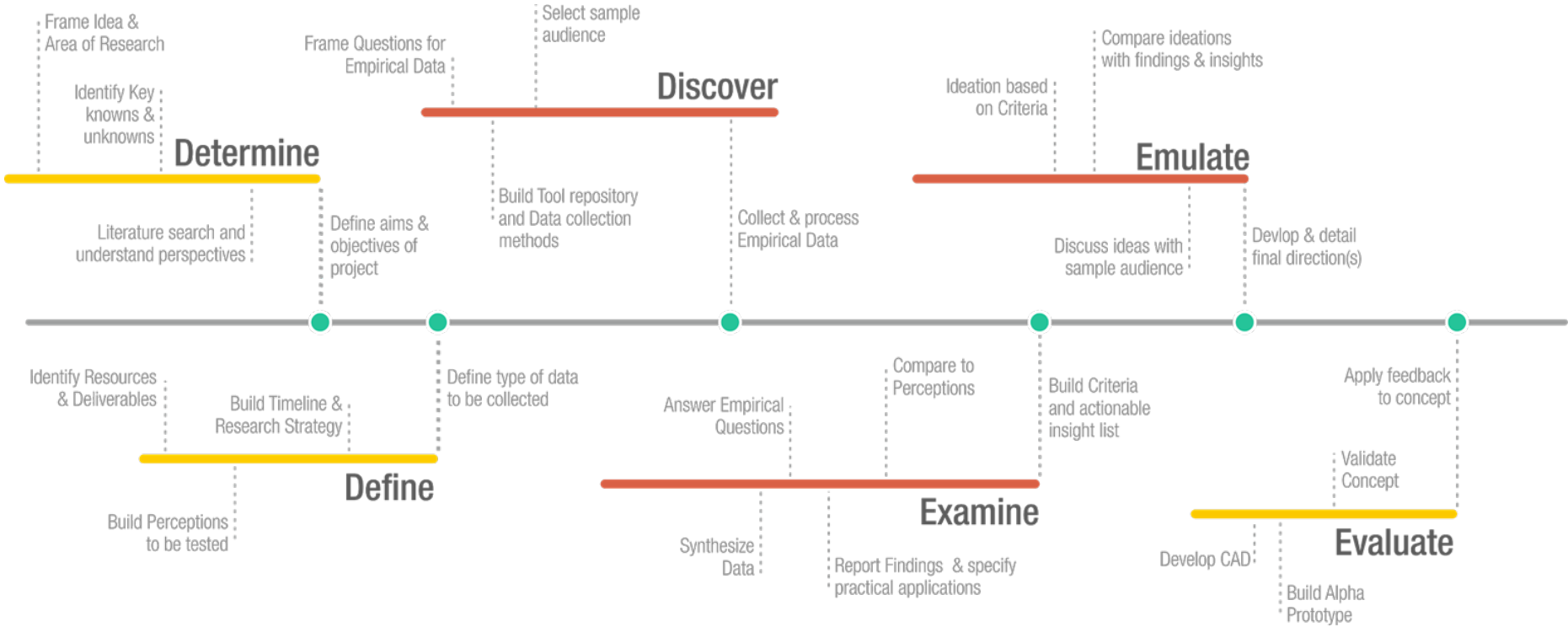
Human Interface:

The Future of Wearable Technologies in Daily Use through the Lens of Interaction & Acceptability

Farhad Mehta | M.F.A. Candidate | SCAD | March 2020

Project Plan



Context

At the beginning of the 21st century, we linked the personal and pervasive, by combining mobile technology with ambient sensing, boosting its potential.

(Birringer & Danjoux, 2009)

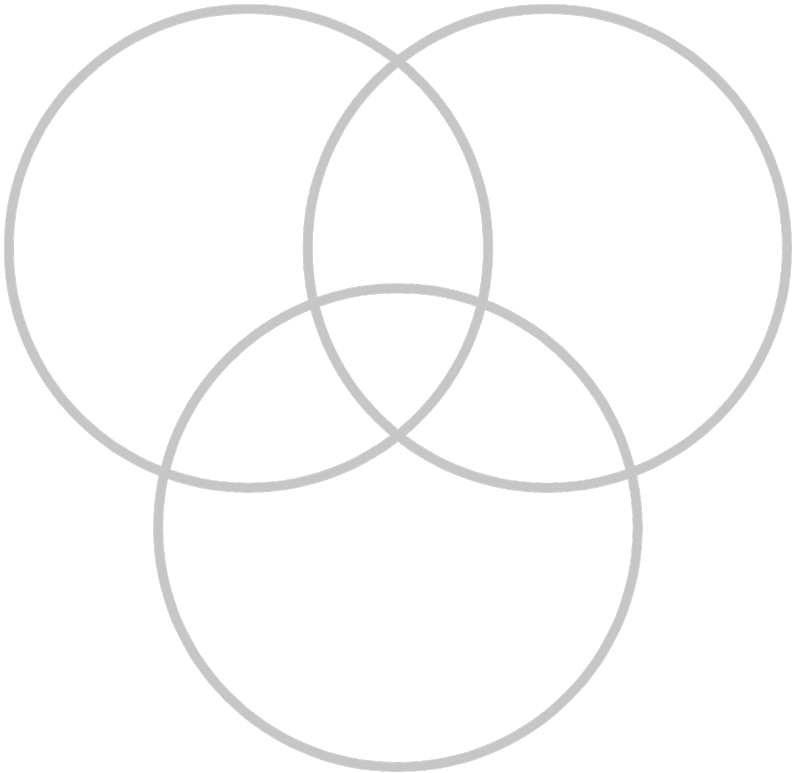
Problem

There is need for a more meaningful interaction & experience with computing technology that makes humans the center of interaction.

Objective

To develop an **improved method of interaction** with **Ambient Intelligence (AmI) Environments** using **Wearable Technology** to enhance human experiences in daily life

Research Space



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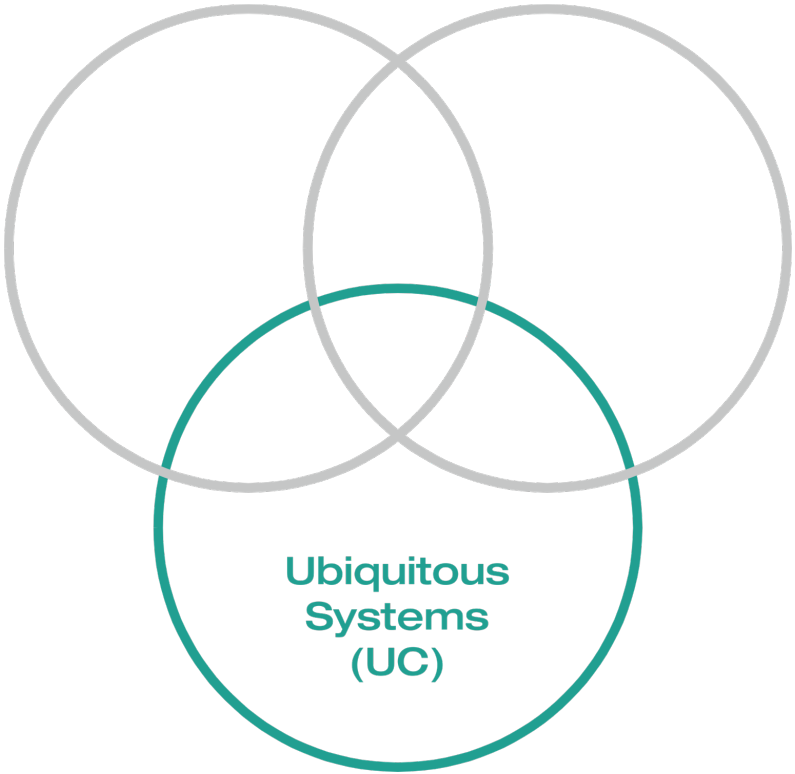

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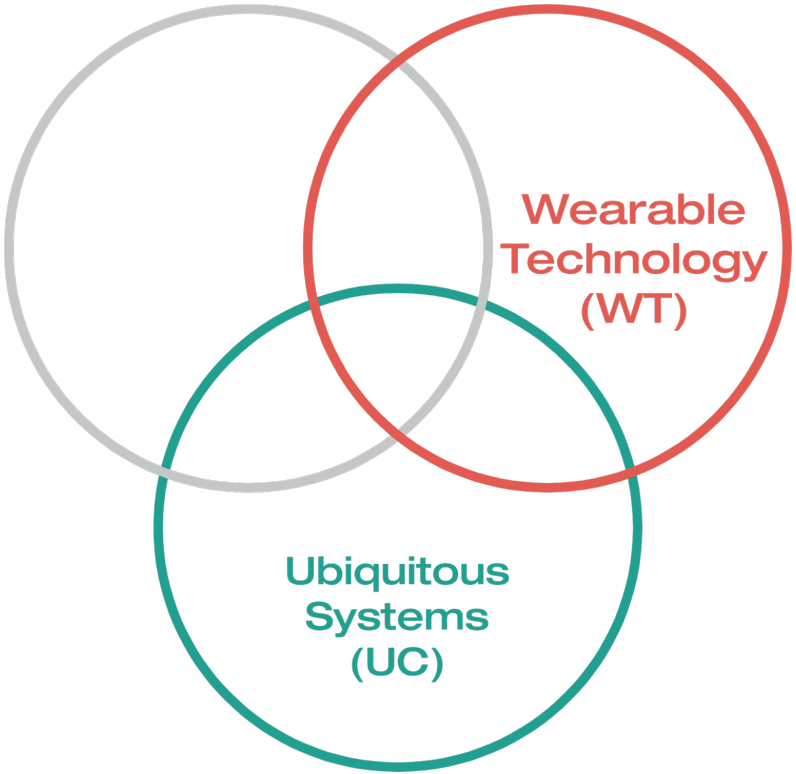

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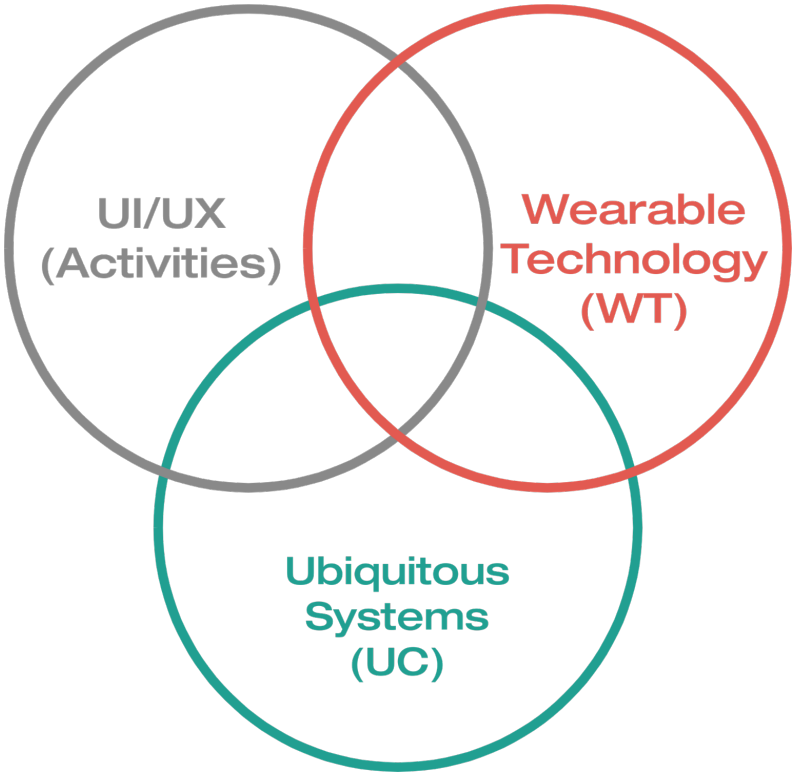

