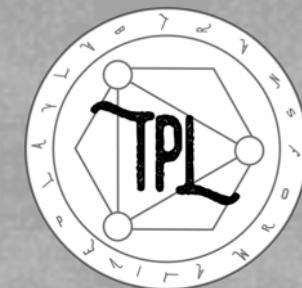




# Designing for Mixed Reality Play

Dr. Joshua Tanenbaum

Assistant Professor - Transformative Play Lab - Department of Informatics - UC Irvine





## A BIT ABOUT ME

- I have worked for Nokia and Intel
- I have a background in theater and music
- I was a professional singer with an Elizabethan Madrigal group
- I've written music for videogames and worked on videogame startups
- I've mixed sound in small nightclub venues for metal bands, in professional theaters, and in large corporate meetings
- I make steampunk costumes and props
- I briefly worked as a Tarot card reader for the Psychic Network
- I did my PhD in Vancouver BC at SFU in the School of Interactive Arts + Technology



# THE TRANSFORMATIVE PLAY LAB

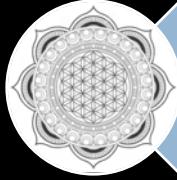
- I run a group called the Transformative Play Lab
- I collaborate with Karen Tanenbaum
- We look at identity, empathy, agency, and transformation in games (among other things)
- We use theories of method acting and performing arts for much of this work
- We also study maker & DIY subcultures in the context of HCI
- Much of our work involves the creation of playful new physical/digital hybrid systems



# Designing for Mixed Reality Play



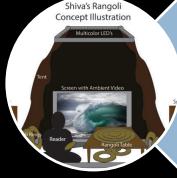
The Reading Glove



Phylactery

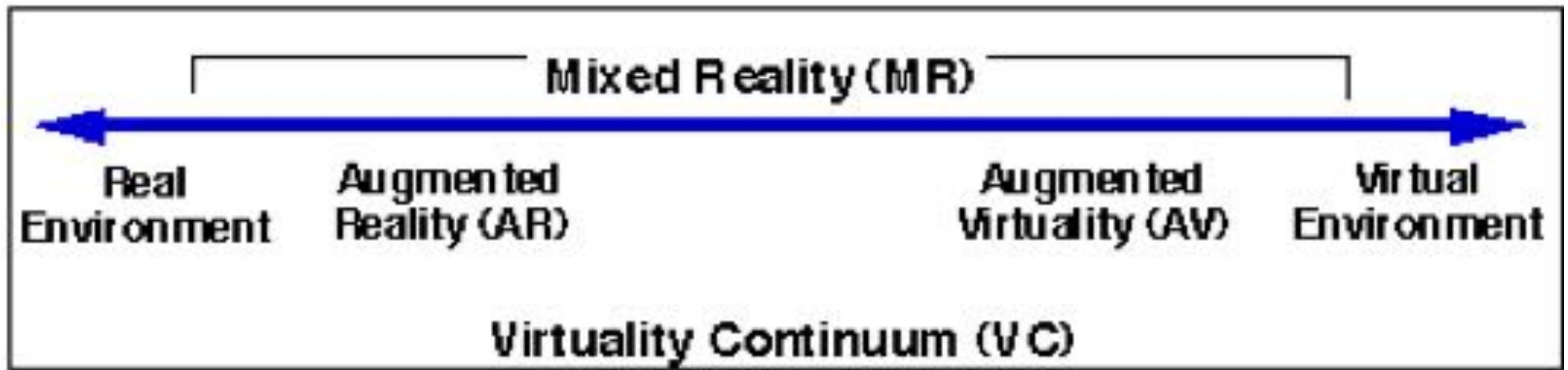


Magia Transformo



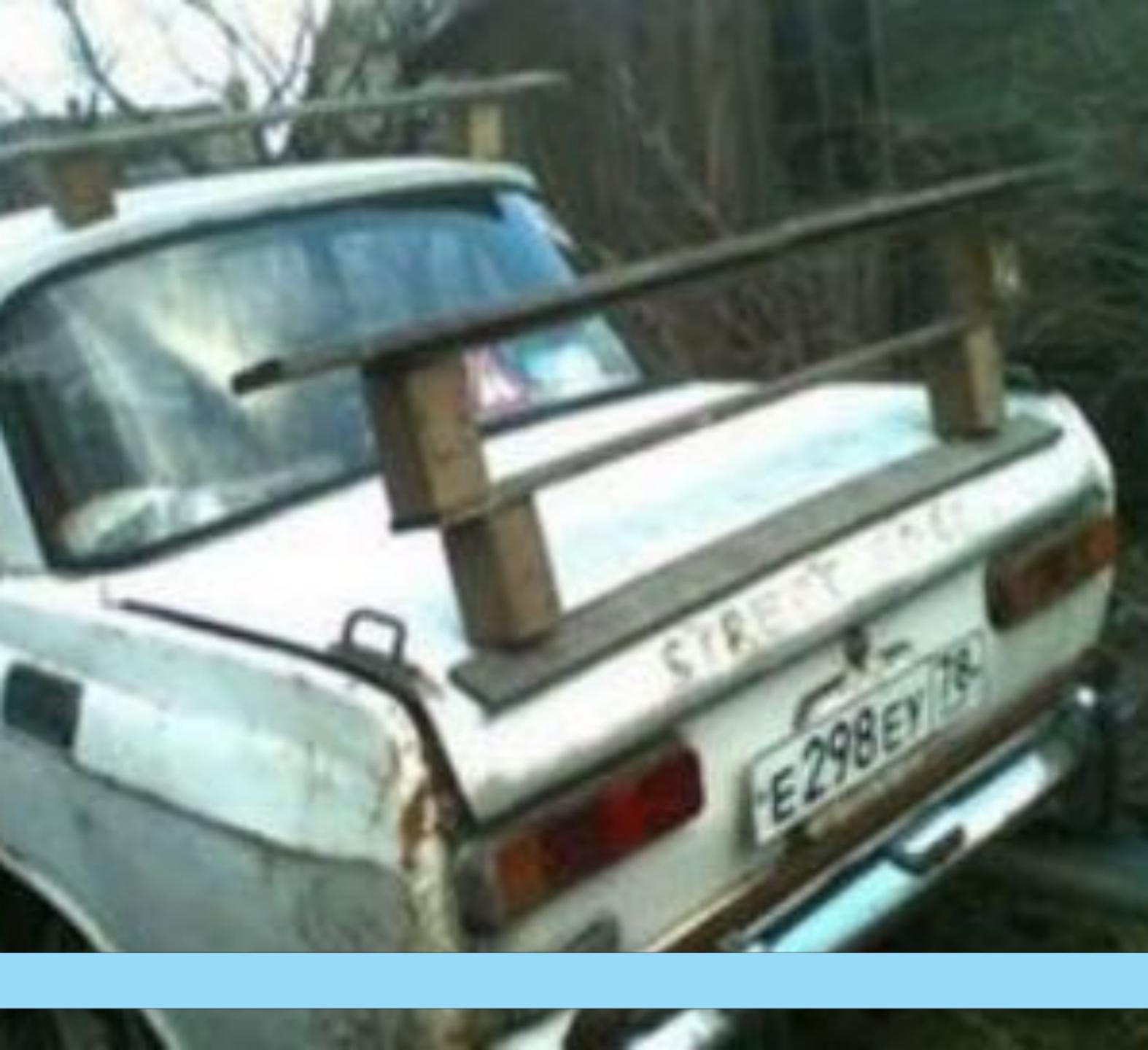
Shiva's Rangoli

# Mixed Reality?



from Milgram & Kishino (1994) *A Taxonomy of Mixed Visual Displays*





# Prototyping as “Bricolage”

- Levi-Strauss contrasts the work of the “*bricoleur*” against that of the engineer
- Bricolage is “devious” - it is the art of **hacking** together clever solutions with the materials at hand, rather than the art of formally designing and building
- It is the fine art of “jury-rigging”



