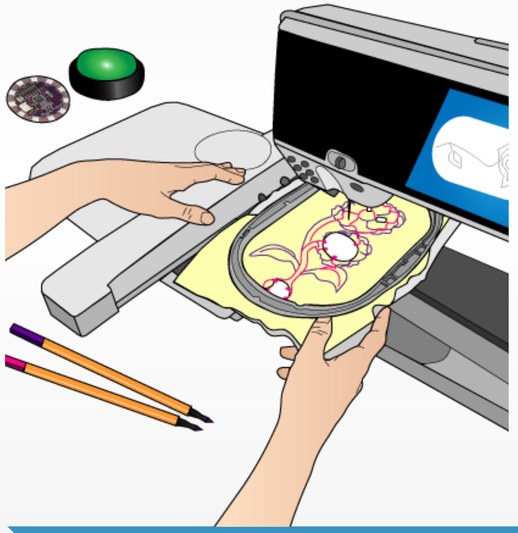
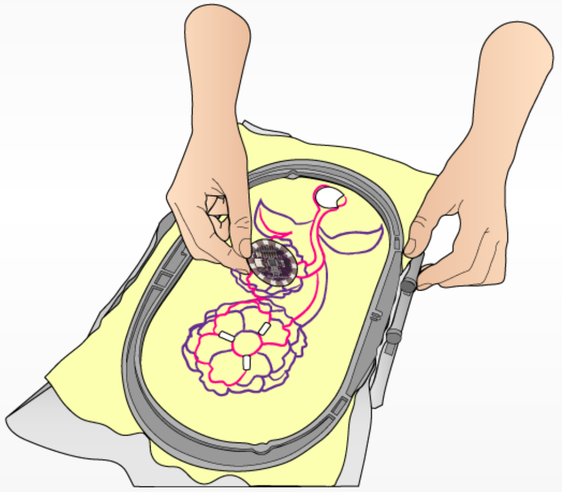
New Workflow