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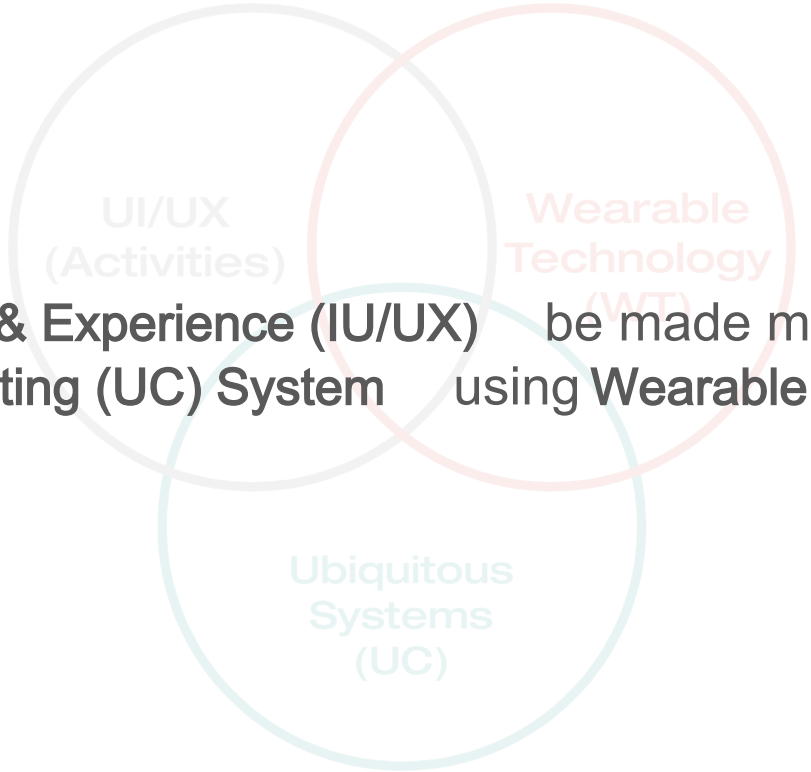
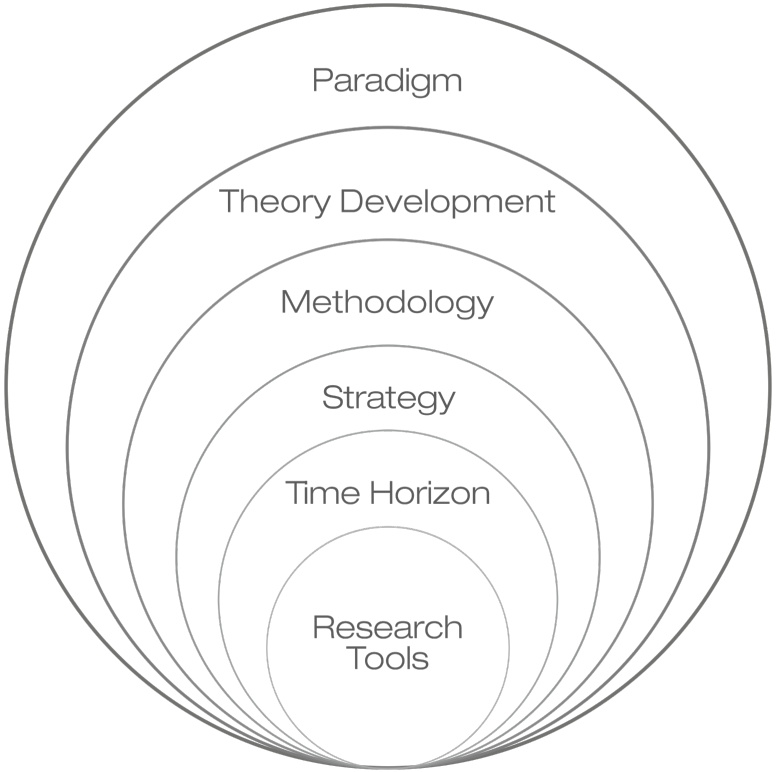


Can **User Interaction & Experience (IU/UX)** be made more meaningful within a **Ubiquitous Computing (UC) System** using **Wearable Technology (WT)?**

Research Space



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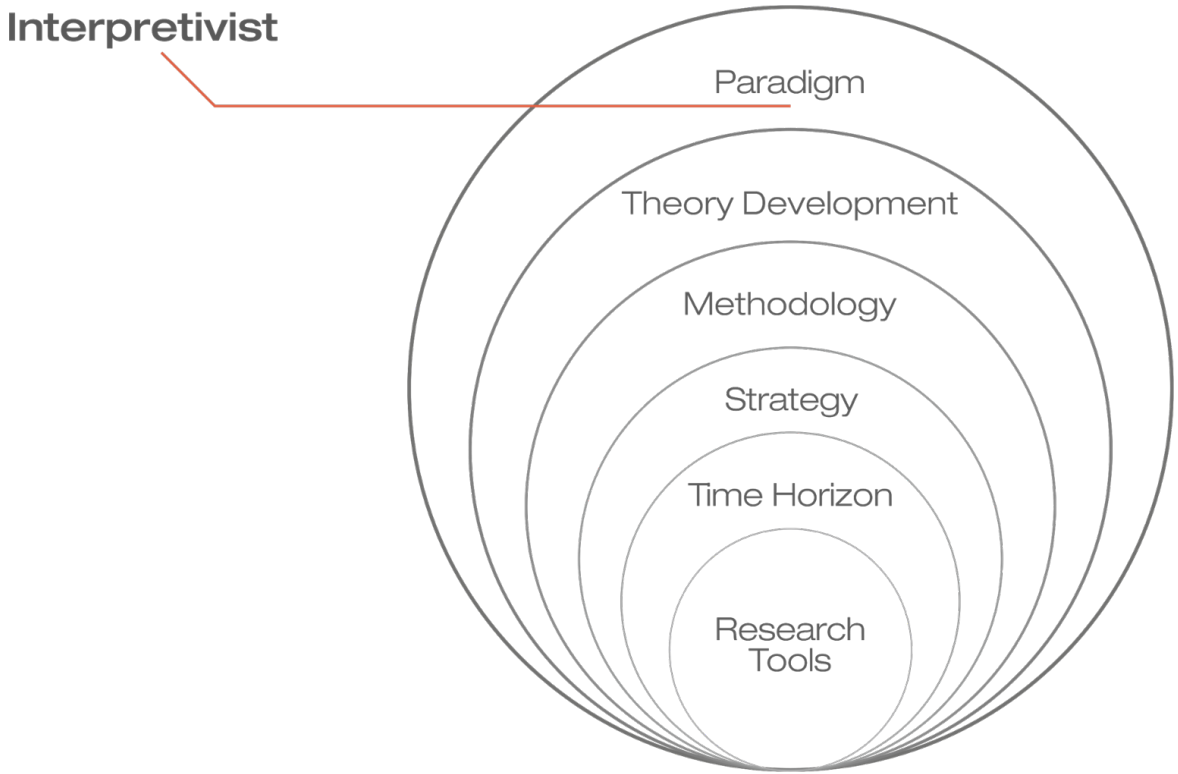

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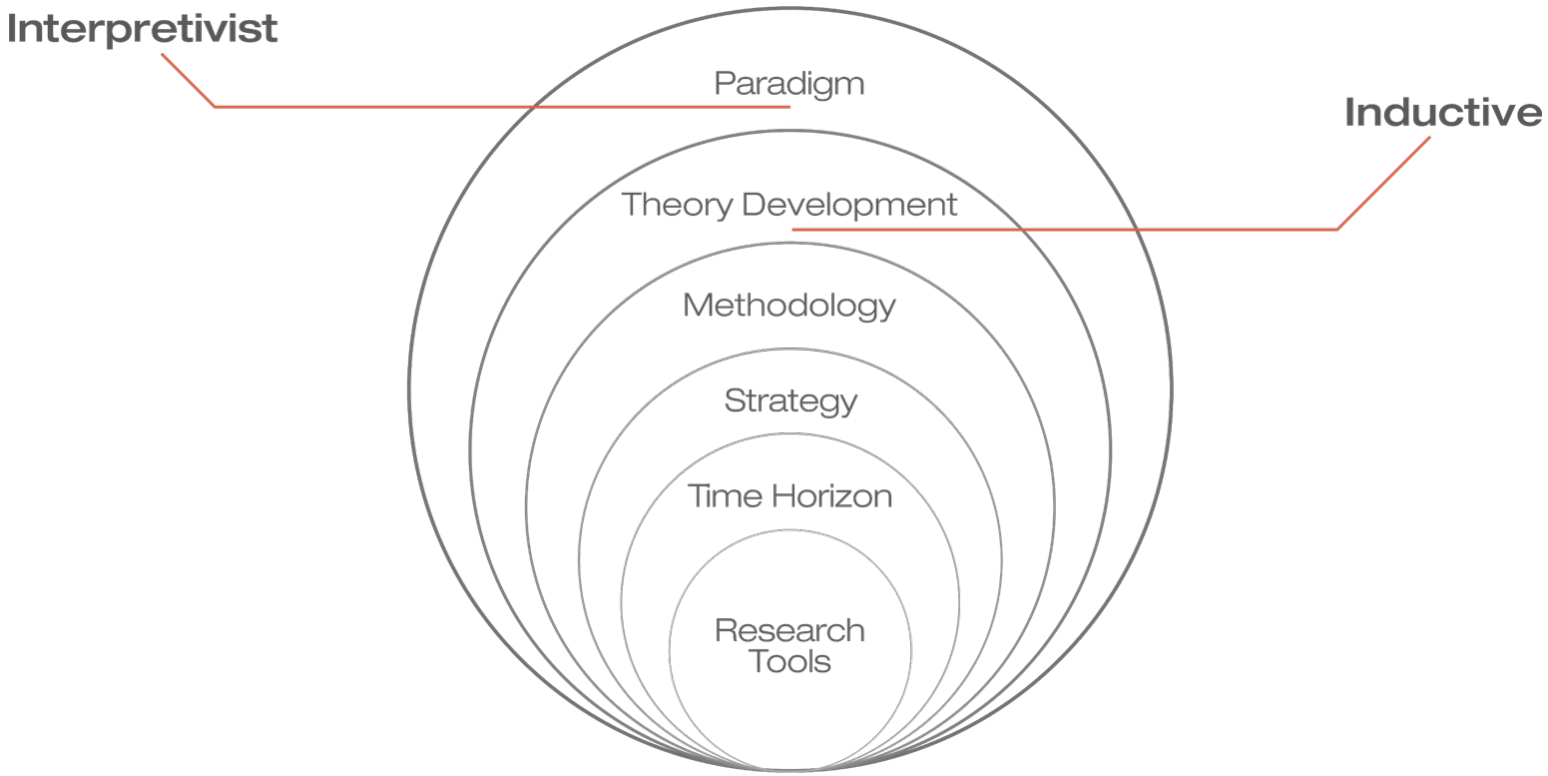