# The Reading Glove

by  
Joshua & Karen Tanenbaum

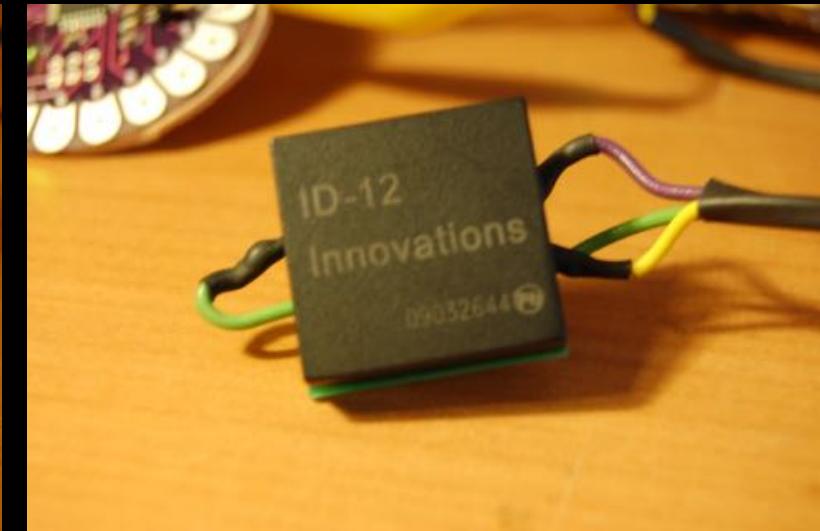
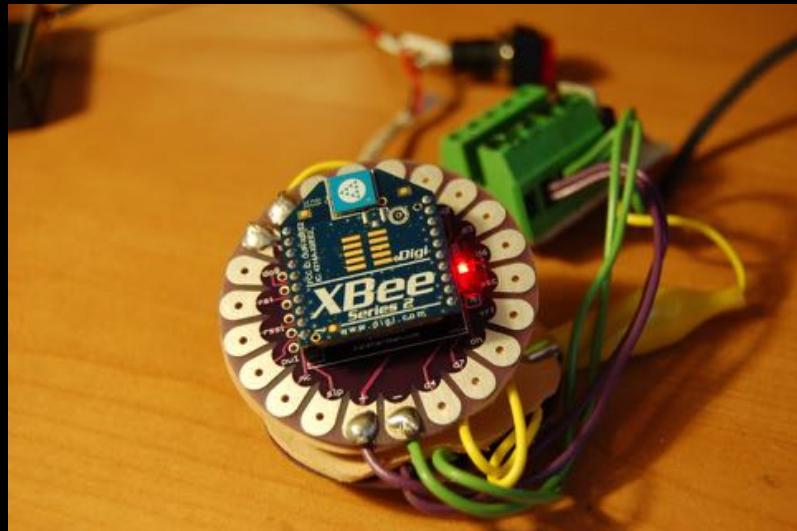
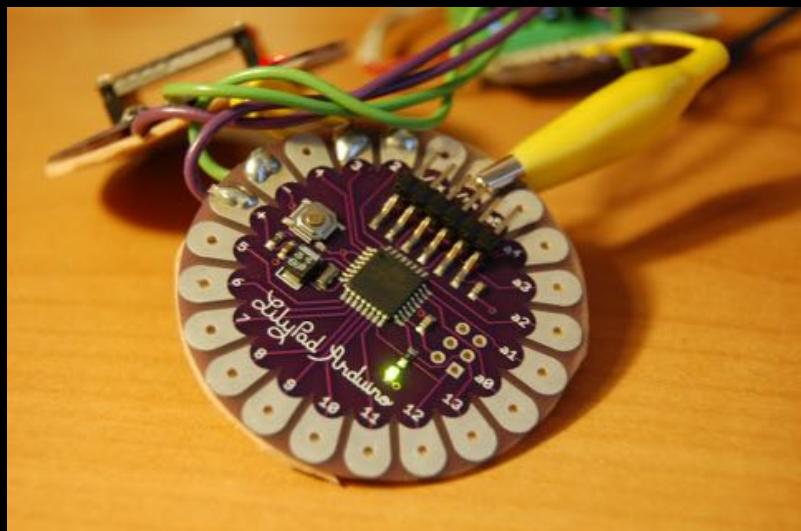


# Narrative Objects





# Glove Hardware

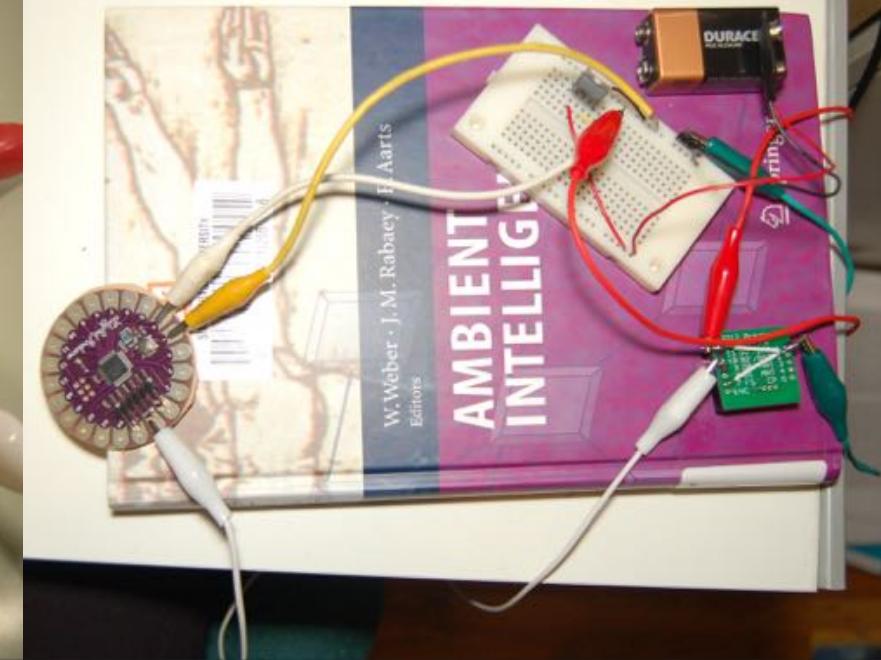
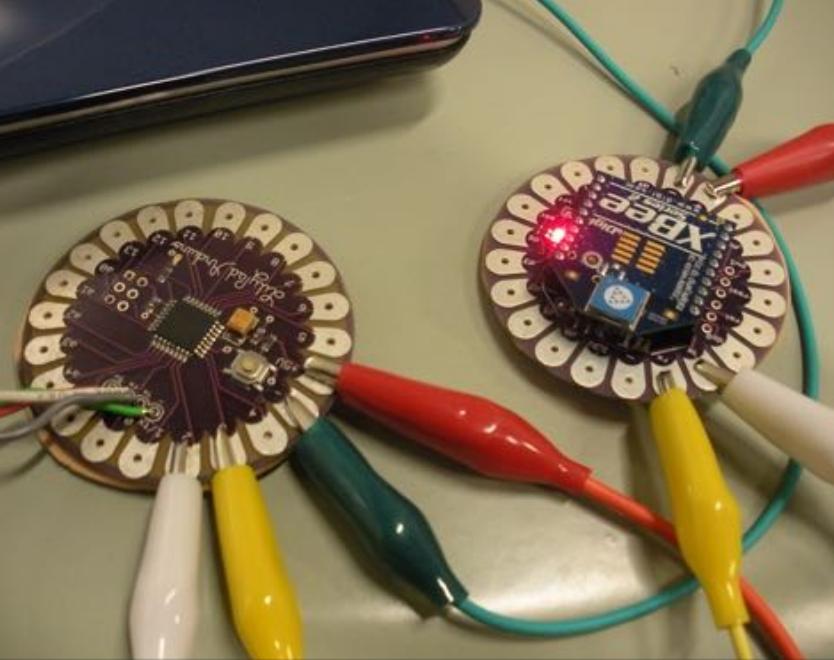
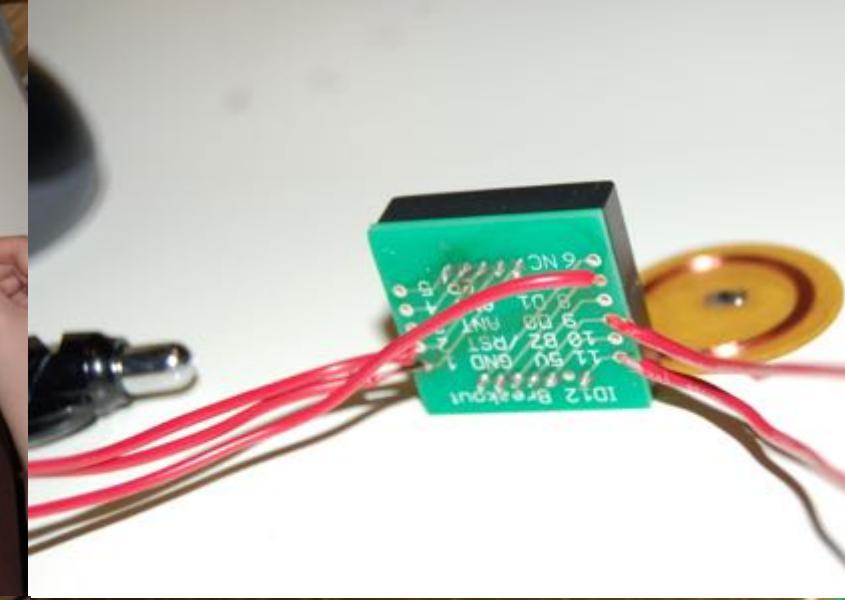
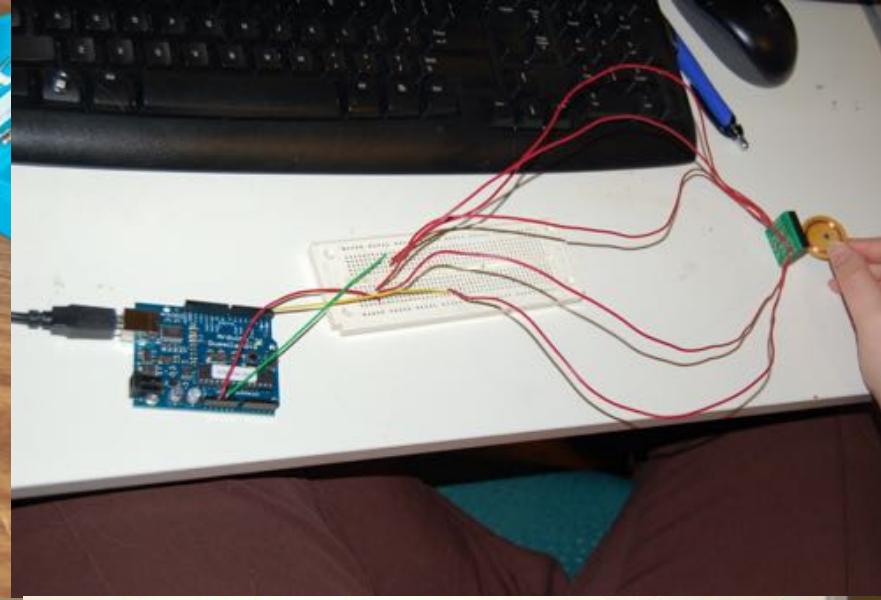