Design
Circuit & Art



Stitch



Attach
Hardware

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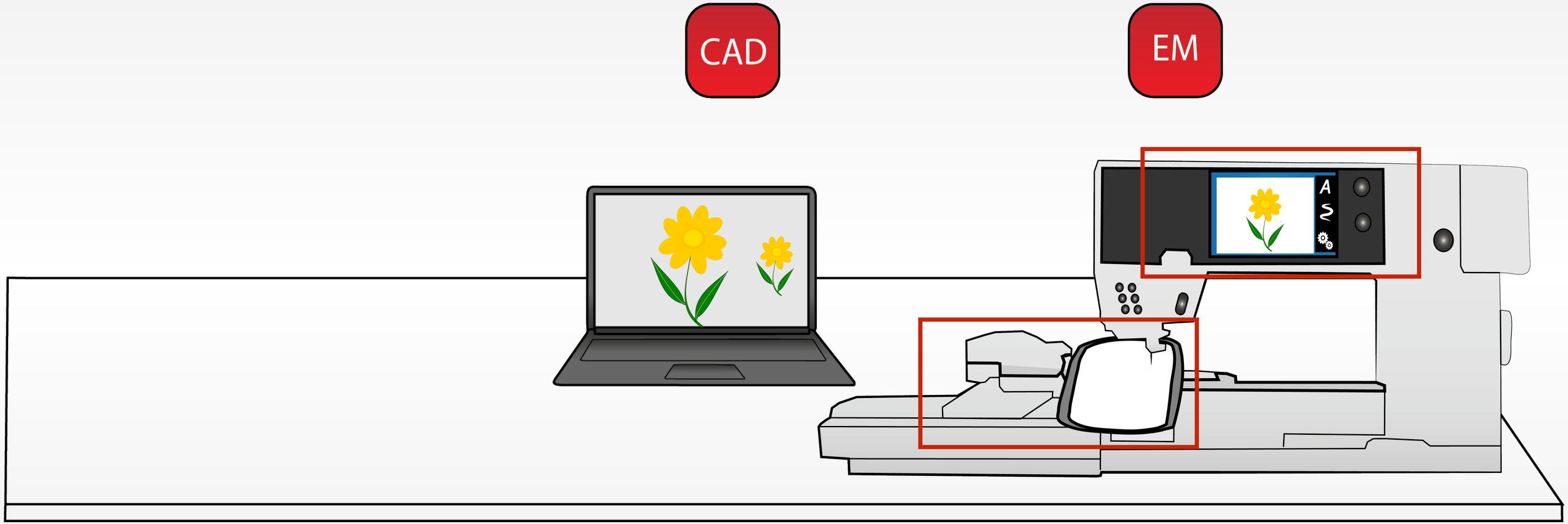
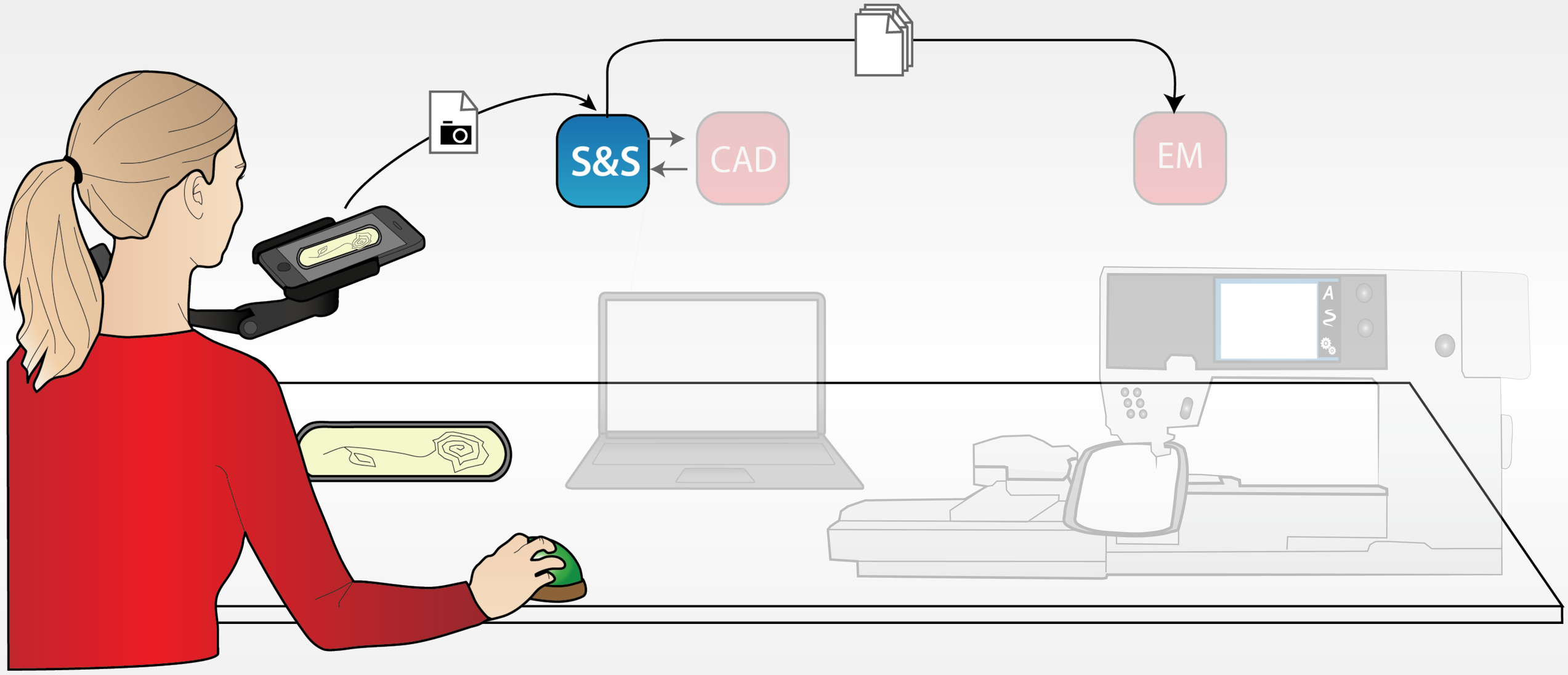
Embroidery Machine




S&S
CAD
EM

Design tools

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Colored Pens

Art Colors

Trace Color

Insulation Color

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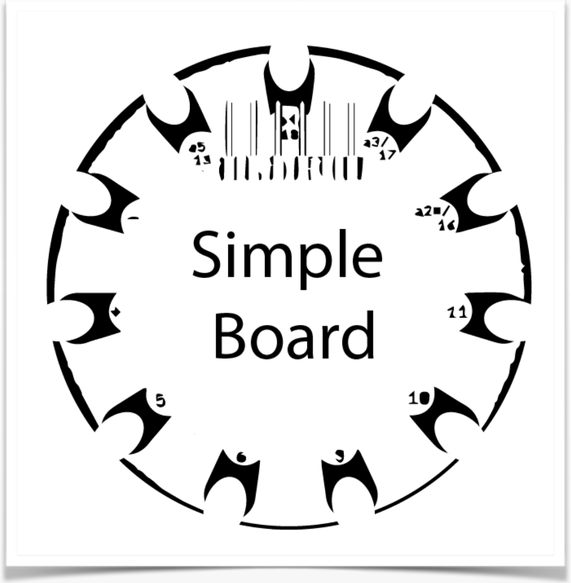
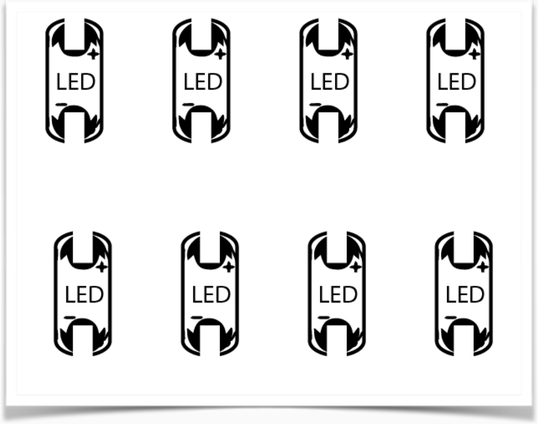
Challenges