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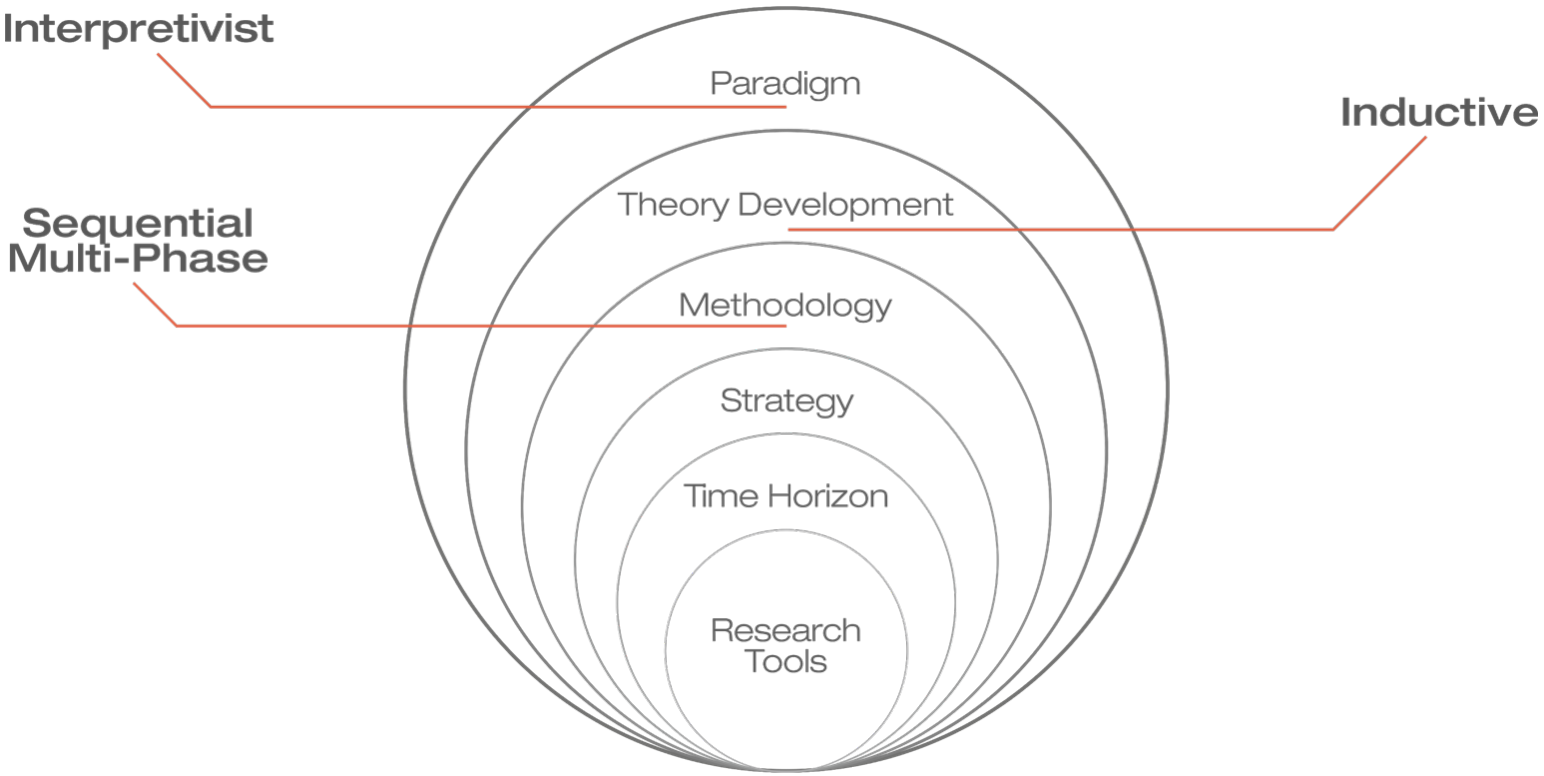

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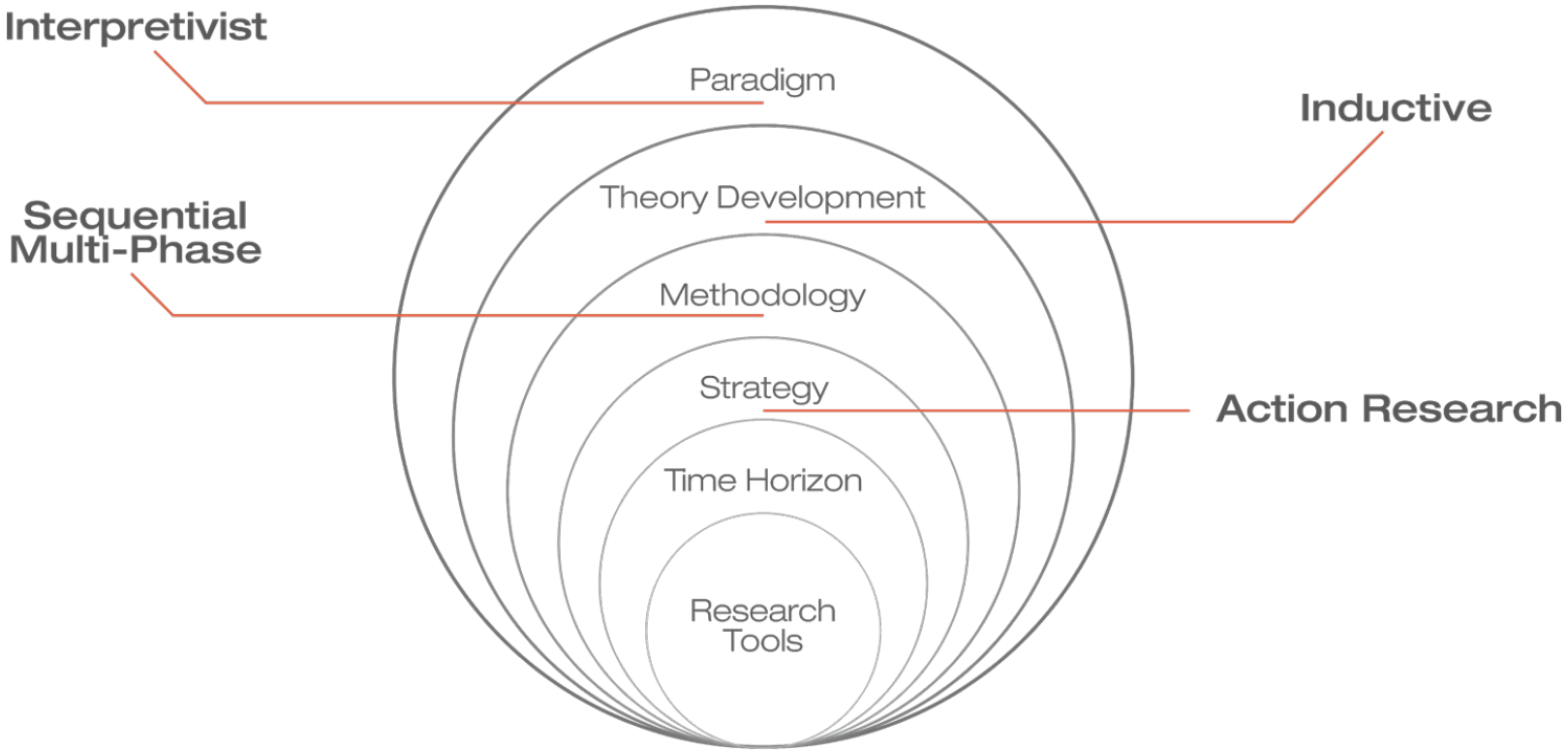

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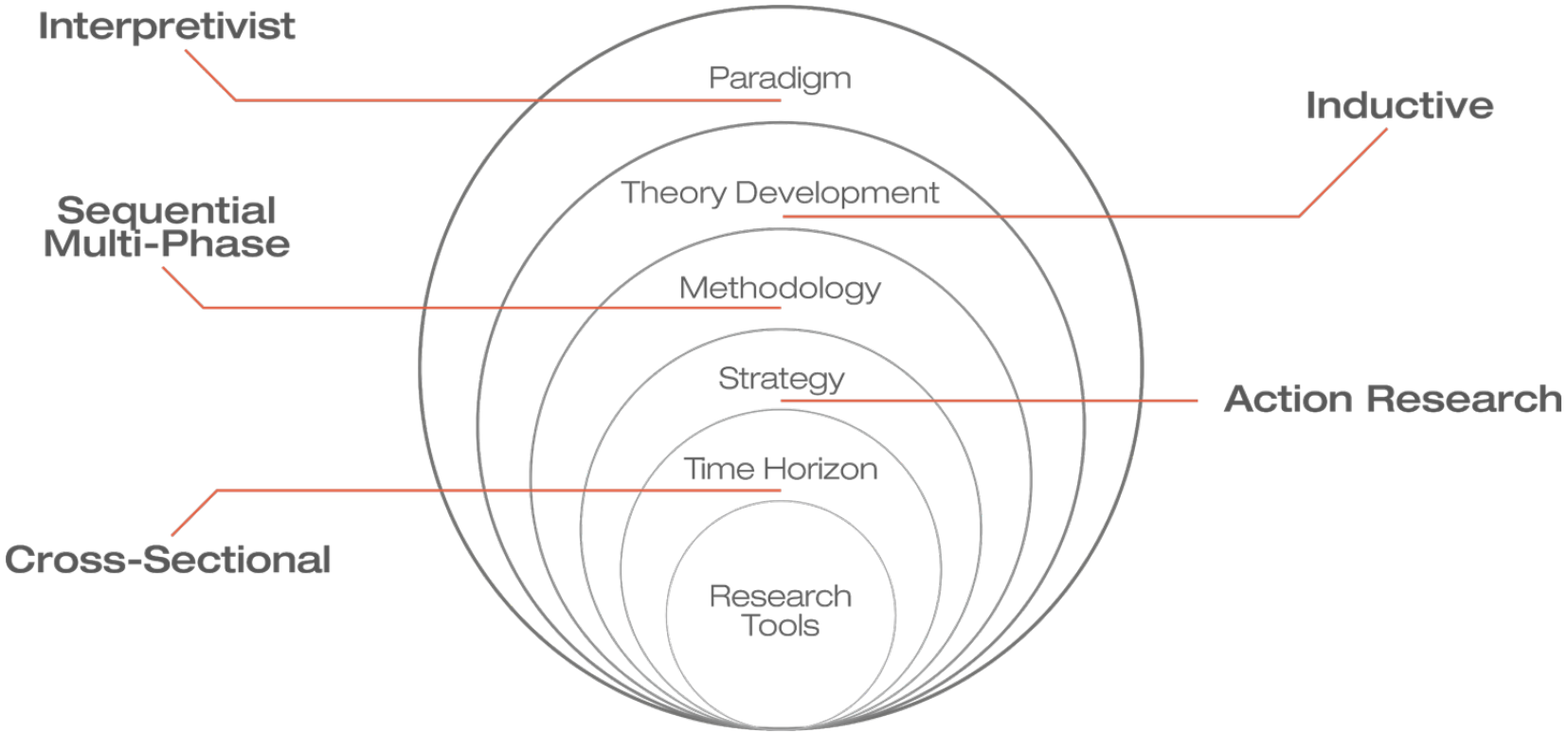