Off the shelf and hobbyist components (circa 2009)

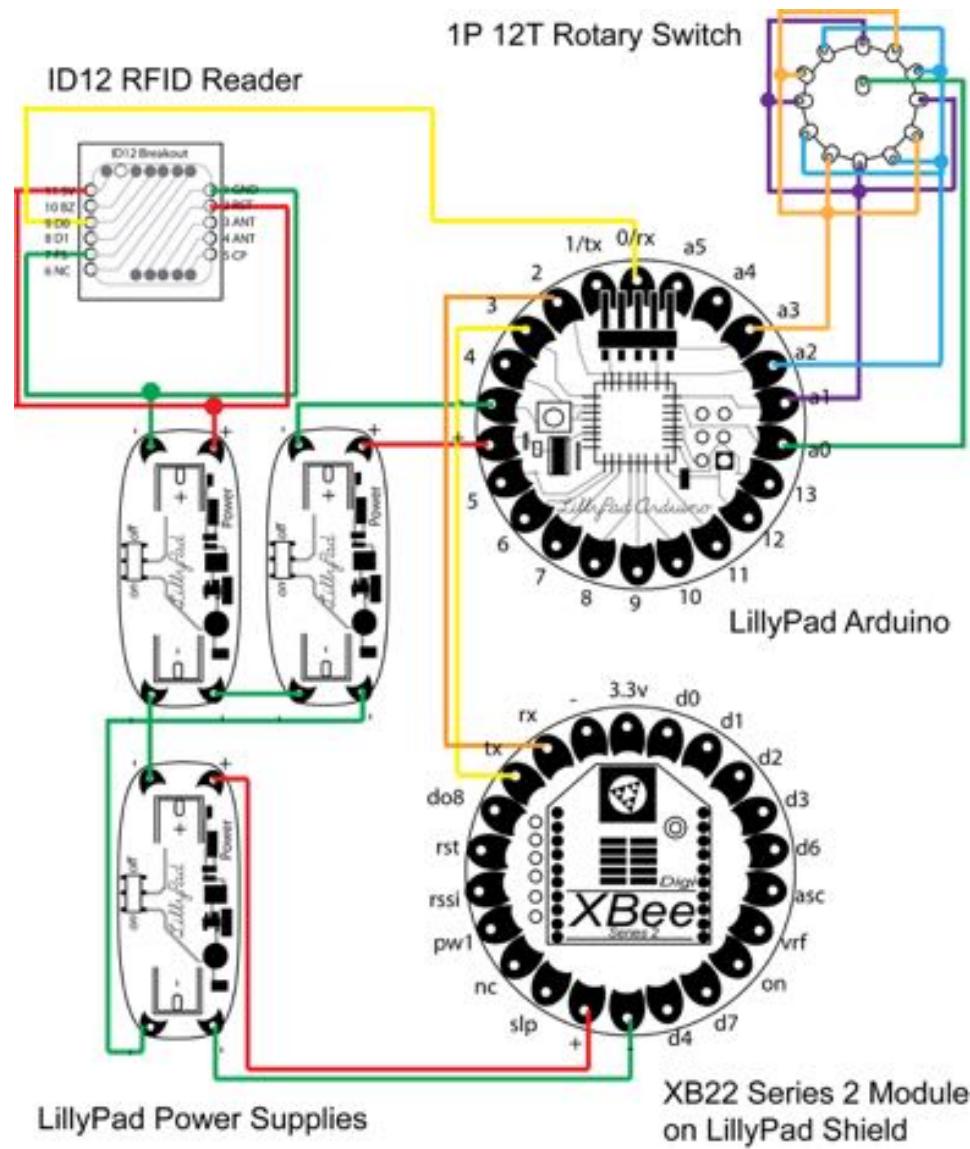
Sourced on SparkFun.com

Highly unstable!





# Early Prototyping



TUNE Glove Diagram

Iterative Design

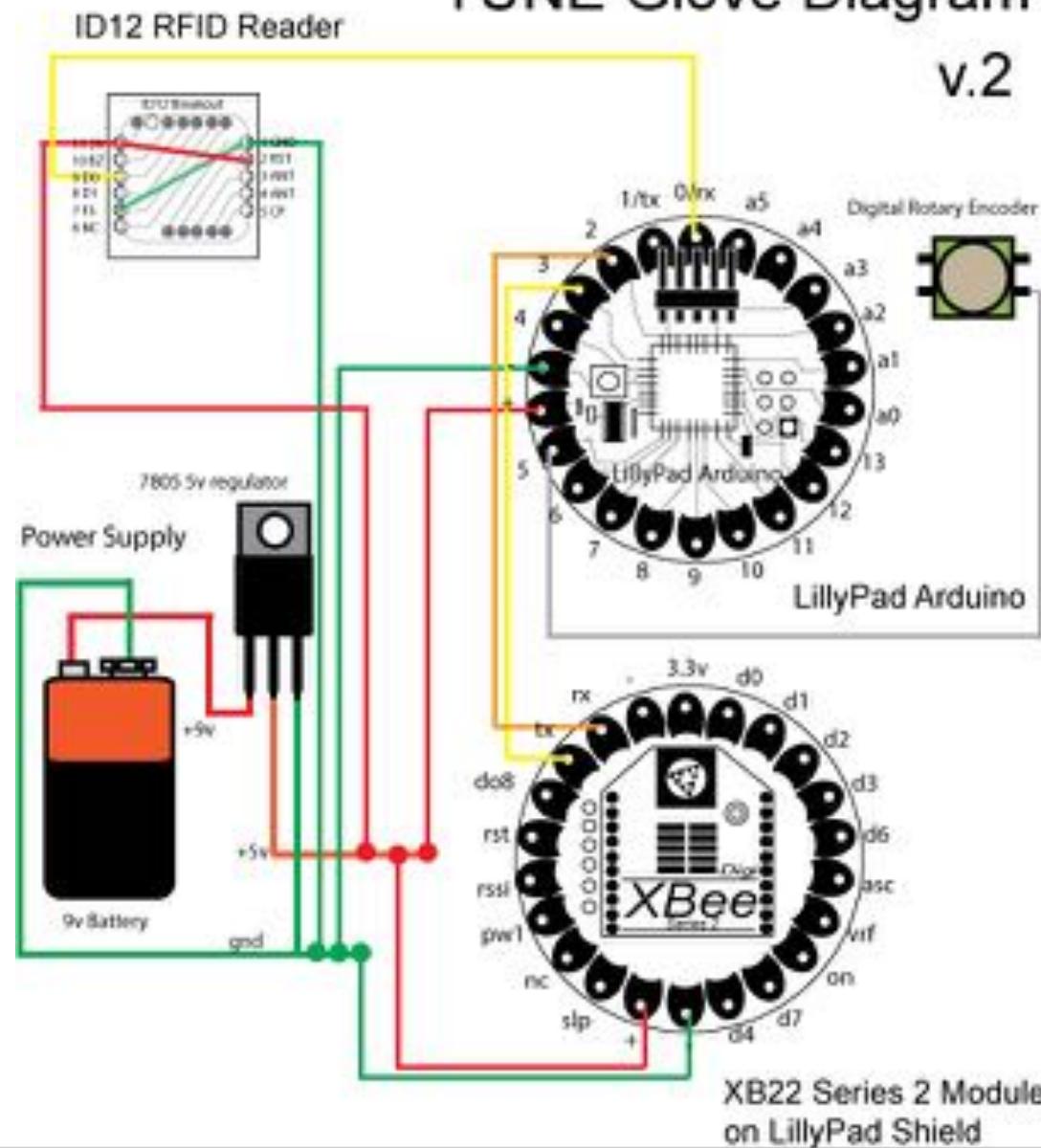
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# TUNE Glove Diagram