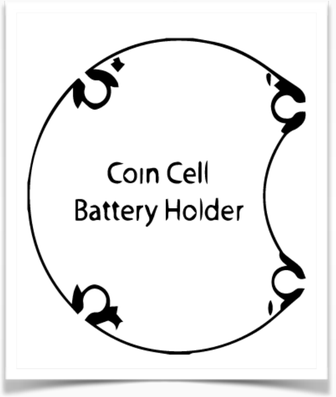
1. Presser foot clearance

2. Automatic tool path

Component Stickers







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Walkthrough

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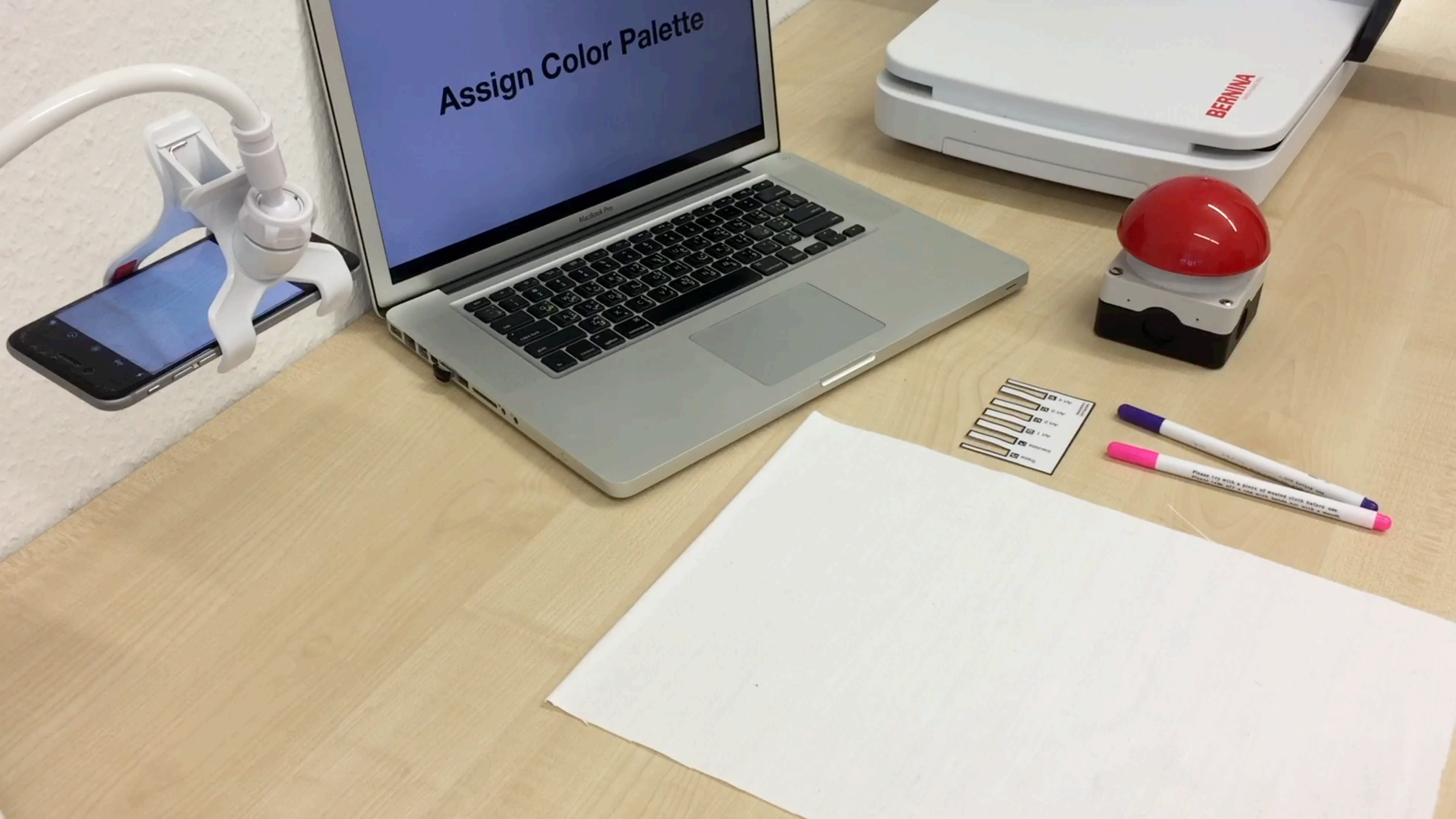
Assign Color Palette
MacBook Pro
BERNINA

What about more complex designs?