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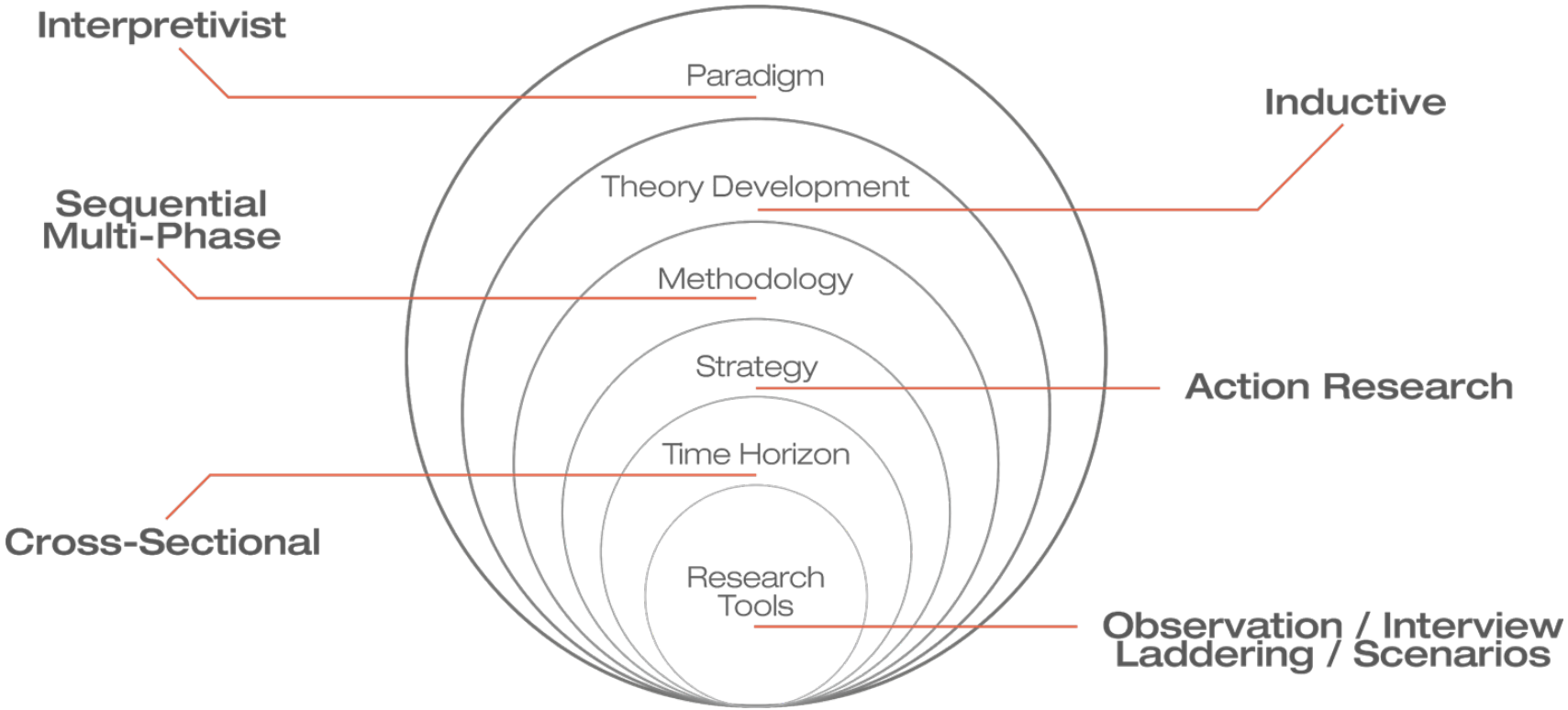
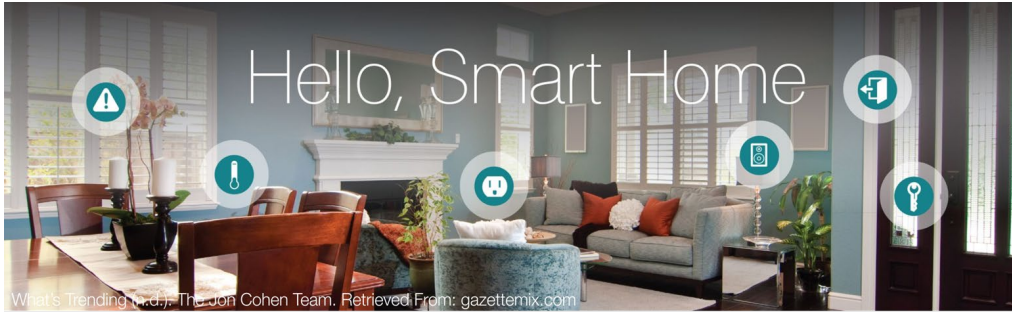


Ubiquitous Computing & Ambient Intelligence (AmI)

Ubiquitous Computing(UC) is a human-centered approach to computing technology.

Machines that fit the human environment instead of forcing humans to enter theirs. (Kerasidou & Charalampia, 2017)



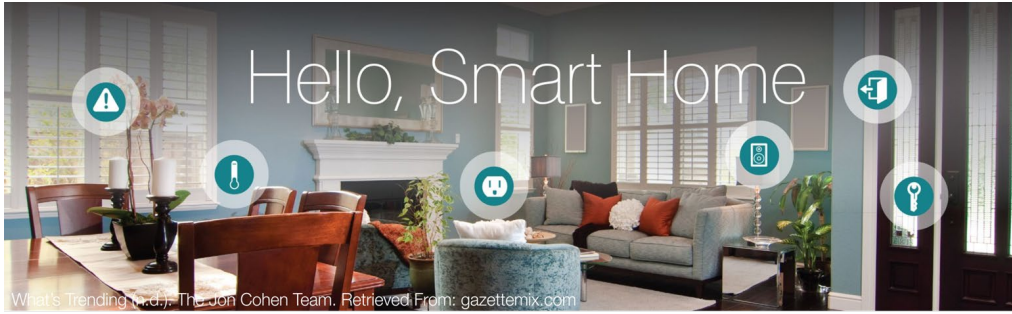
What's Trending (n.d.). The Jon Cohen Team. Retrieved From: gazettemix.com

Visser, N. (2017) Project Soli. Retrieved From: huffingtonpost.com

Alexa. Retrieved From: amazon.com

Ubiquitous Computing & Ambient Intelligence (AmI)

Ambient Intelligence (AmI) environments are aware of the people present within them. (Jose, et al. 2011)



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Sensing Styles

Object Centric Sensing

Sense the presence of and react to actions of humans in an environment.

Present day technology **limits the commercial viability** of these devices.

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Human Centric Sensing

An intermediate device that guides the user through a smart environment.

Sticking to the age old idea of **'adapting the machine in front of you'** limits AmI's true potential.

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Object Centric Sensing

Sense the presence of and react to actions of humans in an environment.

Human Centric Sensing

An intermediate device that guides the user through a smart environment.

A combination of the two styles of sensing, could lead to a more defined system where one solves the problems of the other.

Present day technology **limits the commercial viability** of these devices.

Sticking to the age old idea of **'adapting the machine in front of you'** limits AmI's true potential.

User Perception & Acceptance

A wearable, is more like a piece of clothing than a PC or an appliance. (Kelly & Gilbert, 2016)

Hiskey, T. (2017). Is Google Glass Staging A Comeback? Retrieved From: minutehack.com

MW Technology.(2016).Apple Watch vs Samsung Gear. Retrieved: youtube.com

Gaps in Literature

Acceptance and Adoption of WT

Intervention in Daily Life for AmI

Participant Sample Set

33 Participants across different age groups & Socio-Economic Class.

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33 Participants across different age groups & Socio-Economic Class.

Europe: 5 Participants

Asia: 14 Participants

U.S.A.: 14 Participants

Methodology

PH1

Pre-determined Scenario Observation + Interview

Gauge user's feelings towards WT devices & Identify a balance between invisibility and interaction.

PH2

Participatory Photo Interviews + Laddering

To get a glimpse of participants' everyday rituals and **identify problems faced** that AmI can positively influence

Phase 1 (Scenario observation)

Space & Set -up

Devices Used:
Google Glasses
Apple Watch
Voice Assistant

Testing Spaces:
Private Home Space
Public Space (Park)
Professional Work Space

The home & work spaces had staged prototype interactions.

Methodology

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Pre-determined
Scenario Observation
+
Interview

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Interviews
+
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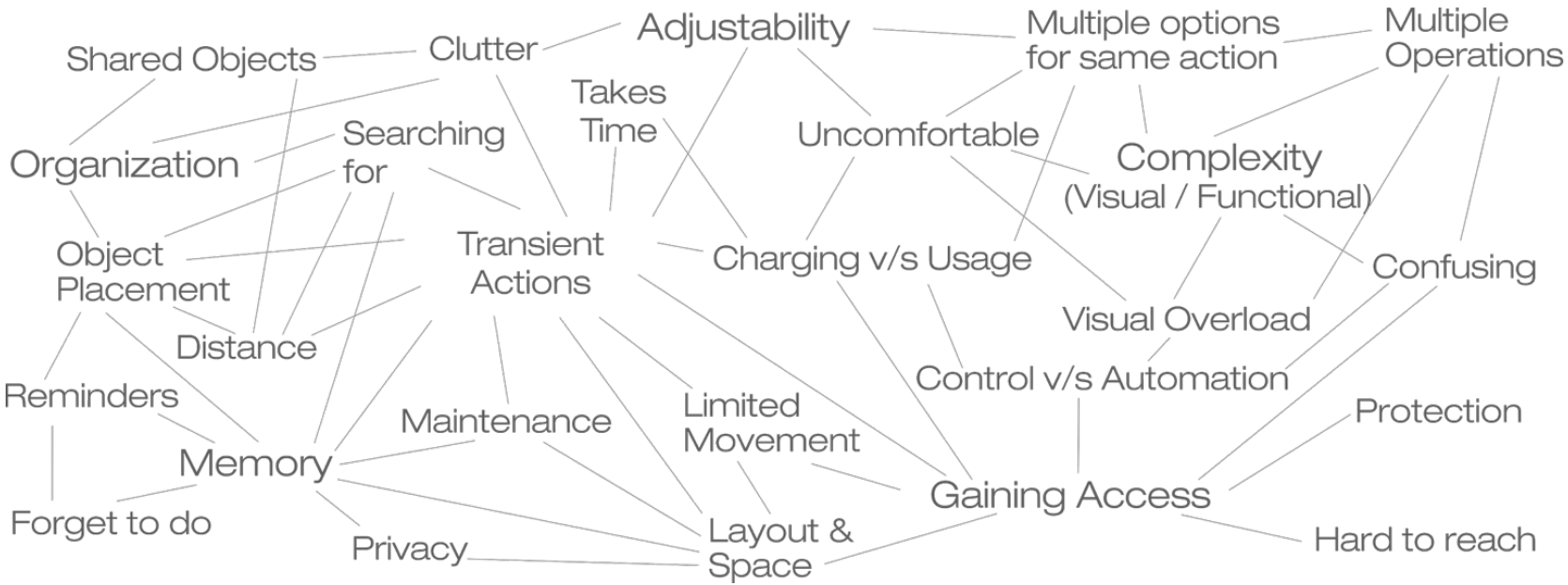
Phase 2 (Participatory Photo interview)

