ABOUT ME

- Engineer, entrepreneur, advocate
  - Women Who Code
- Heavy Research Background
- Telepresence
  - Sensor Optimization
    - Simulations
      - Virtual/ Augmented Reality
    - AI & Computer Vision
ABOUT ME

▸ Engineer, entrepreneur, advocate

▸ Women Who Code
  ▸ Over 80,000 women globally
  ▸ Over 20 Countries
3 Years of Women Who Code Atlanta
WOMEN WHO CODE ATLANTA

- Beginner’s Dev Workshop
- AT&T Women in Tech Hackathon
- Global Village Project Career Day
- Ryan Cameron Leadership Academy Coding Workshop
- The Loft - Coding Internship for Girls
- Google Sandbox Atlanta
- Speakers Workshop
- Career Workshops
- Conference Scholarships
- DevNexus
- CONNECT.TECH
- Great Wide Open
- All Things Open
- Women Interactive Creative Technology Festival
- All the Nerdy Ladies Holiday Party
- International Women’s Day
- 1st All-Women Hackathon
ABOUT ME

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  ▸ Women Who Code

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      ▸ AI & Computer Vision
PROTOTYPING FOR IOT

OUR CONNECTED FUTURE?
LIFE IN 2025...

- Self regulating clothes based on external temperature and my meeting schedule (temperature of conference rooms and colleagues offices)
- Medicines dispersed on my real time health needs—measured using self-powered sensors on my skin
INTERNET OF THINGS

LIFE IN 2025 . . .

- My office furniture detects stress in the body and relieves by adjusting—monitors history of how long I’ve been sitting and reminds me to take a walk

- My meeting notes not only include action items but context information about meeting dynamics, contribution patterns, emotional response to decisions, etc.
WHAT IS THE INTERNET OF THINGS? (IOT)
HOW DO CONNECTED DEVICES WORK?
PROTOTYPING FOR IOT

CONNECTED DEVICES

- Hands-Free
  - Voice / gesture control
- Development Platform
  - 3rd party apps
  - API partners
  - Accessories
- Always-On
  - Low power consumption
  - Instant wake
  - Background working / sensing
- Attention-Getting
  - Less distracting when receiving alerts / reminders / messages
- Environment-Aware
  - GPS
  - Accelerometer
  - Compass
  - Camera
  - Microphone
  - Other Sensors
- Connected
  - Wi-Fi
  - 3G / 4G
  - Bluetooth
  - NFC

Source: MIT, KPCB.

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#openIoT #prototyping
TECHNOLOGIES POWERING THE INTERNET OF THINGS

- Networking
- Microcontrollers
- Sensors
- Cloud Computing & Big Data
- Auxiliary Technologies
  - Computer Vision
  - Augmented Reality
  - Machine Learning & Artificial Intelligence
PROTOTYPING FOR IOT

NETWORKING FOR IOT

Postscapes™
Tracking the Internet of Things

LTE Advanced
Cellular 4G / LTE
3G - GPS / GPRS
2G / GSM / EDGE, CDMA, EVDO
WEIGHTLESS
WIMAX
LICENSE-FREE SPECTRUM
DASH 7

InterPlanetary Network

WiFi
Bluetooth
UWB
Z-WAVE
ZIGBEE
6LoWPAN
NFC
ANT
RFID

IPV4 IPV6 UDP DTLS RPL Telnet MQTT DDS CoAP XMPP HTTP SOCKETS REST API
# Networking Comparison for Connected Devices

<table>
<thead>
<tr>
<th></th>
<th>Voice</th>
<th>Data</th>
<th>Audio</th>
<th>Video</th>
<th>State</th>
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<tr>
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<td>Y</td>
<td>N</td>
<td>N</td>
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<tr>
<td>BLE</td>
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<td>N</td>
<td>Y</td>
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<td>Wi-Fi</td>
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<td>Y</td>
<td>Y</td>
<td>N</td>
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<tr>
<td>Wi-Fi Direct</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
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<tr>
<td>ZigBee</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>ANT</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
</tbody>
</table>

**State:**
- Low bandwidth
- Low Latency
- Low Power Data

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TECHNOLOGIES POWERING THE INTERNET OF THINGS

- Networking
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PROTOTYPING FOR IOT

OPEN SOURCE MICROCONTROLLERS

- Arduino Yún ($70)
- Arduino Lilypad ($22)
- BeagleBone Black ($54.95)
- Particle Photon ($19)
- Particle Electron ($39)
- Tessel 2 ($35)
PROTOTYPING FOR IOT

TECHNOLOGIES POWERING THE INTERNET OF THINGS

- Networking
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We are giving our world a digital nervous system. Location data using GPS sensors. Eyes and ears using cameras and microphones, along with sensory organs that can measure everything from temperature to pressure changes.
COMMON SENSORS USED IN CONNECTED DEVICES