1. *Optimizing attachment*
2. *Insulation*
3. *Crossing traces*
4. *Interactivity*

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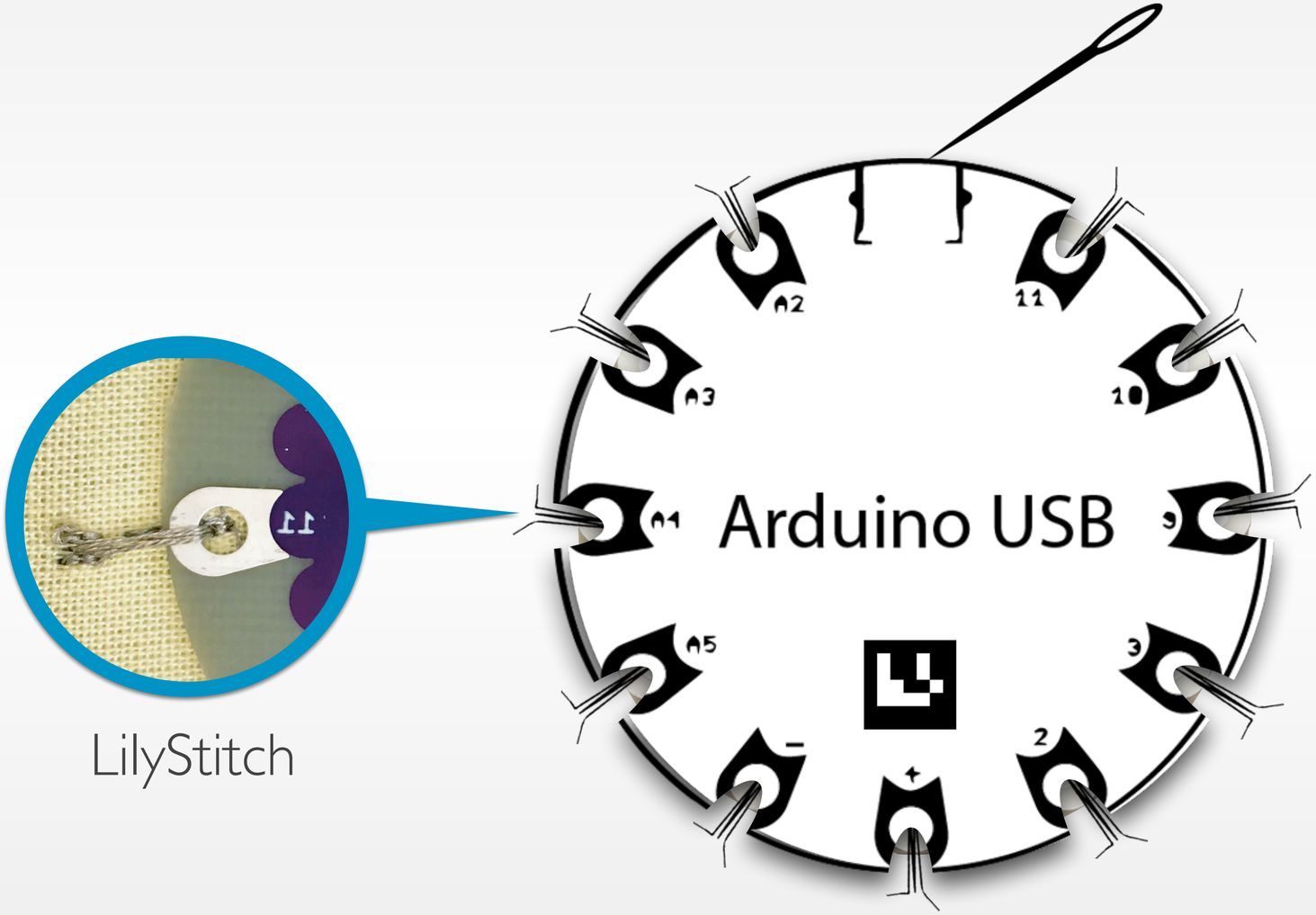
1. Optimizing Attachment