v.2



Iterative Design

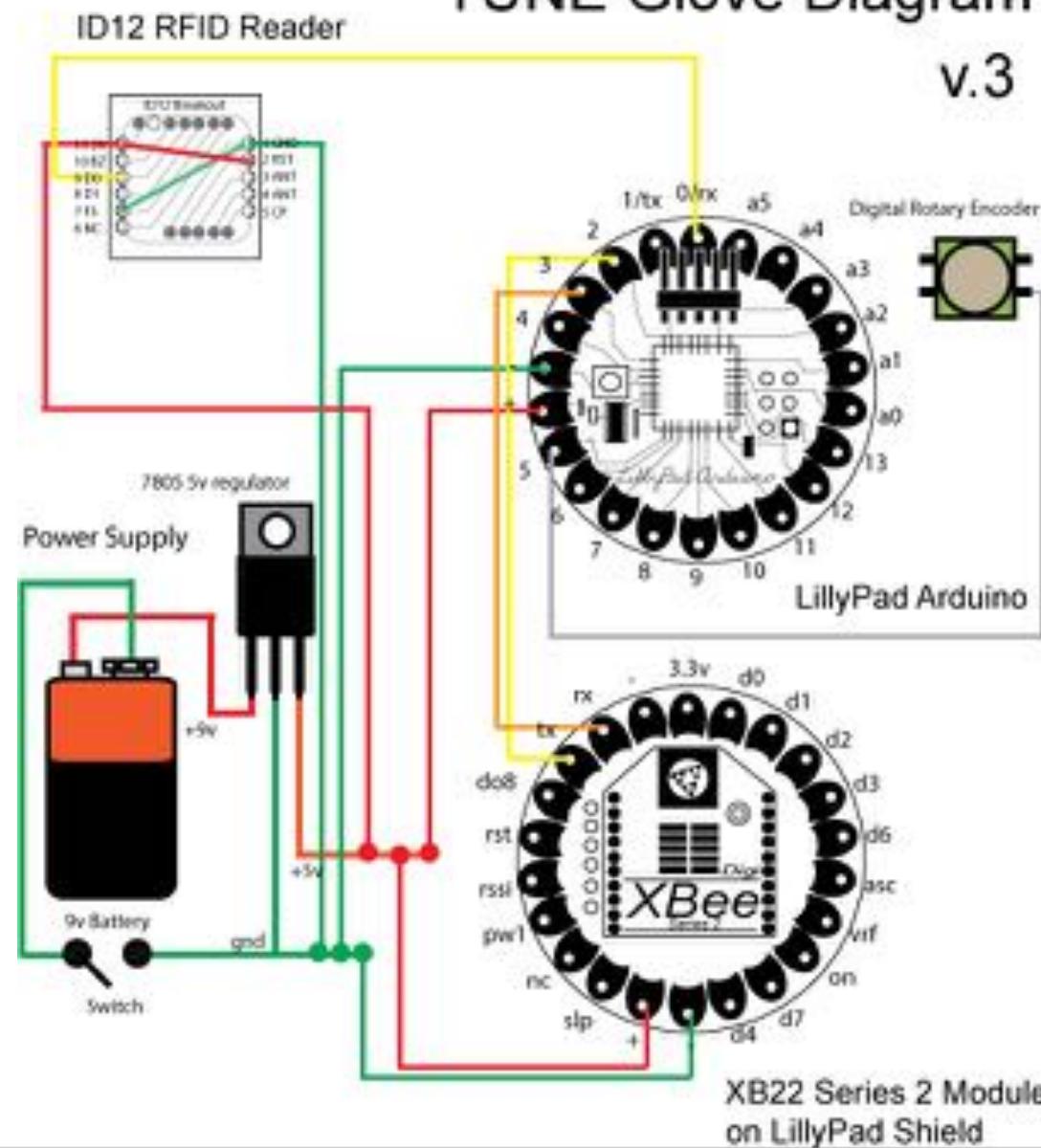
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# TUNE Glove Diagram

v.3

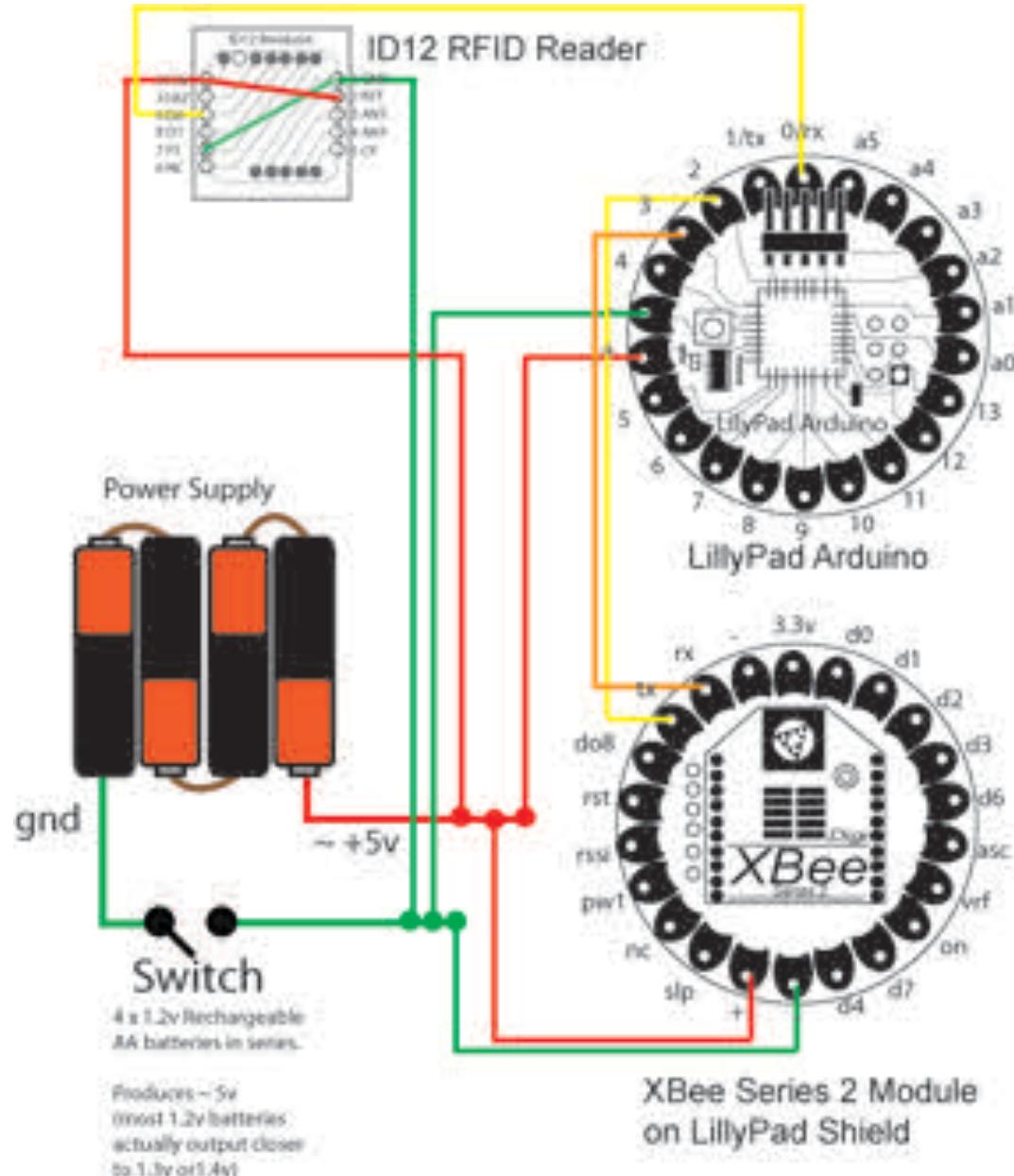


# Iterative Design

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# Iterative Design





# The Final Hardware

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# Interaction Design Challenge:

- How would **you** solve this problem?
  - Each object has 2 lexia associated with it that you want to play alternately
    - Interactor picks up the object and Lexia A plays
    - Interactor puts down the object
    - Interactor picks up the object and Lexia B plays
    - Repeat...
  - The RFID reader sends continuous tag data so long as it is detecting a tag
    - Interactor picks up an object
    - RFID sends: “TAGID#, TAGID#, TAGID#” 5 times a second continuously until the object is set down.
  - Each lexia is a different length.
- How do you get the system to allow Lexia A to complete playing before triggering Lexia B without “hard coding” each lexia length/object interaction into the system?