Participants were asked to take photos of inconveniences faced



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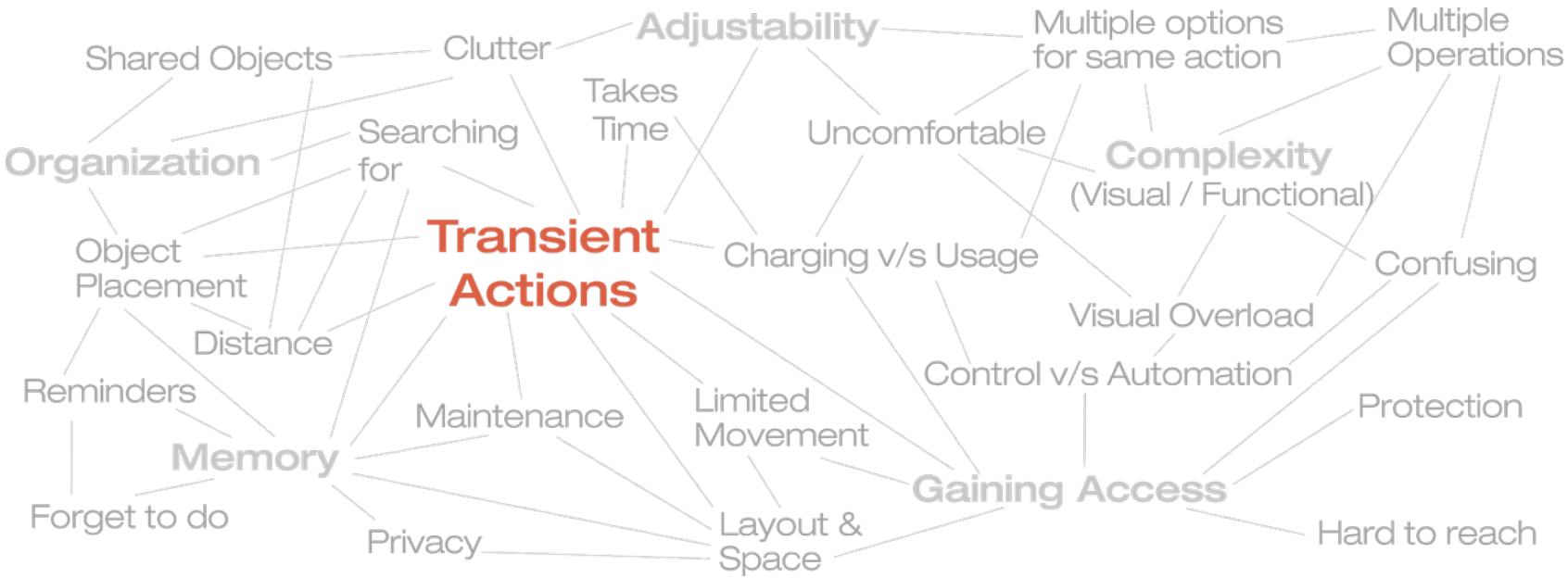

Conclusions

Intervention in Daily Life

Menial transient activities are usually seen as a hindrance and need to be bypassed in order to achieve an ultimate goal faster

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Gaining/Blocking Access to...

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Remembering to do…

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Gaining/Blocking Access to...

Remembering to do…

Finding…

Conclusions

Intervention in Daily Life

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Gaining/Blocking Access to...

Remembering to do…

Finding…

Adjusting/Readjusting….

Conclusions

Acceptance & Adoption of WT

Balance between ambient and physical	Familiarity of interaction	Clear Feedback of ambient actions

Conclusions

Balance between ambient and physical

Social image

Interactions in Private spaces

Familiarity of interaction

Clear Feedback of ambient actions

Conclusions

Balance between ambient and physical

Familiarity of interaction

Past Knowledge

Rooted in Physical Artifacts

Clear Feedback of ambient actions

Conclusions

Balance between ambient and physical

Familiarity of interaction

Clear Feedback of ambient actions

Trust in Technology

Loss of Control

Limitations of Research

A.I. Control v/s
Human Control

Limitations of Research

A.I. Control v/s Human Control

Who is in Control (suggest v/s do)?

Does it matter for menial tasks?

How to deal with Emotion & Irrational Behaviors.

Dealing with complex systems

How do we build trust in A.I.?

Markovics Paradox

We can teach machines to solve the hard problems, but it's the easy ones that are difficult

(Hamer A. 2018)

A.I. is not the answer,

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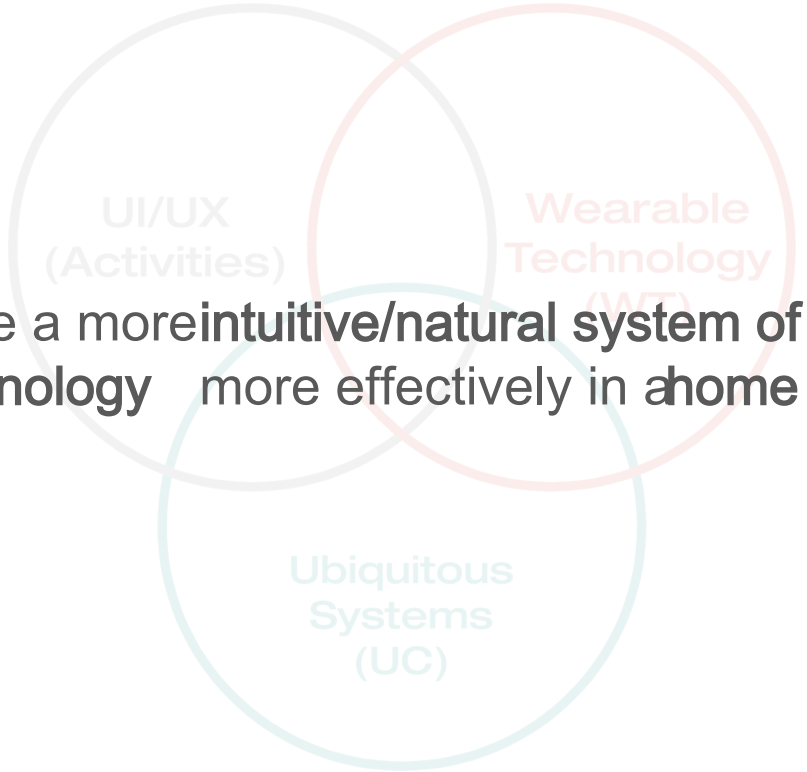
Humans are !!!

A.I. is not the answer,
Humans are !!!

With a little help from A.I.

Thesis Re-frame



How might we create a more **intuitive/natural system of interaction** using **Wearable Technology** more effectively in a **home environment?**

Thesis Re-frame

Human Interface (HI)

A method of interaction that uses human attributes like, gesture, location and biological readings to control the AmI environment around them.

Human Interface (HI)

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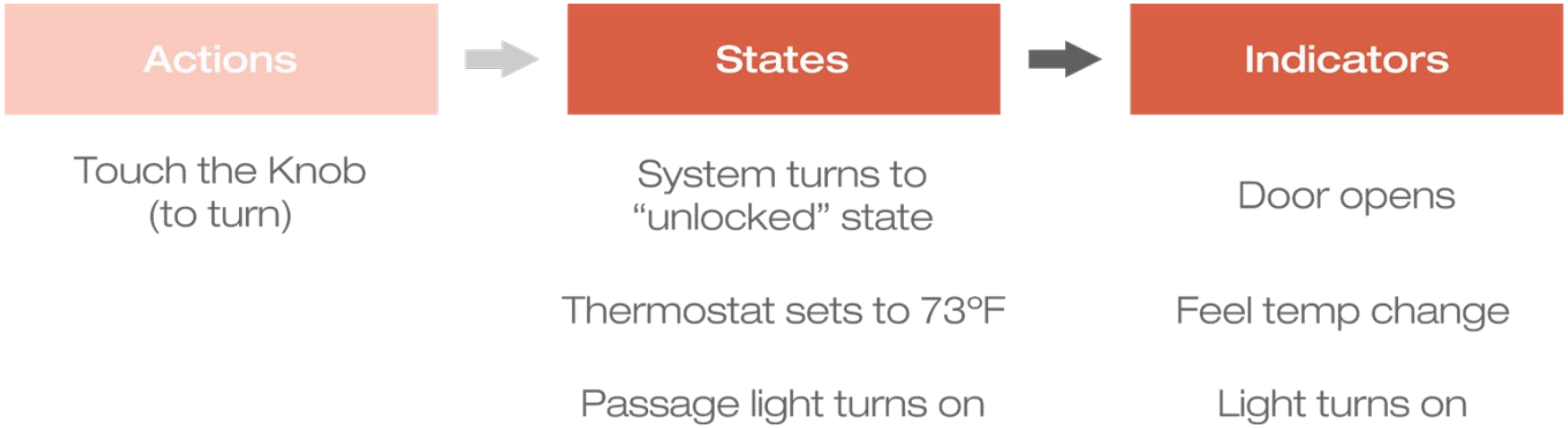

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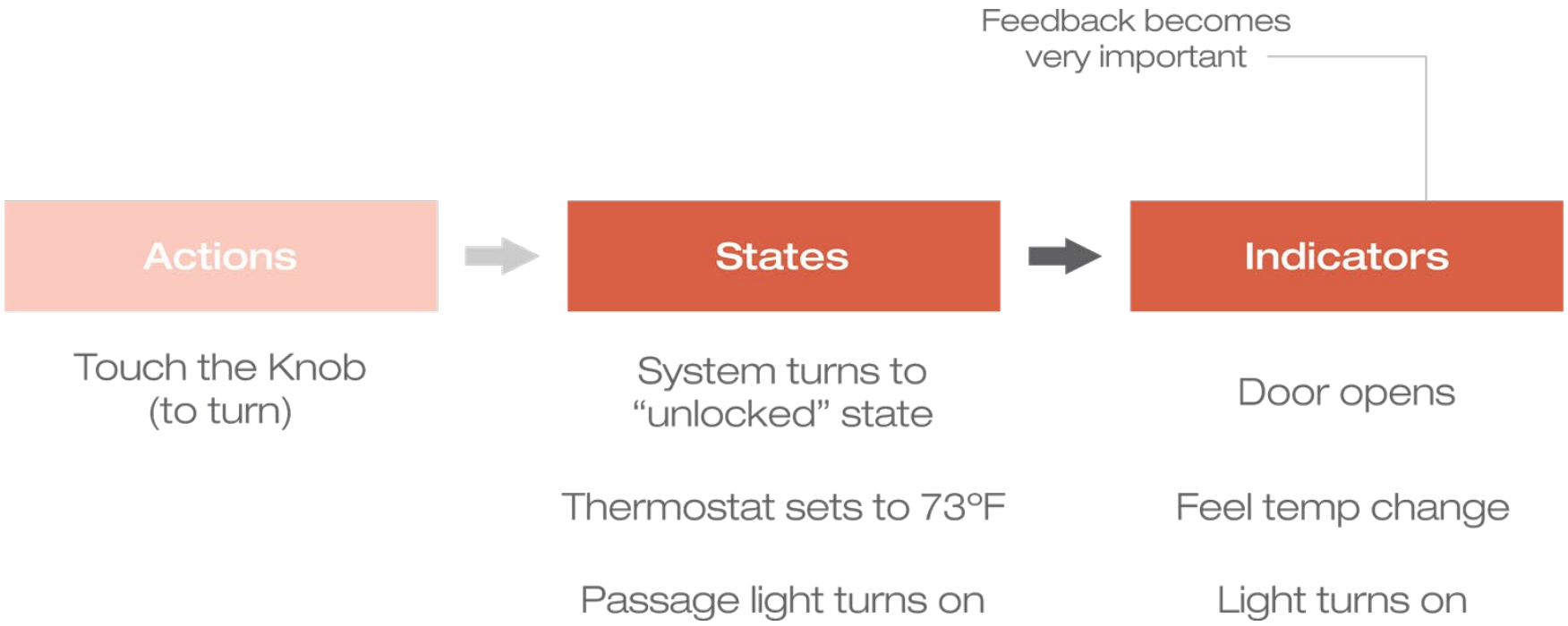