LilyStitch

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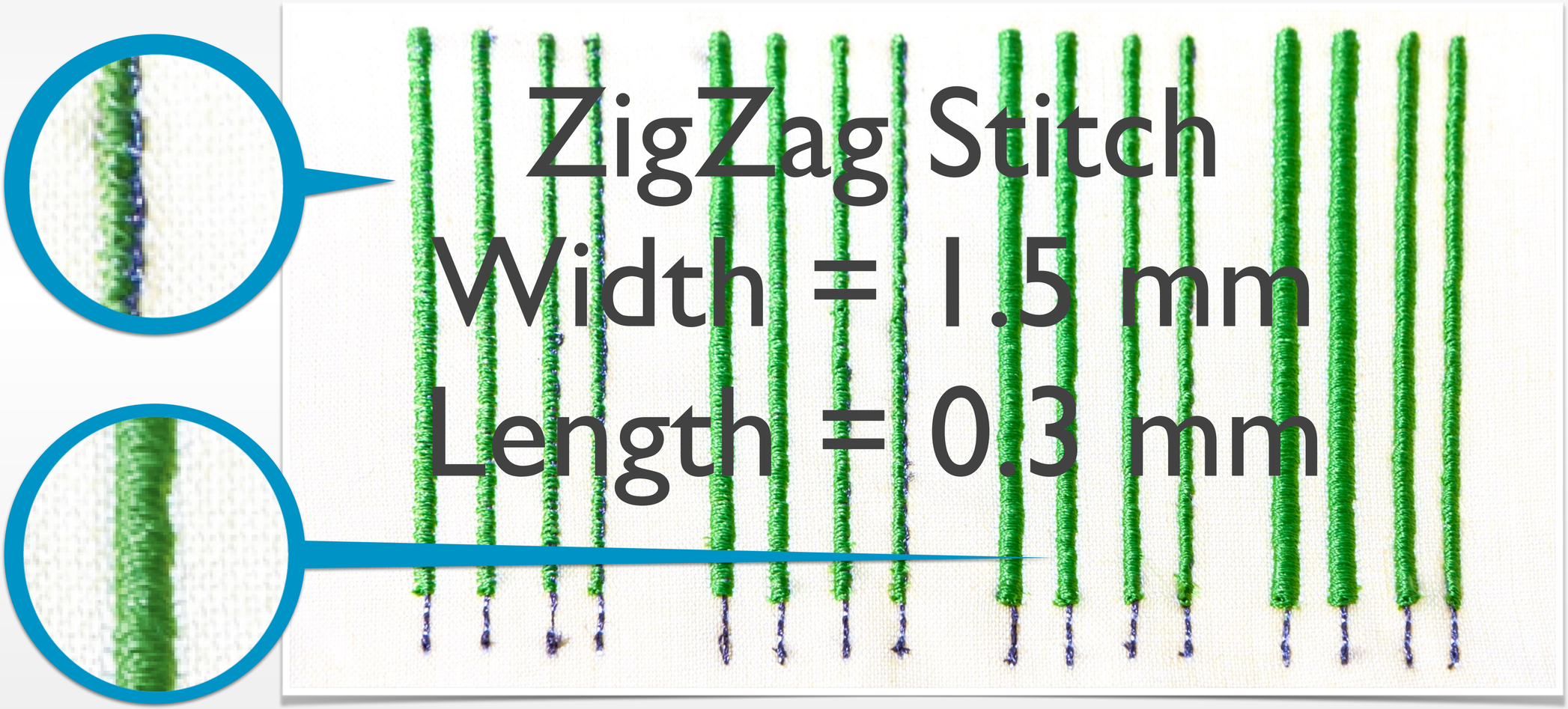
2. Insulation