## Our (imperfect) solution:

- When a reader picks up an object, and the system reads its tag, Lexia A's playback is triggered
- The system then locks out any subsequent tag reads - the object is essentially dead, until...
- The reader picks up any other object and triggers any other lexia.
- This resets the lockout on the first object, and cues up Lexia B.
- This also can interrupt whatever lexia is currently playing.
- When the reader returns to the object, the new lexia plays.



# Phylactery

by

Charu Chaudhari & Joshua Tanenbaum





Phylactery - A magical object that contains a piece of a person's soul

PHYLACTERY

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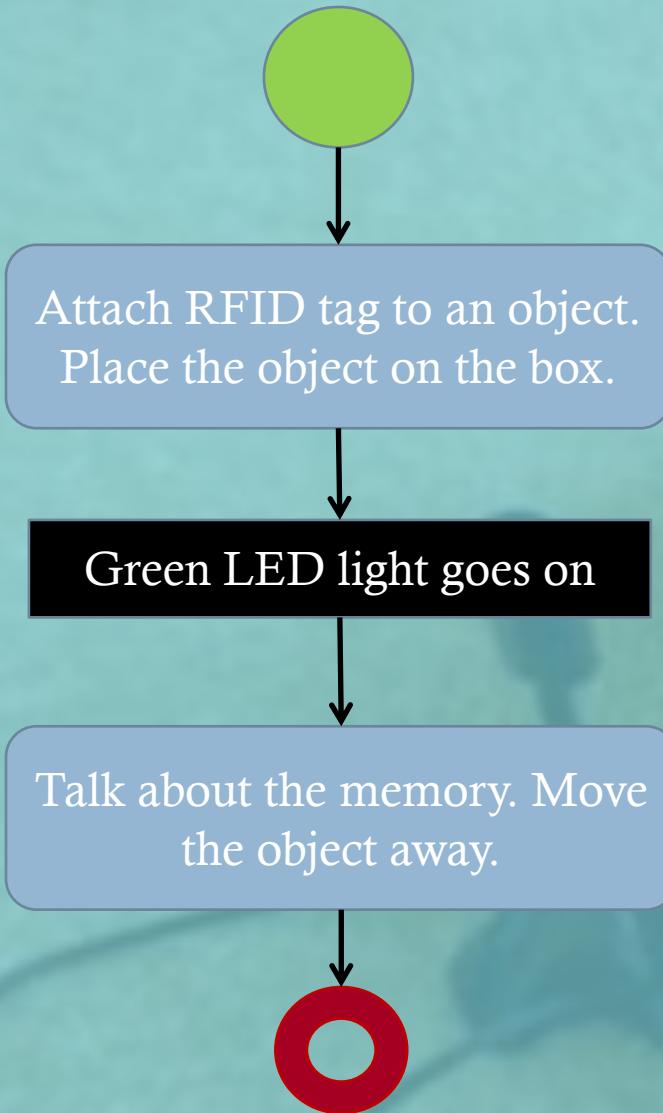


# Intergenerational Storytelling

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## Attaching a memory

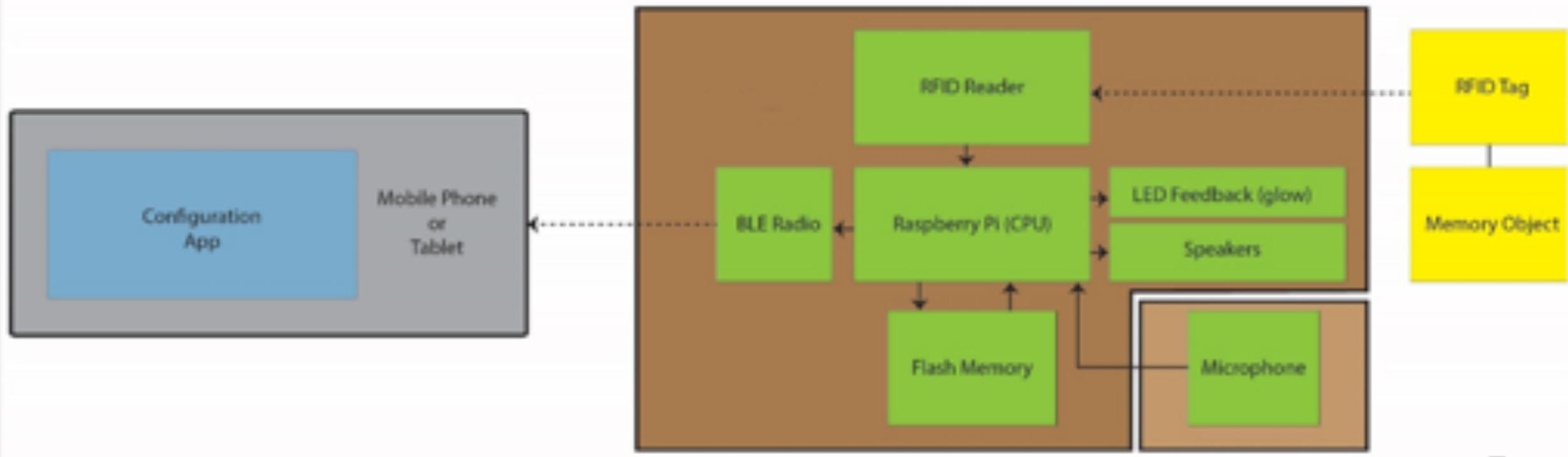


# Interaction Design Challenge:

- How would **you** solve this problem?
  - Phylactery needs to be accessible, and not intimidating to a diverse and often non-technical audience
    - Potential users include young children and family elders
  - The interaction design needs to focus on the people and activities that are present in the space, rather than the technology itself
  - The audio files the system produces are large, and need to be stored somewhere remotely
    - There's not enough room on an SD card to capture many stories
    - Users should be able to access memories with any phylactery, or really, any RFID reader
- How do you make the system configurable enough to allow for sophisticated manipulation of data, without alienating non-technical users?
- How do you do this without adding extra interface objects/widgets?

