A RAPID TOUR OF MY
EXPLORATIONS IN E-TEXTILES
"Joy is a well-made object, equaled only to the joy of making it."

- a Canadian Native American tribe saying, as quoted by Mark Faunfelder (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://cmsc386-f12.wikispaces.com](http://cmsc386-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 74,295 views and have been favorited 347 times (as of Jan 2014) including boardSight R/C 334 views, Passive Electric Gate 116 views, and more!
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/
Flutters in direction of sound

Source: IWSC2012
Electro-Mechanical Dress
Designer: Hussein Chalayan
T-Shirt Tetris

Source: http://youtu.be/dsi3bIHlKv4

YouTube User: Marc Kerger
What if…
our clothes revealed information about our exercise? How would this change the fitness experience? For good or bad?
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

- Total Run Time: 52:43
- Heart Rate: 132 bpm, 60-70% (Weight Control)
- Total Run Distance: 4.5 miles
- Current Running Pace: 9:37 min/mile
- Stop
- Pause
We created three prototypes, which differed in display technology, resolution, viewability, weight
CUSTOM FLEX PCB + LED MATRIX DISPLAY

24x6 = 144 “pixels”
MATERIAL EXPLORATIONS
PROTOTYPE #3

FLEX E-INK DISPLAY

32x16 = 512 “pixels”
SOCIAL FABRIC FITNESS

PILOT TESTS
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
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
“It made me run faster because my performance was on display”
Potential Dichotomy

Increased motivation vs. increased anxiety

SFF Externalizes Performance
What if... we translated the dynamics of lightweight social interactions that arose in social media to the physical world?

I LIKE THIS SHIRT
With Ladan Najafizadeh and Seokbin Kang

[CHI'14]
Jon Froehlich
Edit Profile

News Feed
Messages 20+
Events 1

GROUPS
- Arts District Hysters 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 20+
- Manage Your Groups
- Create Group
- Find New Groups

FRIENDS
- Washington, District... 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

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

James Fogarty
May be 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...
PEOPLE LIKE THIS SHIRT
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?”
BODYVIS PROTOTYPES

PROTOTYPE 1: MID-FI
Stuffed fabric organs
Heart rate Only
LEDs, EL-Wire
Arduino Uno

PROTOTYPE 2
Improved Anatomy
Heart rate, Breathing
LEDs
Lilypad Arduino

PROTOTYPE 3
Labeled, Removable Anatomy
Heart rate, Breathing, Digestion
LEDs, Sound, Touchscreen
Arduino Uno, Smartphone

PROTOTYPE 4: HI-FI
Added Organs (e.g., Bladder)
Heart rate, Breathing, Digestion
LEDs, Sound, Haptics, Touchscreen
Arduino BLE Mini, Smartphone
BODYVIS PROTOTYPES

PROTOTYPE 1
Stuffed fabric organs
Heart rate Only
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Added Organs (e.g., Bladder)
Heart rate, Breathing, Digestion
LEDs, Sound, Haptics, Touchscreen
Arduino BLE Mini, Smartphone
BODYVIS PROTOTYPES

BODYVIS: FOUR GENERATIONS

**PROTOTYPE 1**
- Stuffed fabric organs
- Heart rate Only
- LEDs, EL-Wire
- Arduino Uno

**PROTOTYPE 2**
- Improved Anatomy
- Heart rate, Breathing
- LEDs
- Lilypad Arduino

**PROTOTYPE 3**
- Labeled, Removable Anatomy
- Heart rate, Breathing, Digestion
- LEDs, Sound, Touchscreen
- Arduino Uno, Smartphone

**PROTOTYPE 4**
- Added Organs (e.g., Bladder)
- Heart rate, Breathing, Digestion
- LEDs, Sound, Haptics, Touchscreen
- Arduino BLE Mini, Smartphone
BODYVIS

HOW IT WORKS

HEART

Magnets

LEDs

Vibro-Motor

LUNGS

Magnets

Flexible LED Strips

STOMACH

Samsung Galaxy S4 Mini
BODYVIS
HOW IT WORKS

Magets

LEDs

Zephyr BioHarness 3
Physiological Sensor

Magnets

Flexible LED Strips

Samsung Galaxy S4 Mini

STOMACH

LUNGS
**BODYVIS**

**SENSING SYSTEM**

**ZEPHIR 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
BODYVIS INTERACTIONS
Actively Engaging Body
UNEXPECTED FINDING

How Does It Work?
How can we...

enable young children to build their own interactive wearables?

STEAM EDUCATION

MAKERWEAR

With Majeed Kazemitabaar and many others
MAKERWEAR INTRODUCTION
CURRENT WEARABLE TOOLKITS

**EMBEDDED PROGRAMMING**

**BASIC CIRCUIT & ELECTRONICS KNOWLEDGE**

**MANUAL SKILLS LIKE SEWING / SOLDERING**
THE MAKERWEAR SYSTEM

https://github.com/MakerWear
1. Makerwear System

Tangible Modules
2. **MAKERWEAR SYSTEM**

**Magnetic Socket Mesh**
Provides power to all connected modules

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

**MODIFIERS**
Transform signals into other types of signals

**ACTIONS**
Translate signals into perceptual forms

**MISC**
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
“MOTION-REACTIVE CLOTHES”

Motion-reactive clothes!
“MOTION-REACTIVE CLOTHES”

Now with fade effect
MAKERWEAR EXAMPLES

“MOTION-REACTION CLOTHES”
“MOTION-REACTIVE CLOTHES”
MAKERWEAR EXAMPLES

“MOTION-REACTIVE CLOTHES”
We can create a diverse set of designs tangibly
MAKERWEAR EXAMPLES

“CHAMELEON CLOTHES”

- Power
- Distance Sensor
- Threshold
- Color Detector
- MultiColor Light
- MultiColor Light
- MultiColor Light
**“LASER TAG ARMBAND”**

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

When “hit” by IR beam, turns red.
“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.
MAKERWEAR WORKSHOPS
Highly engaged in making
Wide variety of designs
Applied computational thinking
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%
SUPER NINJA
Maker: Daniel, Age 7
9 modules: 5 actions, 2 misc, 1 sensor
2 socket meshes
2 lo-fi pieces

“UPPER CUT” ARMBAND
Blue Light
MultiColor Light
Light Bar
Wire Start
Impact Sensor
Power

“NINJA” BELT
Spinner
Red Light
Wire End
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
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
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
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

Wire Connection
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