Non-conductive thread

Conductive thread

Insulation Trade-offs



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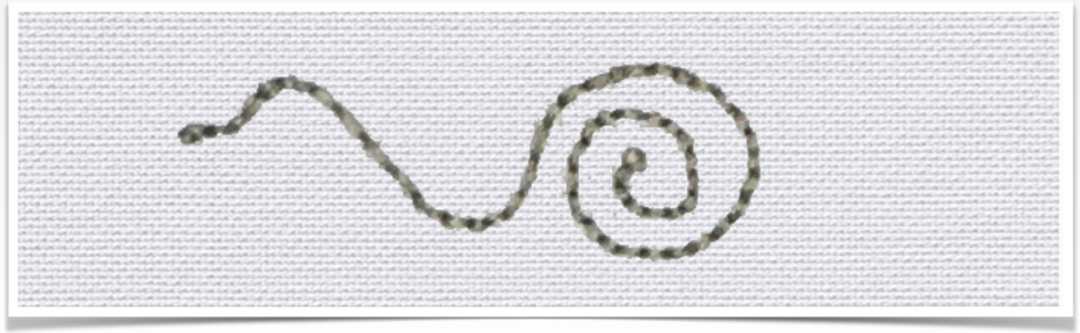
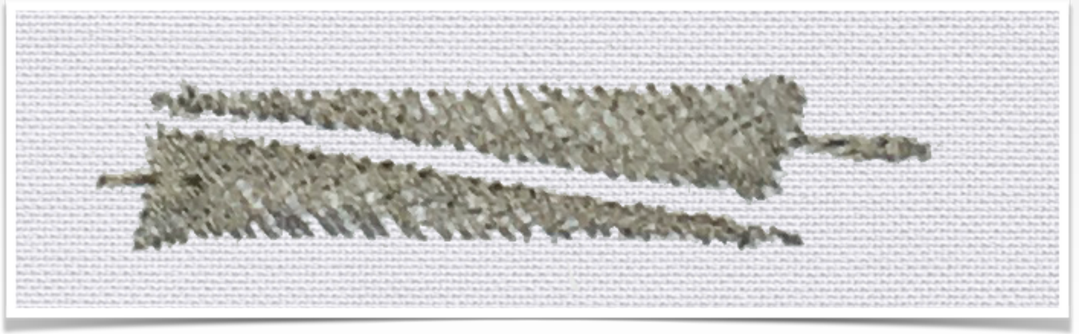
3. Handling Crossing Traces

BridgeStitch

4. Interactivity



Capacitive pushbutton



Capacitive slider

Resistive pushbutton

Resistive slider

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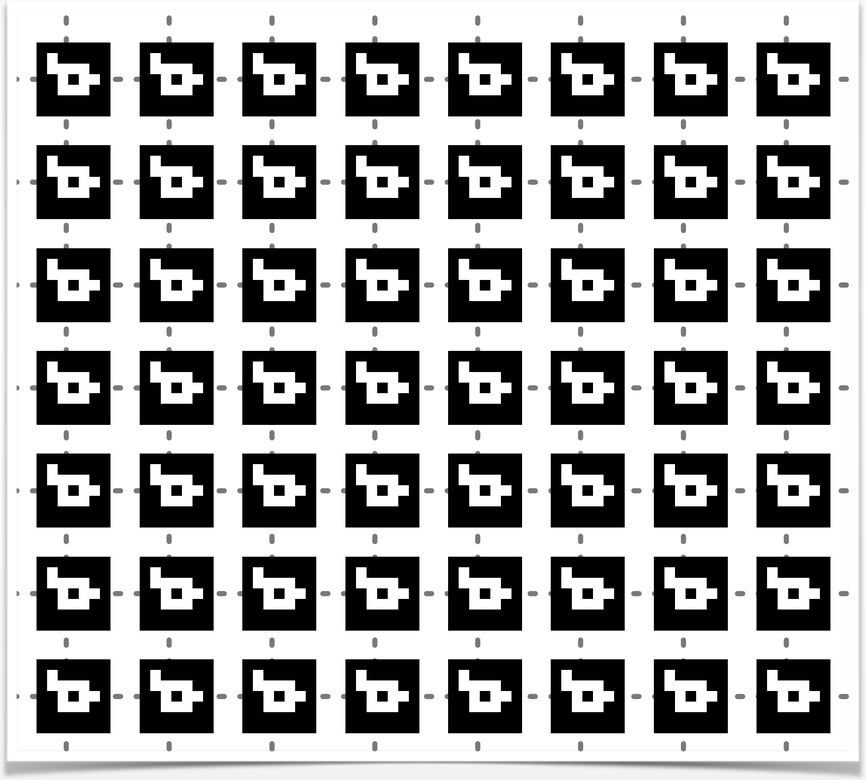
Sensor Sticker