# Our (in progress) solution:

Phylactery Hardware Architecture



# Magia Transforma

The Dance of Transformation

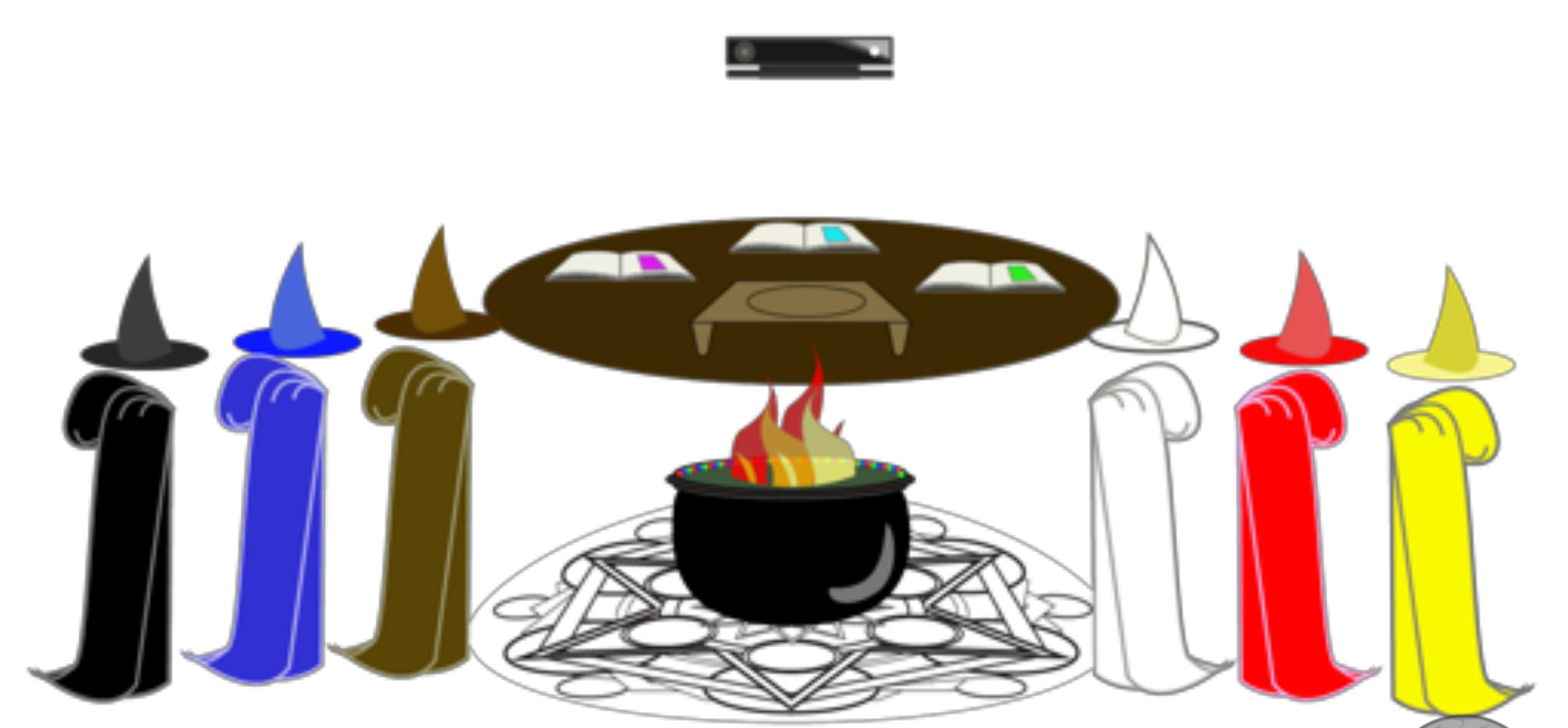
By

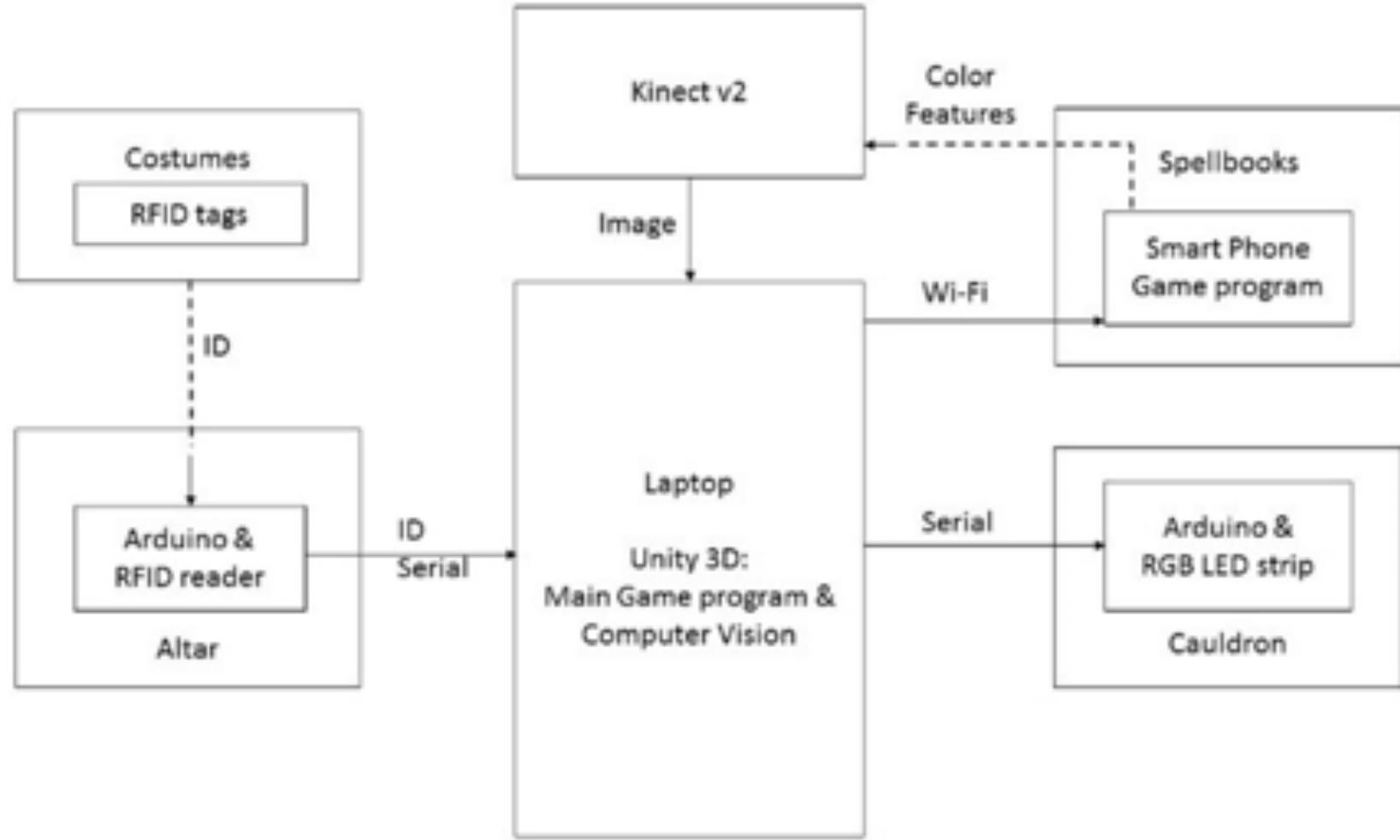
Joshua & Karen Tanenbaum, Natalie Nygaard,  
Ke Jing, Vincent Chang, & Mark Pareja

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Let the dance of  
transfo<sup>n</sup>mation  
begin!







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# Interaction Design Challenges



How do you know that your player has put on an article of clothing after scanning it?

How do you make sure a scanned item ends up assigned to the correct player's spellbook?

How do you guide players through the game without visual cues or screens?

How do you detect, and then correct for, player misunderstandings?

How do you direct information at a specific player when there are three players in the space?

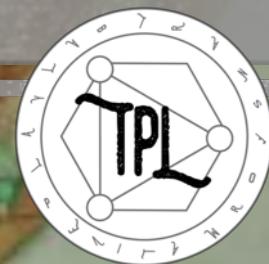
How do you keep players from getting distracted by their screens?