- acceleration
- water leaks
- sound
- temperature
- light
- orientation
- natural frequency
- proximity
WHERE TO GET SENSORS

- Spark Fun
- Particle
  - Several included with Maker Kit
- Tessel
  - Sold separately as modules
PROTOTYPING FOR IOT

TECHNOLOGIES POWERING THE INTERNET OF THINGS

› Networking
› Microcontrollers
› Sensors
› Cloud Computing & Big Data
› Auxiliary Technologies
   › Computer Vision
   › Augmented Reality
› Machine Learning & Artificial Intelligence
OPEN SOURCE CLOUD SOLUTIONS FOR IOT

- OpenStack - (IaaS)
- OpenShift from RedHat - (PaaS)
- Apache CloudStack - (IaaS)
  - Java based
- Open Nebula (IaaS)
- Particle Cloud Platform (PaaS)
  - Over the air device updates
  - Rest API
  - Secure, scalable, real-time messaging
OTHER SOFTWARE TOOLS

- Eclipse IoT
  - Provides open source implementations for IoT protocols such as CoAP, ETSI SmartM2M, MQTT or LwM2M.
- Huginn
  - Open source, rails-based “IFTTT”
- SiteWhere
- Contiki - Open Source OS for IoT
TECH CHALLENGES

- Connectivity & Processing vs Power Consumption
- Fragmentation
- Privacy and Security

One does not simply build the Internet of things
SECURITY GUIDELINES

▸ Understand your vulnerabilities
▸ Build security from the ground up
▸ Start with the OS
▸ Build an End-to-End Security Solution
PROTOTYPING FOR IOT

SECURITY RECOMMENDATIONS FOR SOFTWARE DEVELOPERS

▸ Use updated APIs/ frameworks/ protocols
▸ Secure APIs should be used to strengthen applications
▸ Ex: TrueVault healthcare APIs for HIPAA reqs
▸ Proactively test your apps
▸ Be aware of security flaws
▸ Use secure enterprise infrastructure to store and distribute software
▸ Be aware of industry-specific risks and guidelines
DDOS ATTACK OCTOBER 2016

- Ensure all default passwords are changed to strong passwords. (Default usernames and passwords for most devices can easily be found on the Internet, making devices with default passwords extremely vulnerable.)

- Update IoT devices with security patches as soon as patches become available.

- Disable Universal Plug and Play (UPnP) on routers unless absolutely necessary.

- Purchase IoT devices from companies with a reputation for providing secure devices.
PROTOTYPING FOR IOT

DESIGN CONSIDERATIONS: SCREENS, TOUCH/POINTER
PROTOTYPING FOR IOT

DESIGN CONSIDERATIONS:
LOOK MA, NO SCREENS!
INTERACTION MODELS

CLI
- Command Line Interface
- Static
- Disconnected (Abstract)
- High - Low
- Directed
- Recall

GUI
- Graphical User Interface
- Responsive
- Indirect
- Double Medium
- Exploratory
- Recognition

NUI
- Natural User Interface
- Evocative
- Unmediated (Direct)
- Fast Few
- Contextual
- Intuition

OUI
- Organic User Interface
- Fluid
- Extensive
- Constant Zero
- Anticipatory
- Synthesis

INTERFACETYPES 
& THEIR CHARACTERISTICS
- DENNIS WIXON
PROTOTYPING FOR IOT

OUI INTERACTION MODEL

SMaG

Speech
- Voice
  - Subvocal
  - Tip
    - Pad
      - Knock
- Discrete Touch
- Continuous Touch
- Non-Deformation
- Deformation
- Tangibles
  - Pen/Laser/Stylus
  - Others
- Gestures
  - Hand
    - Eye
    - Facial
    - Body
  - Others

Manipulation
- Drawing
  - Handwriting
  - Two-handed
- In-hand
- Plastic-like
- Paper-like
PROTOTYPING FOR IOT

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In-hand
- Two-handed

Plastic-like
- Paper-like
- Fabric-like
- Clay-like
- Gel-like
- Liquid-like
VOICE INTERFACES: UNDERLYING COMPONENTS

- Recognition: Words, ASR
- Interpretation: Meaning, NLU
- Dialog: Appropriate Engagement
- Intelligence: Context, memory, knowledge

Hey watch – say something funny.

So these pants walk into a bar…
VOICE INTERFACES: UNDERLYING COMPONENTS

1. Recognition: Words
   - ASR
2. Interpretation: Meaning
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3. Dialog: Appropriate Engagement
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Initiates AudioStream, captured by device

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VOICE INTERFACES: UNDERLYING COMPONENTS

Recognition
- Words
- ASR

Interpretation
- Meaning
- NLU

Dialog
- Appropriate Engagement

Intelligence
- Context, memory, knowledge

Initiates AudioStream, captured by device

Hey watch – say something funny.