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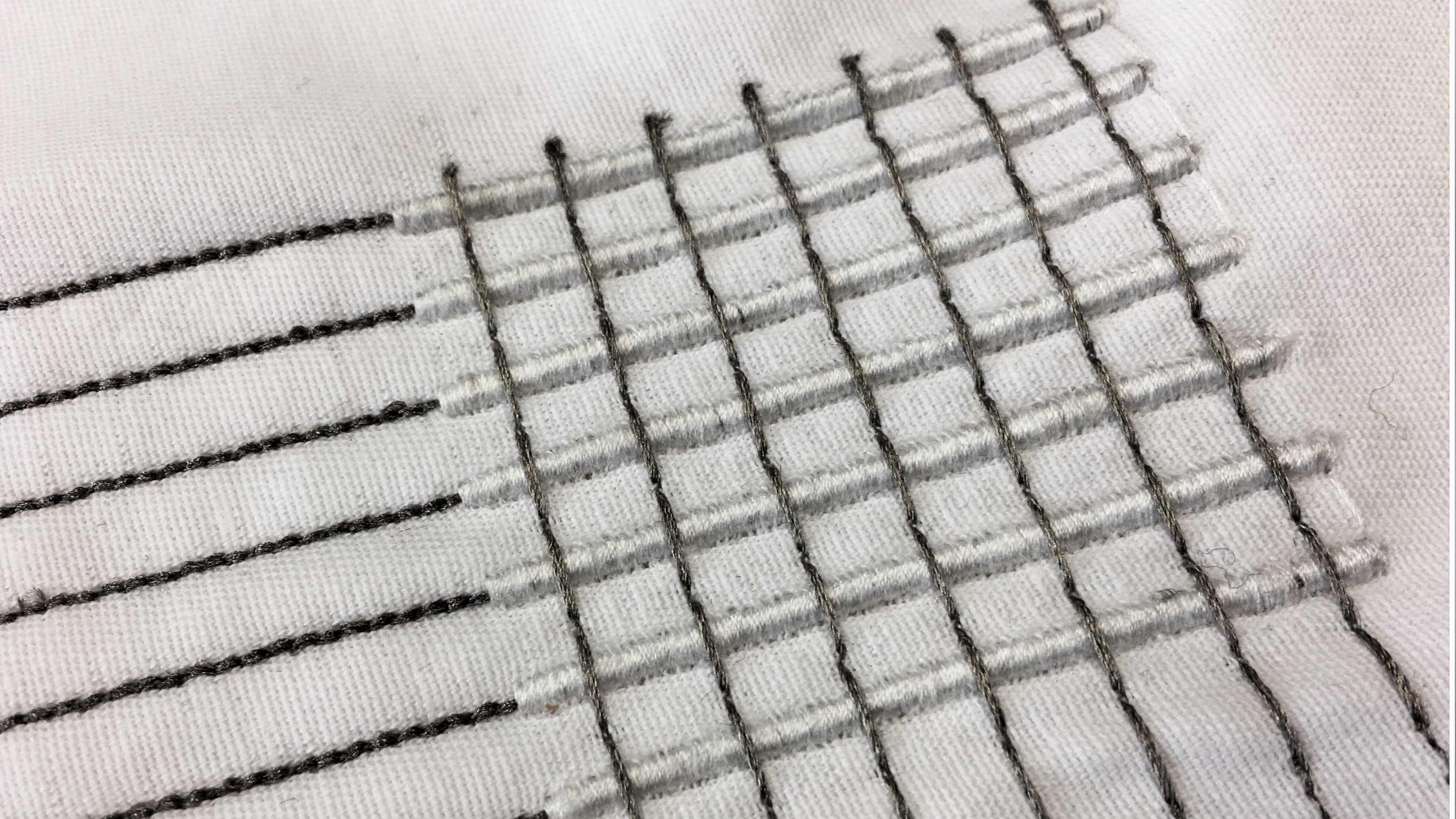
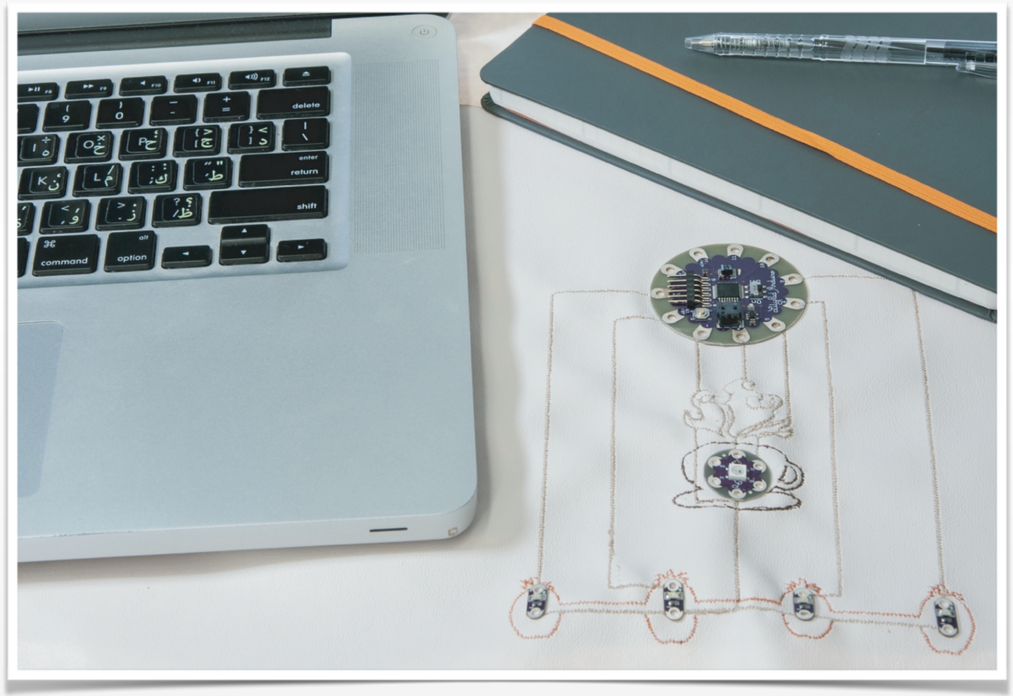