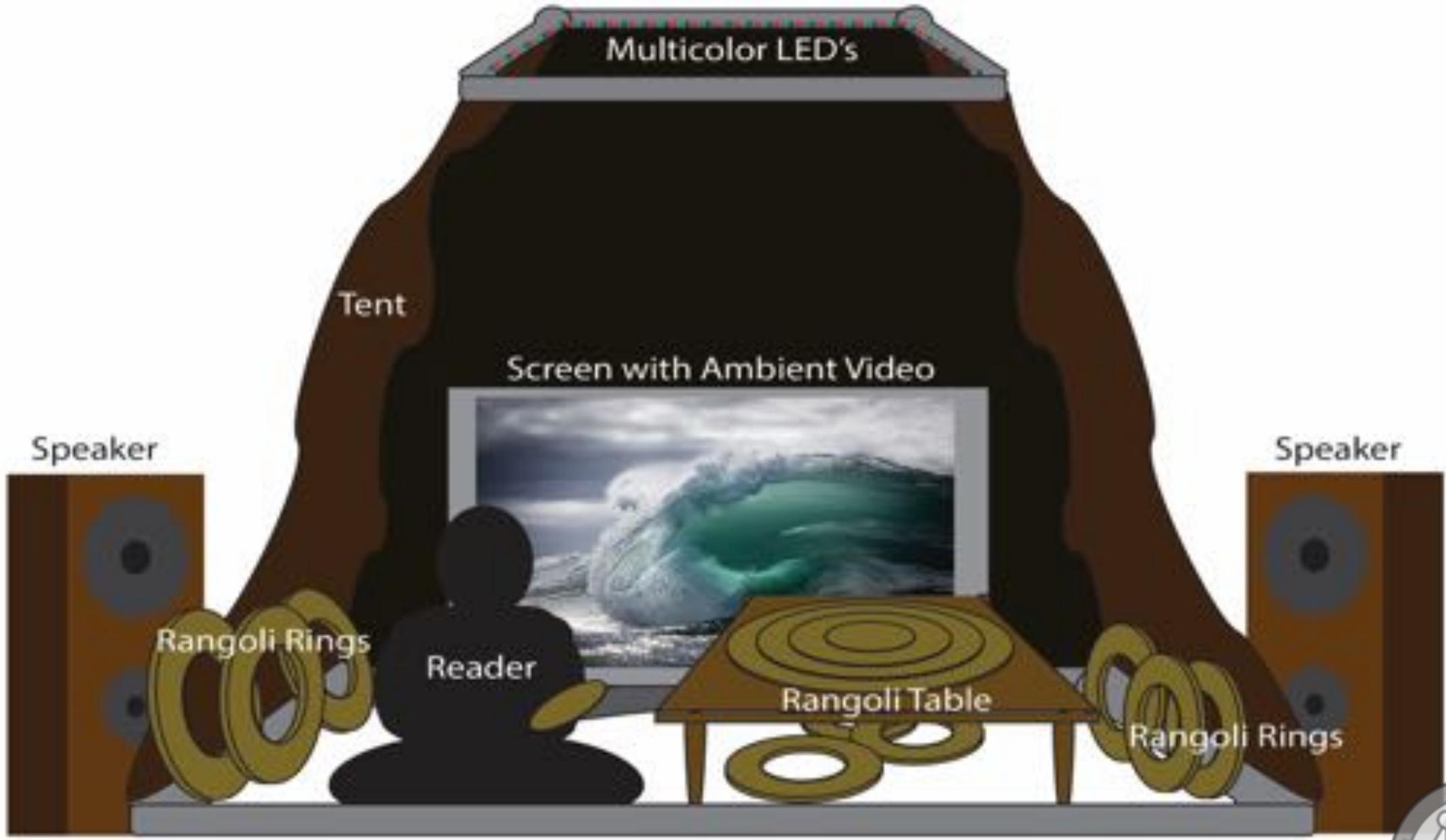


# Shiva's Rangoli

by  
Saumya Gupta & Joshua Tanenbaum







# Implementation Challenge:

- For Shiva's Rangoli, we wanted the tangible tabletop to be able to detect when different rings were placed upon it in different combinations
- We had 12 rings, and 2 centerpieces to detect, for a total of 14 things that needed to be detected
- The rings needed to nest together tightly, meaning that RFID wasn't an optimal solution this time
  - Would have required 4 RFID readers, which would have been costly, and complicated to engineer
  - Rings were close together, so it would be tough to keep RFID readers from interfering with each other, or detecting adjacent rings
- To further complicate things, we needed the rings to be easily removed and replaced, but internally nested rings were hard to remove

# Our solution:





Our solution:

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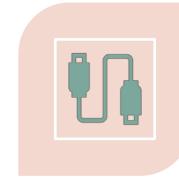
1. LOCATION  
SENSING



2. ACTIVITY  
VALIDATION



3. SIGNPOSTING  
AND ATTENTION  
MANAGEMENT



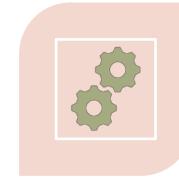
4. TRANSMEDIA  
INTEGRATION



5. ACCESSIBILITY



6. DISTRIBUTION



7. UPKEEP AND  
ROBUSTNESS

# Seven Challenges for Mixed Reality Design

# Challenge #1: Location sensing

- Technologies for tracking and identifying people in space remain inaccessible.
- Solutions include:
  - Camera Vision (Kinect, blob detection, skeleton detection, etc.):
    - Strengths: fairly reliable, does not encumber users, allows for gesture detection
    - Weaknesses: limited field of view, highly sensitive to lighting conditions, doesn't differentiate well
  - Pulsed IR Beacon Triangulation
    - Strengths: allows unique identification, can be deployed over large scales
    - Weaknesses: high maintenance costs, easily occluded, cannot track fine body movements
  - RSSI Triangulation
    - Strengths: allows unique identification, can be deployed over large scales
    - Weaknesses: high maintenance costs, cannot track fine body movements, imprecise

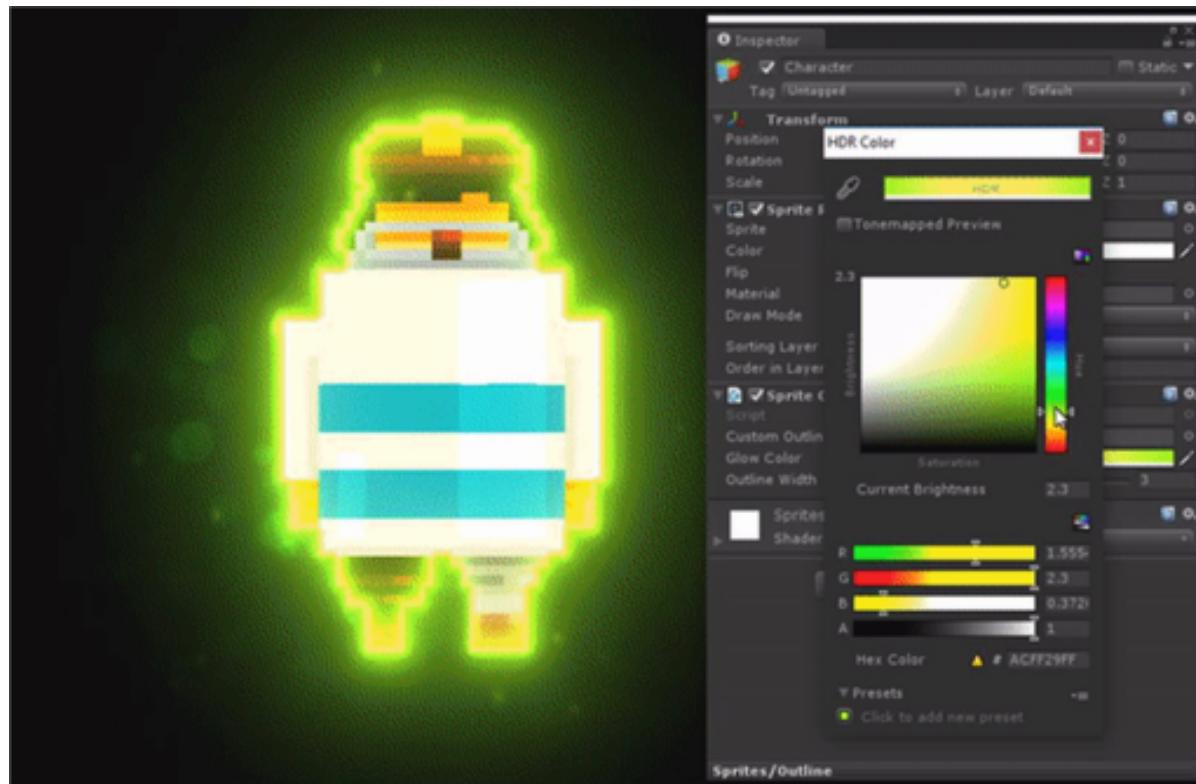


# Challenge #2: Activity Validation

- How do we know that people are doing any specific activity?
- In a software environment, we can easily verify if a user has done a desired thing, because we completely define the possibility space for interaction
- In the physical world, the possibility space for behavior greatly exceeds our ability to anticipate and respond



# Challenge #3: Signposting and Attention Management



- The physical world lacks many of the affordances that we use in software to manage and direct user attention
- How do we call attention to opportunities for interaction?
- How do we guide a user through a structured experience without visual cues?
- If we are reliant upon audio cues, how do we manage distractions, interruptions, overlaps, and other environmental factors?