Called on experiences shared by device and user.

So these pants walk into a bar...

The vision for your system will determine how you put these components together.
VOICE INTERFACES: BEST PRACTICES

When to use:

- Any use case where touch interaction is not desired and user's visual focus is low
  - In-car interaction and navigation
  - Eyes and hands are occupied
  - Medical environments requiring sterility
- Security
  - Powerful mechanism for identifying user
- Shared experiences
PROTOTYPING FOR IOT

OUI INTERACTION MODEL

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MANIPULATION BASED INTERFACES

- Natural real-world intuitive interactions (NUI)
  - 2 Main types
    - Deformable
    - Non-deformable
      - screen based touch
      - texting
      - tangible handling
MANIPULATION BASED INTERFACES: DEFORMABLE (OUI)

- Input interactions that users perform using freehand manipulations that change the shape of a deformable object or display

- Rely on skills users already have and use in real world activities
MANIPULATION BASED INTERFACES: BEST PRACTICES

▸ When to Use:

▸ Physical form compliments/ enhances function

▸ Precision/ accuracy is desired

▸ Public places where voice or gesture tracking would be difficult
MANIPULATION BASED INTERFACES: BEST PRACTICES

When to Avoid:

- Hands are likely occupied
- Driving/ Cycling
- Situations requiring sterility
  - Medical situations
- Serving/ Eating food
In 2D spaces, ensure at least a 15mm surface radius for interactive elements and at least 5mm between.

In 3D spaces, consider visual feedback (ex. depth) for movable elements.

Consider haptic feedback when visual feedback isn't available/desired.

Respond to every contact with immediate feedback and fluid transitions.

Enable basic, direct manipulation.

Avoid secondary controls, when possible.
PROTOTYPING FOR IOT

OUI INTERACTION MODEL

SMaG

Speech
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Gestures
- Hand
- Eye
- Facial
- Body
GESTURE BASED INTERFACES

- In-Air Gestures (OUI)
- Like Speech, one of the oldest forms of human-human communication
- Used to issue a command or communicate with devices
- Must design system to capture gestures
  - Hand movements
  - Facial Expressions
  - Body Motion
  - Eye Tracking
GESTURE BASED INTERFACES

- When to Use
  - Interaction with large displays
  - Situations requiring sterility

- When to Avoid
  - Public places
  - Interactions where errors can have life-threatening impact
GESTURE BASED INTERFACES: BEST PRACTICES

- Avoid time-based gestures as it delays power users
- Clearly communicate how to start and stop a gesture
- Handle false gestures, positive & negative
RECOMMENDED INTERACTION PATTERN: MICRO INTERACTIONS

Contained product moments that revolve around a single use case and have one main task.

TRIGGER > RULES > FEEDBACK > LOOPS & MODES
RAPID PROTOTYPING FOR IOT

- Mix of Design and Technology in Thinking and Making
- Fundamental to creating new features and products
- Applies even more to IoT, since hardware is usually involved
PROTOTYPING FOR IOT

BUILDING YOUR TEAM

- Overlapping skills in small, cross-functional team

- Skills/ Roles
  - UX/ UI
  - Software/Embedded Engineer
  - Electrical Engineer

- Hackathons great way to quickly build cross-functional teams
  - Look for hackathons focusing on IoT/ Wearables
PROTOTYPING FOR IOT

LEAN COLLABORATIVE PROCESS

Develop customer knowledge
- Interview customers
- Understand what they want
- Develop product hypothesis
- Devise minimal "lovable" product

Test the product hypothesis
- Light-weight tests
- Usability
- Accessibility
- Real-time monitoring

Iterate the product
- Agile teams
- Multi-disciplinary skills
- Rapid deployment
- Continuous delivery

learn

measure

build
PROTOTYPING FOR IOT

LEAN + DESIGN THINKING = DESIGN SPRINTS

Understand Define Diverge Decide Prototype Validate
PROTOTYPING FOR IOT

DESIGN SPRINTS EXPLAINED

day 1

understand

• who are the users
• what are their needs
• what is the context
• competitor review
• formulate strategy
PROTOTYPING FOR IOT

DESIGN SPRINTS EXPLAINED

**Day 1**
- Understand
  - who are the users
  - what are their needs
  - what is the context
  - competitor review
  - formulate strategy