Human Interface (HI)

A.I. Approach

Set temp. based on past settings

H.I. Approach

Set temp. when the user walks in

Human Interface (HI)

Trust in functionality

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Control when and how the system and smart devices behave

Trust in functionality

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Control when and how the system and smart devices behave

Introduce clear feedback that informs the user of changes in states

Human Interface (HI)

Trust in functionality

Control when and how the system and smart devices behave

Introduce clear feedback that informs the user of changes in states

Allow manual override to change states personally

Observation (Interactions with smart homes)

To gain an understanding of user interaction with smart spaces

Practices:

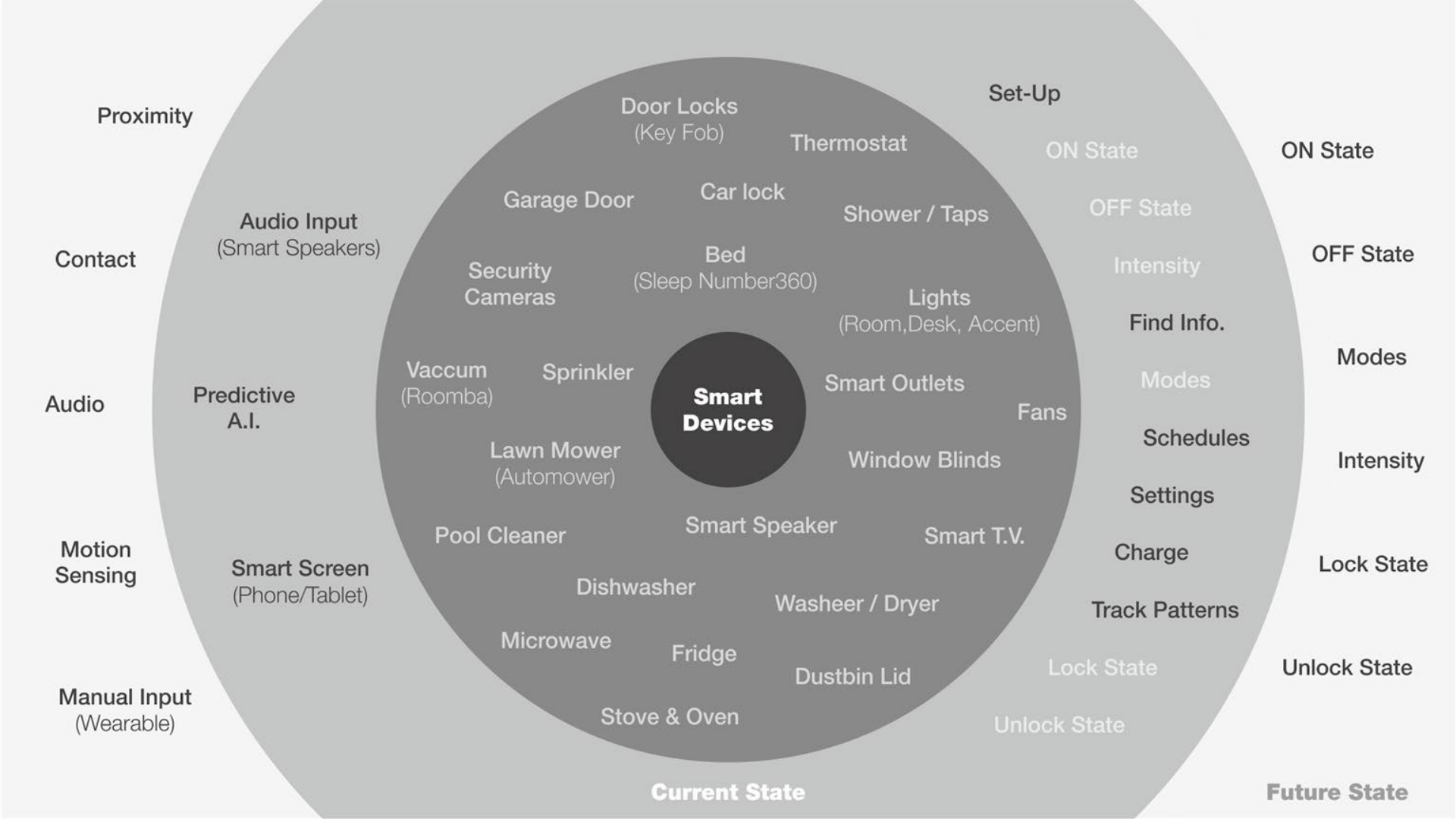
Morning Routine
Evening Routine

Devices Used:

Google Mini

Survey

To develop a list of smart devices users wanted to purchase.


Proximity
Contact
Audio
Motion Sensing
Manual Input (Wearable)
Audio Input (Smart Speakers)
Predictive A.I.
Smart Screen (Phone/Tablet)
Door Locks (Key Fob)
Thermostat
Garage Door
Car lock
Shower / Taps
Bed (Sleep Number360)
Security Cameras
Lights (Room,Desk, Accent)
Vaccum (Roomba)
Sprinkler
Smart Outlets
Smart Devices
Fans
Lawn Mower (Automower)
Window Blinds
Pool Cleaner
Smart Speaker
Smart T.V.
Dishwasher
Washeer / Dryer
Microwave
Fridge
Dustbin Lid
Stove & Oven
Current State
Set-Up
ON State
OFF State
Intensity
Find Info.
Modes
Schedules
Settings
Charge
Track Patterns
Lock State
Unlock State
Future State
ON State
OFF State
Modes
Intensity
Lock State
Unlock State

Observation (Interactions with smart homes)

Input Modalities & Modes

Need for a central command

Device Groups & Modes

Observation (Interactions with smart homes)

Input Modalities

H.I. Actions

Manual Controls

Decision v/s Suggestion

Need for a central command

Device Groups & Modes

Observation (Interactions with smart homes)

Input Modalities

Need for a central command

Ecosystem & H.I. Action Set-up

Ecosystem Failsafe

Device Groups & Modes

Observation (Interactions with smart homes)

Input Modalities

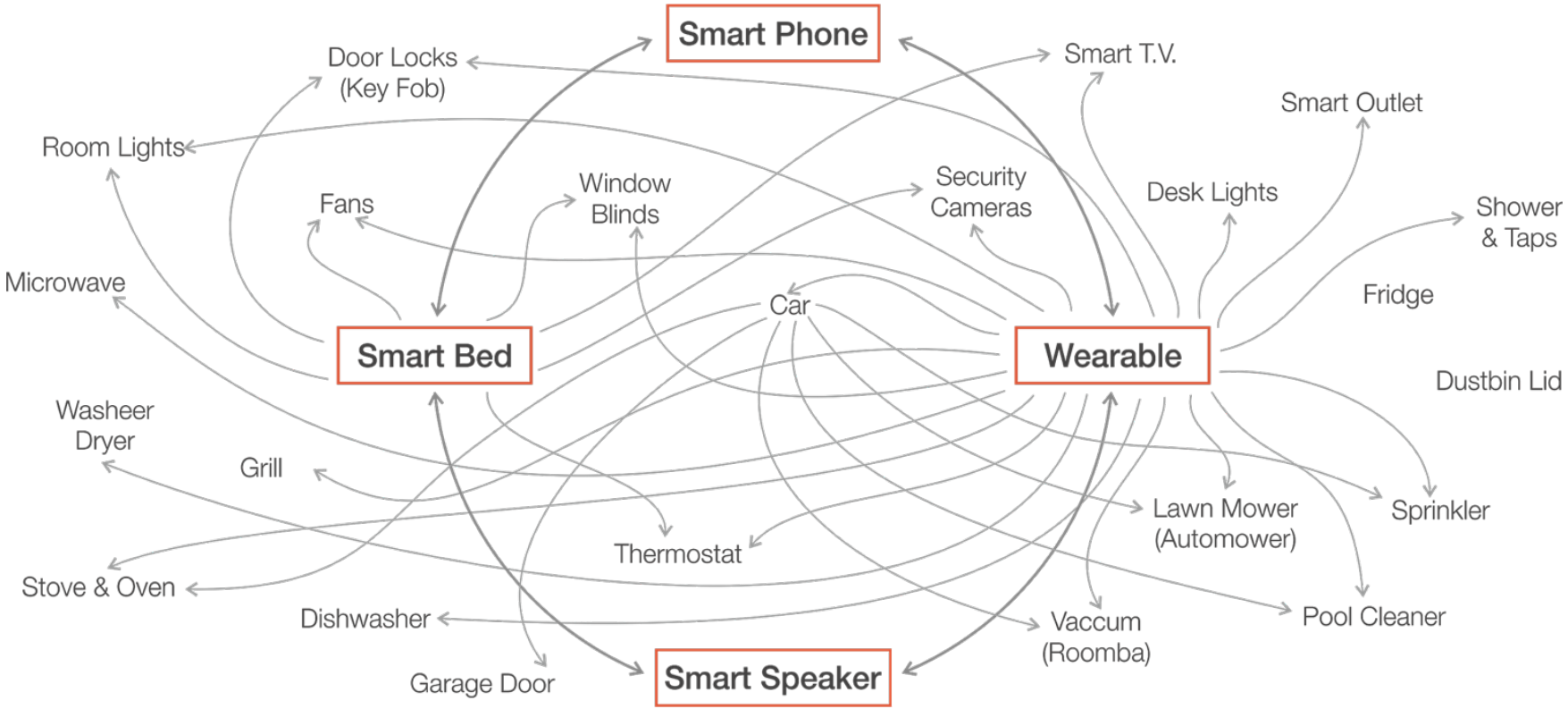
Need for a central command

Device Groups & Modes

Active & Inactive devices

Home Away & Sleep Modes

Connected Ecosystem



Wearable Device Considerations

Wearable Device Considerations

Parameters

Input Methods

Form & Placement

Wearable Device Considerations

Parameters

Discrete Actions (on/off, +1/-1) with unique device feedback

Function: Activate other Smart device functions

Input Methods

Form & Placement

Wearable Device Considerations

Parameters

Controls & Capabilities

Manual controls:
Select, Scroll, Back

Sensing Capabilities:
Proximity (NFC)
Biological Readings
External Data (WiFi)