Example Applications



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One-Hour Nap Pillow

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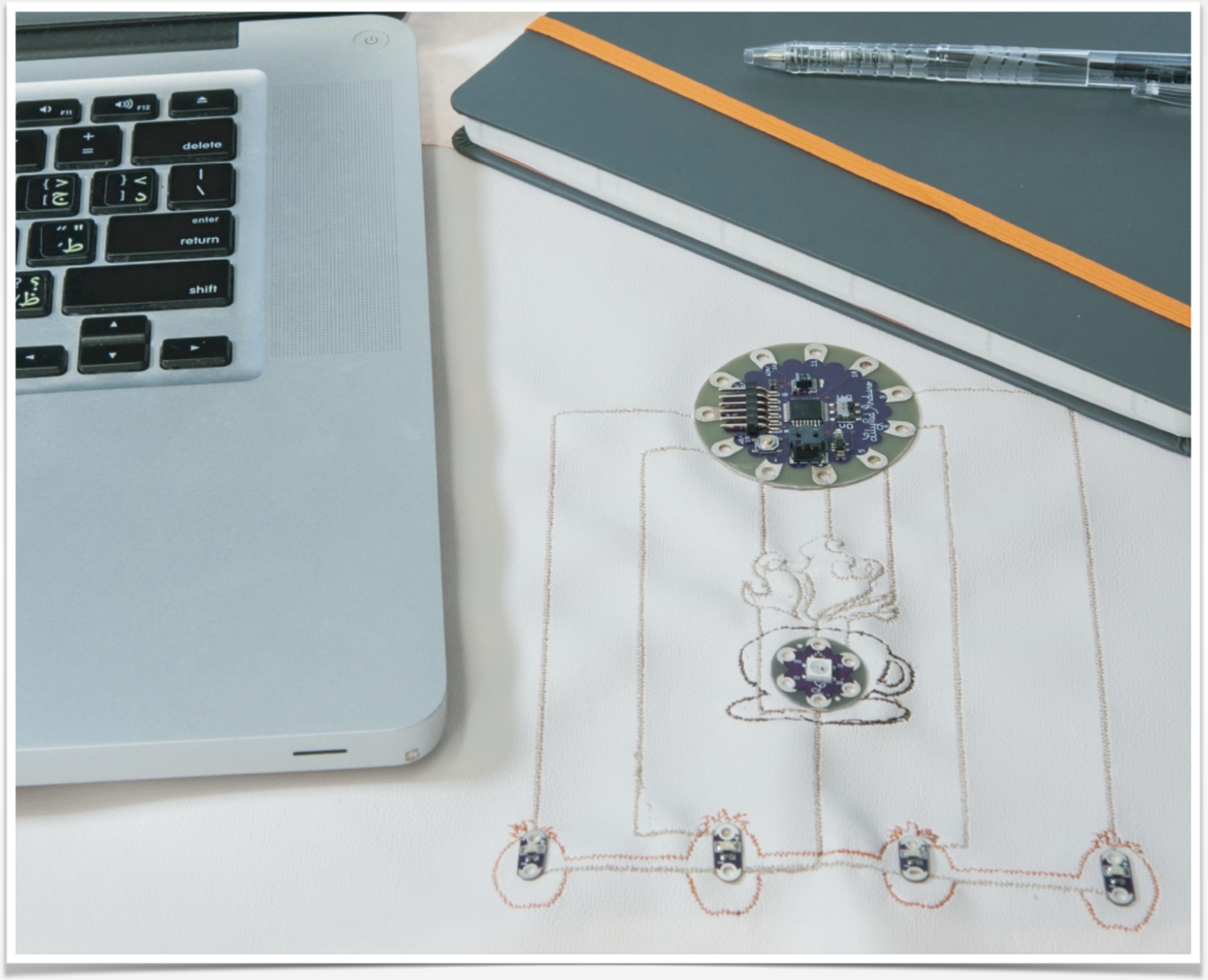
Sketching on fabric allowed

- *evaluating designs quickly and in context*
- *understanding the material and getting inspired by it*

Wearable Mandala

New emerging processes

- *Scribble on paper, commit on fabric*
- *Use stickers to frame the design*



Interactive Desk Mat

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