**Day 2**
- Diverge
  - envision
  - develop lots of solutions
  - ideate
PROTOTYPING FOR IOT

DESIGN SPRINTS: CRITICAL PATH DIAGRAM

- Highlights the story most critical to the challenge at hand.
- Where does your customer start, where should they end up and what needs to happen along the way?
- Allows inspection of key inventive aspect much sooner in the prototyping process

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PROTOTYPING FOR IOT

DESIGN SPRINTS EXPLAINED

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day 3
decide
• choose the best idea
• storyboard the idea

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PROTOTYPING FOR IOT

DESIGN SPRINTS EXPLAINED

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day 3: decide
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day 4: prototype
- build something quick and dirty to show to users
- focus on usability not making it beautiful

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PROTOTYPING FOR IOT

DESIGN SPRINTS EXPLAINED

**day 1**
- **understand**
  - who are the users
  - what are their needs
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  - competitor review
  - formulate strategy

**day 2**
- **diverge**
  - envision
  - develop lots of solutions
  - ideate

**day 3**
- **decide**
  - choose the best idea
  - storyboard the idea

**day 4**
- **prototype**
  - build something quick and dirty to show to users
  - focus on usability not making it beautiful

**day 5**
- **validate**
  - show the prototype to real users outside the organisation
  - learn what doesn’t work

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PROTOTYPING FOR IOT

DESIGN SPRINT APPLIED TO CONNECTED DEVICE PROTOTYPING

Engineering

IxD

Identify potential design & component solutions

Breadboarding/ conceptual hardware testing

Develop use case / create user flows

Develop wireframes

UNDERSTAND

DEFINE

DIVERGE

DECIDE
IDENTIFYING POTENTIAL DESIGN & COMPONENT SOLUTIONS:
HARDWARE PROTOTYPING WITH FRITZING

- Open source electronic design automation software
- Aids in collaborating on designs with engineers and non-engineers alike
- Easy to create PCB layout and share with a manufacturer

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PROTOTYPING FOR IOT

DESIGN SPRINT APPLIED TO CONNECTED DEVICE PROTOTYPING

Engineering

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ixoD

UNDERSTAND
DEFINE
DIVERGE
DECIDE

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PROTOTYPING FOR IOT

DESIGN SPRINT APPLIED TO CONNECTED DEVICE PROTOTYPING

IxD Engineering

Understand

Define

Diverge

Decide

Identify potential design & component solutions

Breadboarding/conceptual hardware testing

Data Modeling

Develop use case / create user flows

Develop wireframes

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PROTOTYPING FOR IOT

DESIGN SPRINT APPLIED TO CONNECTED DEVICE PROTOTYPING

Engineering

IxD

UNDERSTAND

DEFINE

DIVERGE

DECIDE

LOW FIDELITY PROTOTYPE

Identify potential design & component solutions

Breadboarding/conceptual hardware testing

Data Modeling

Alpha prototype hardware & initial firmware

Develop use case / create user flows

Develop wireframes

Visual design / specification

Identify potential design & component solutions

Breadboarding/conceptual hardware testing

Data Modeling

Alpha prototype hardware & initial firmware

Develop use case / create user flows

Develop wireframes

Visual design / specification
Design Sprint Applied to Connected Device Prototyping

**Engineering**
- **Understand**
  - Identify potential design & component solutions
- **Define**
  - Breadboarding/conceptual hardware testing
- **Diverge**
  - Data Modeling
- **Decide**
  - Alpha prototype hardware & initial firmware
- **Low Fidelity Prototype**
  - Develop wireframes
- **UI Development**
  - Visual design / specification

**IxD**
- Develop use case / create user flows
- IxD Engineering

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PROTOTYPING FOR IOT

DESIGN SPRINT APPLIED TO CONNECTED DEVICE PROTOTYPING

UNDERSTAND
- Identify potential design & component solutions

DEFINE
- Develop use case / create user flows

DIVERGE
- Breadboarding/ conceptual hardware testing

DECIDE
- Develop wireframes

LOW FIDELITY PROTOTYPE
- Data Modeling
- Alpha prototype hardware & initial firmware

UI DEVELOPMENT
- Visual design / specification

VALIDATE

IxD

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PROTOTYPING FOR IOT

3D PRINTING FOR HIGH FIDELITY PROTOTYPES

- Use a decent 3D printer
  - <100 micron resolution, preferably 50 micron
  - prints numerous material types, including flexible materials

- Test Loop
  - Identify candidates for field testing.
  - Iterate and make any necessary physical design changes quickly.
APPLICATIONS OF CONNECTED DEVICE DESIGN SPRINT

- Hardware MVP
- Hackathons and hardware projects involving teams
- Adding features to an existing connected device
PROTOTYPING FOR IOT

QUESTIONS?

U HAVE A QUESTION

I HAVE AN ANSWER

MAYBE…