Form & Placement

Wearable Device Considerations

Parameters

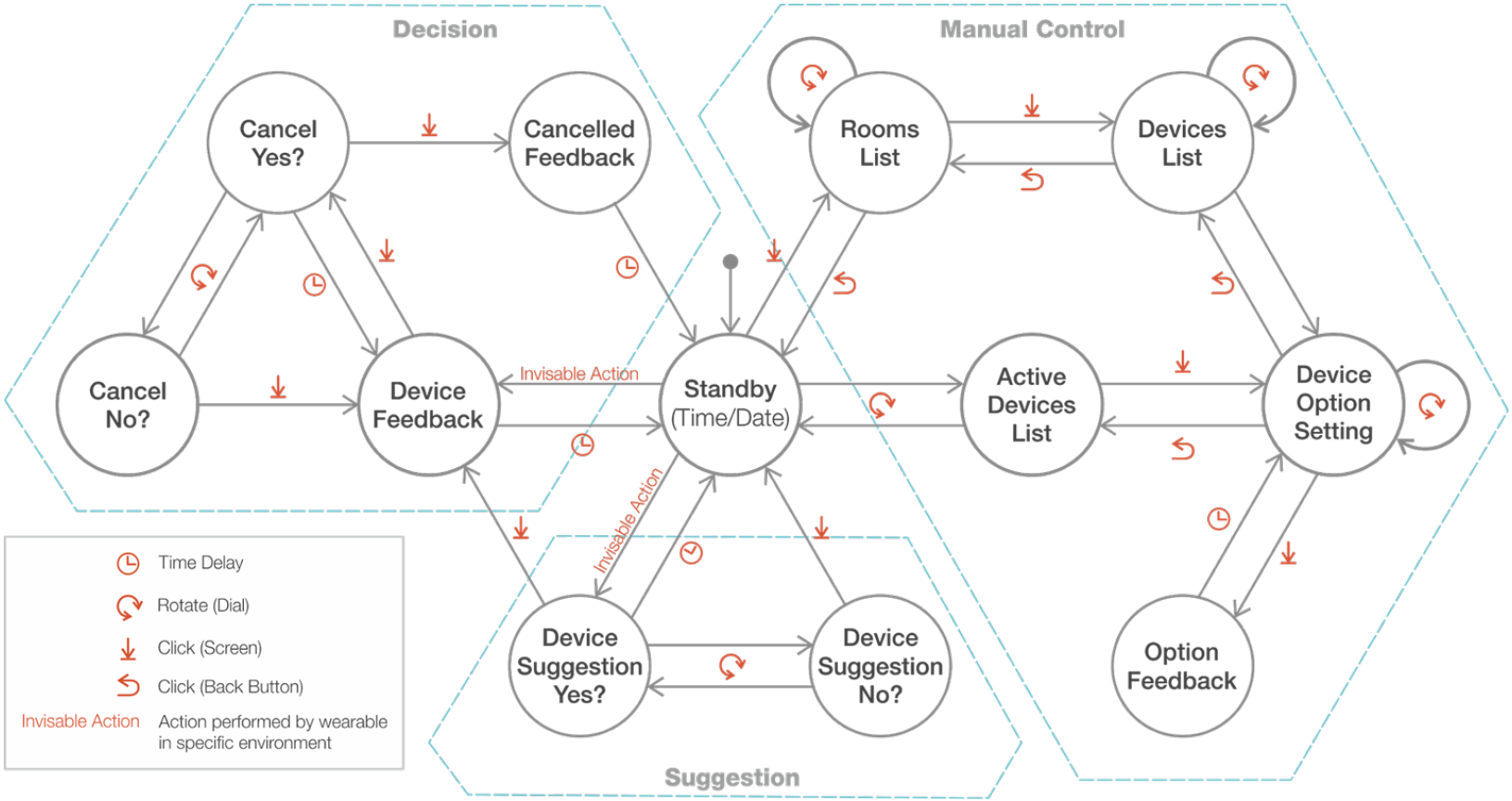
Input Methods

Form & Placement

Placement:
Most used body parts (Hand/arm)