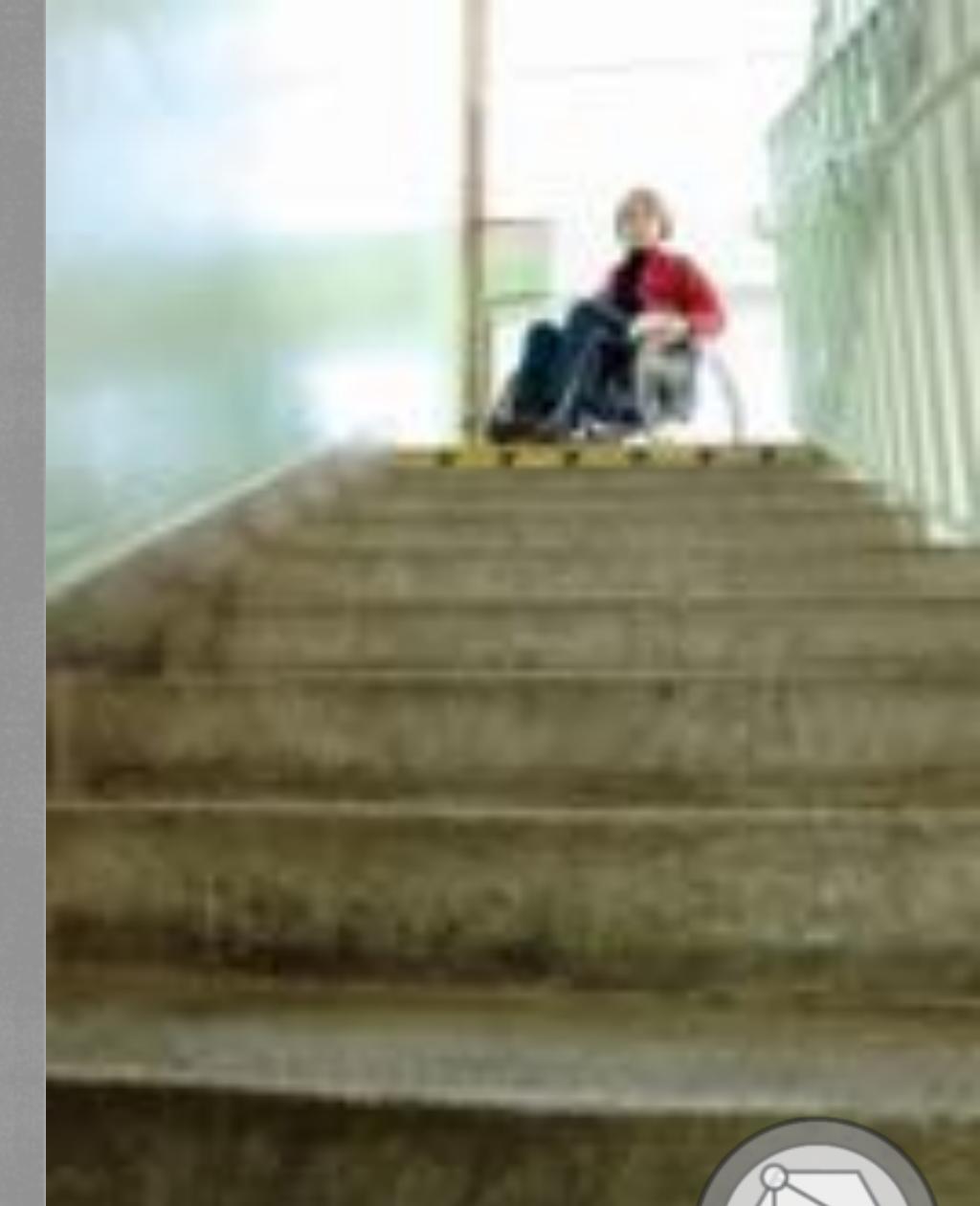
# Challenge #4: Transmedia Integration

- Mixed reality design often requires us to combine various technologies and media in new and unique ways.
- How do we get different generations of technology to play well together?
- How do we manage all of the different drivers, platforms, connections, and data types needed to work these systems?
- How many USB connections are too many?



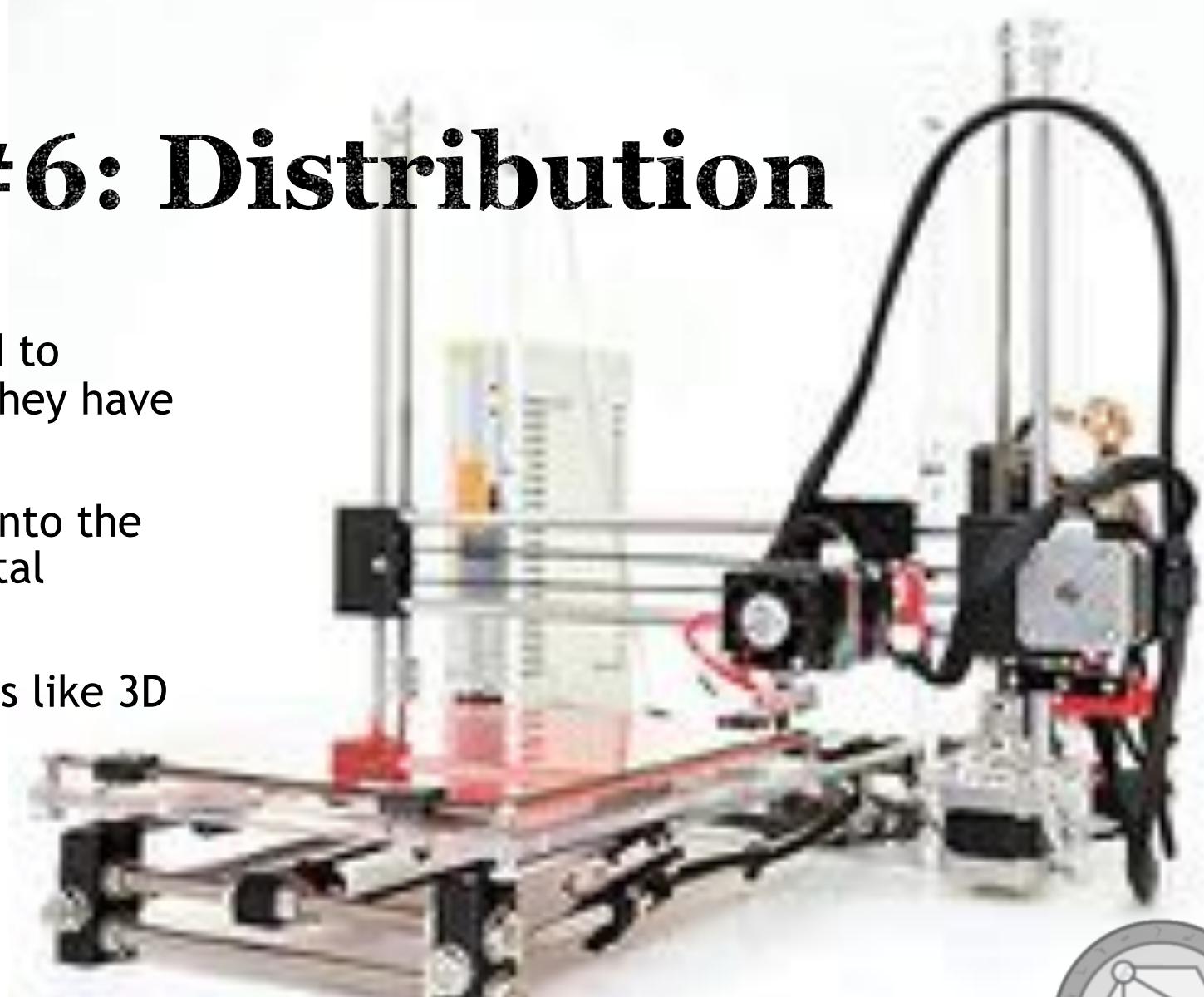
# Challenge #5: Accessibility

- Mixed reality design is often more physically demanding than screen-based design
- How do we support users with diverse levels of ability?
- How can we learn from accessible design to improve mixed reality design (e.g.: audio-only interfaces)?
- How do socioeconomic factors impact accessibility (e.g.: why build anything for a \$3000 HoloLens?)



# Challenge #6: Distribution

- Mixed reality designs are hard to digitally distribute, because they have physical elements
- How do we get our work out into the world when we can't use digital distribution methods?
- Can access to fabrication tools like 3D printers offset some of these challenges?



# Challenge #7: Upkeep and Robustness

- Most of these systems require significant ongoing maintenance in order to function
- Regular use is enough to cause significant wear and tear:
  - Solder joins snap
  - Batteries lose their charge
  - Cables fray
  - Drivers become outdated
  - Replacement parts become obsolete
  - Students with expertise graduate
  - APIs are retired or changed
- How do we design systems to withstand regular use, and the vagaries of time?



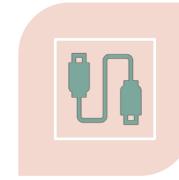
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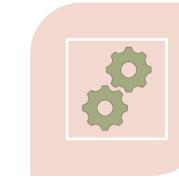
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5. ACCESSIBILITY



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I don't have all the answers!  
Thank you for your time!  
Any questions?