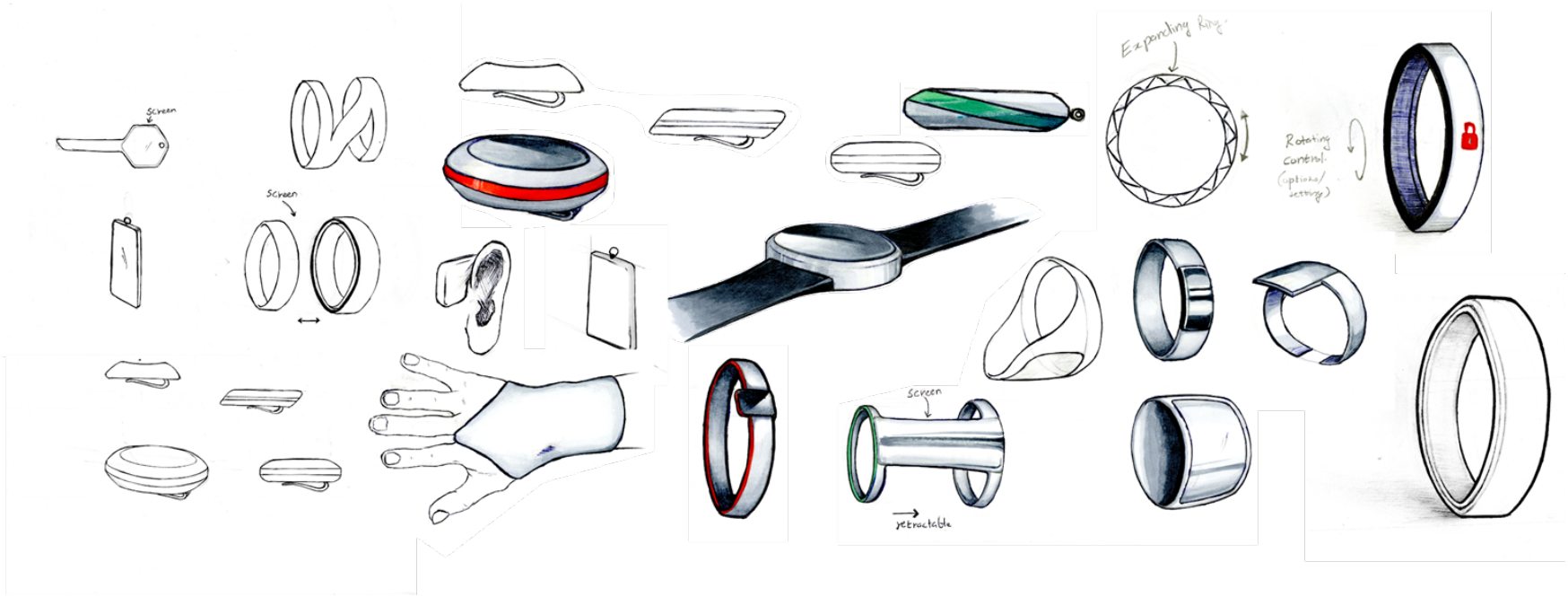
Device Form:
Range of wearable devices

State Diagram



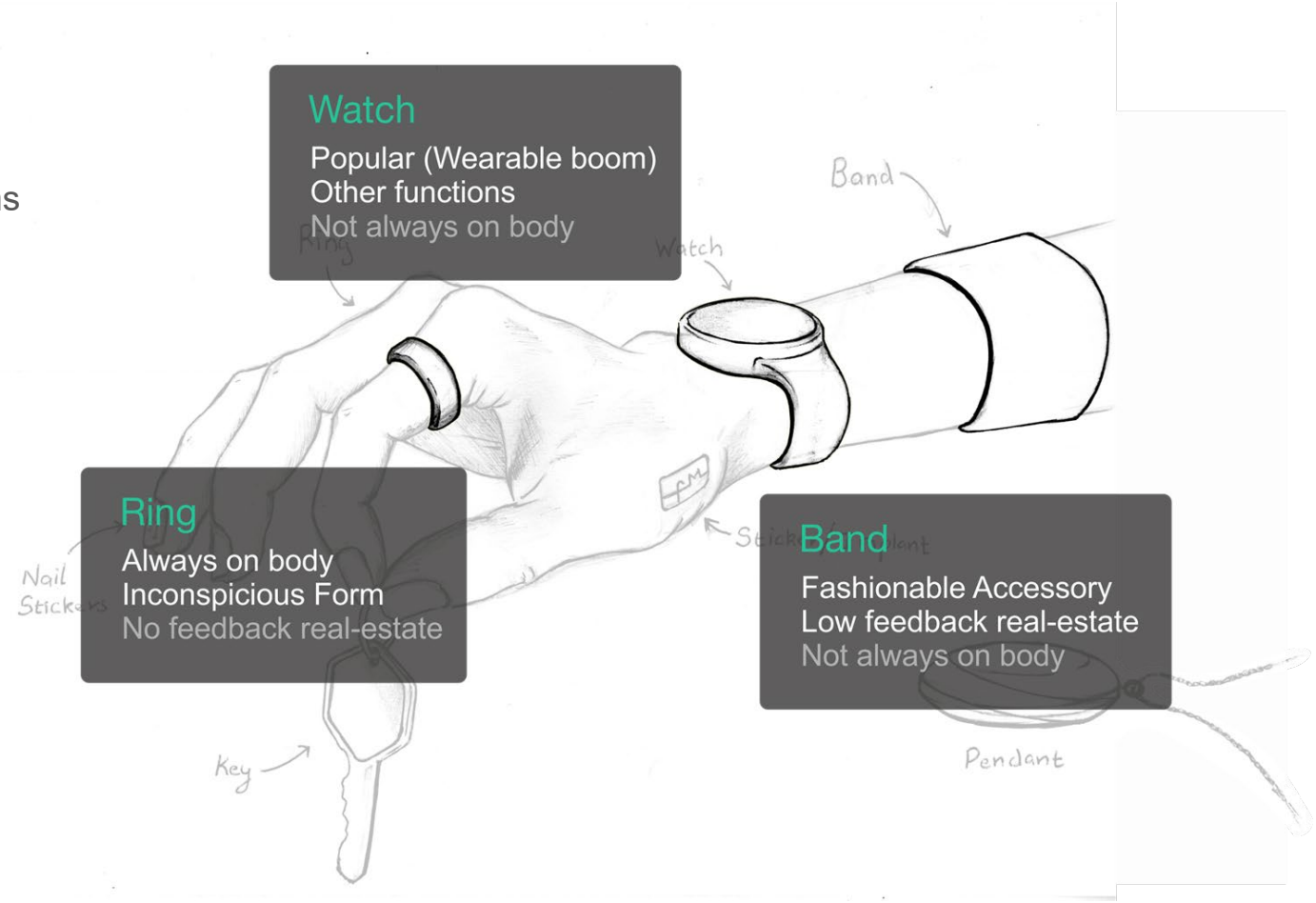
Ideation

Various forms around the wrist were explored for considered for initial ideation

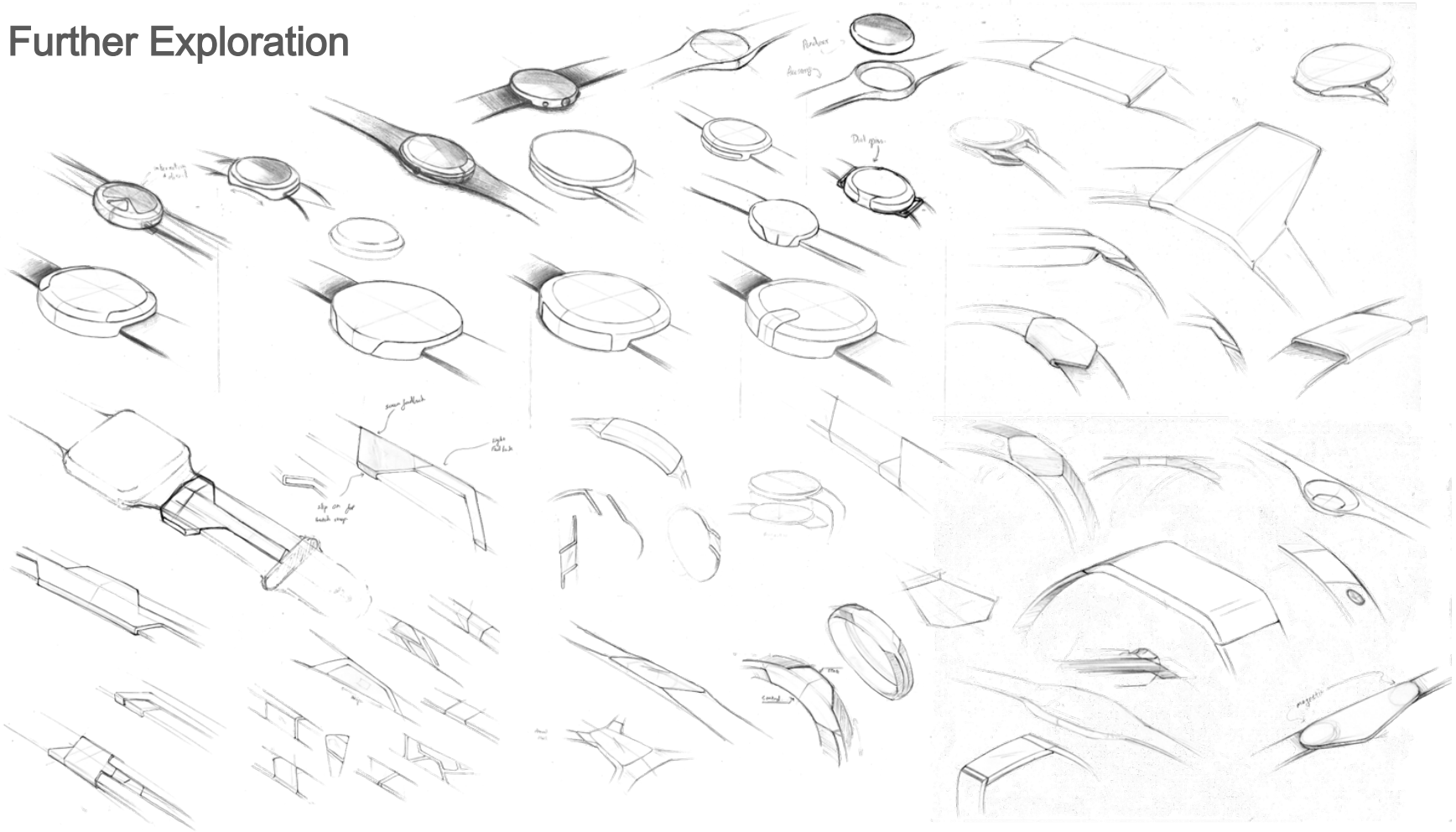


Ideation

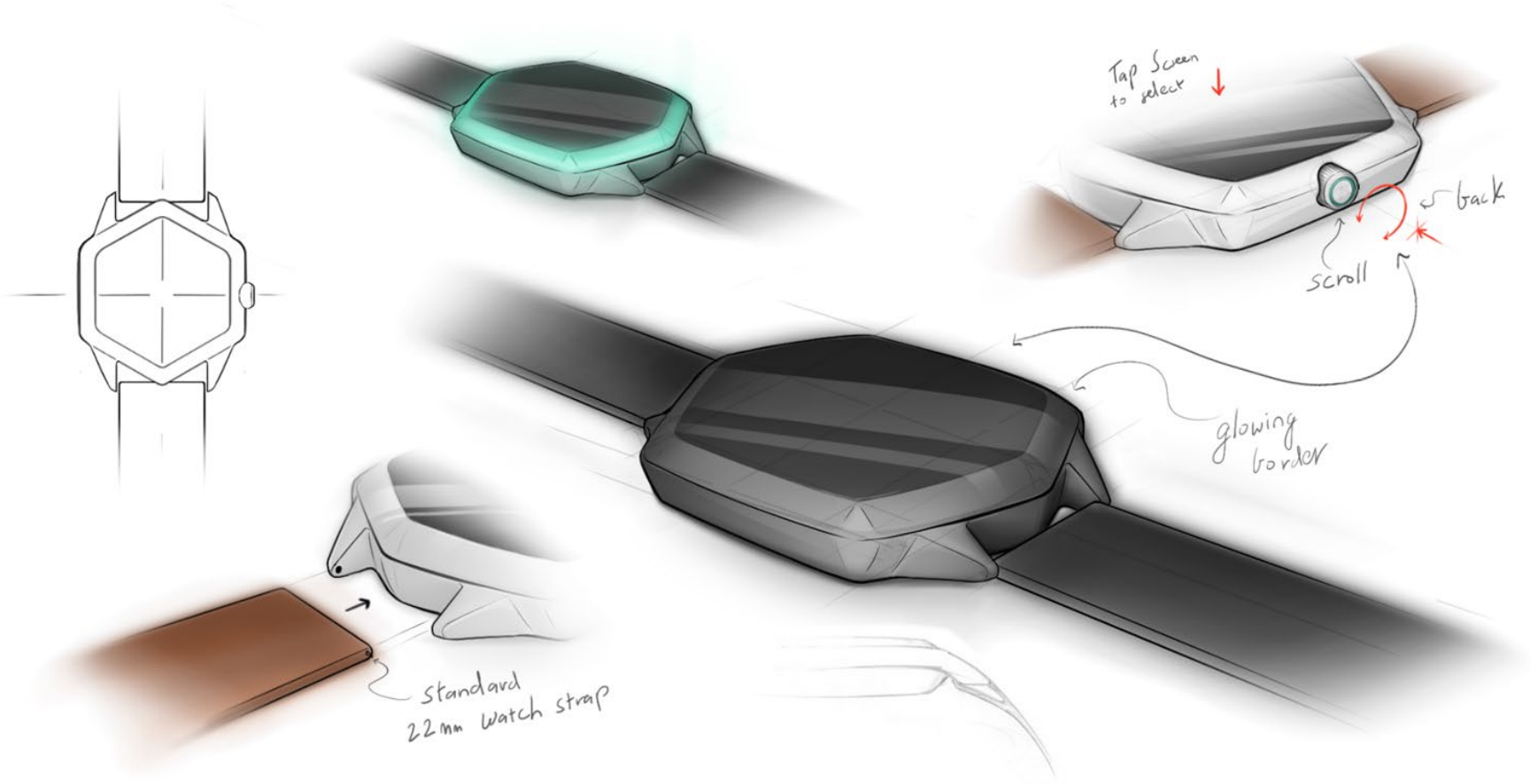
Based on participant feedback, these 3 forms were taken forward.



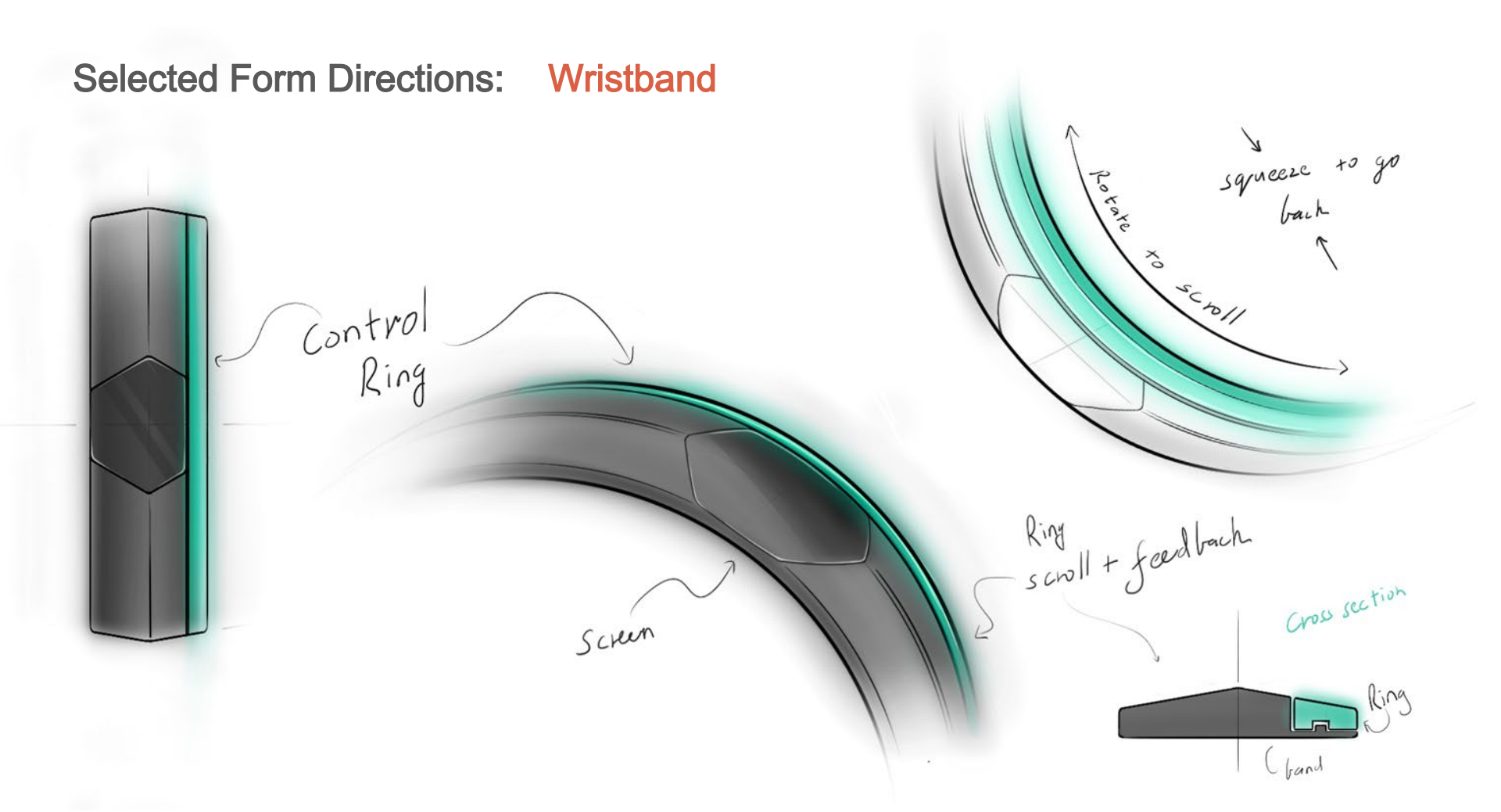
Further Exploration



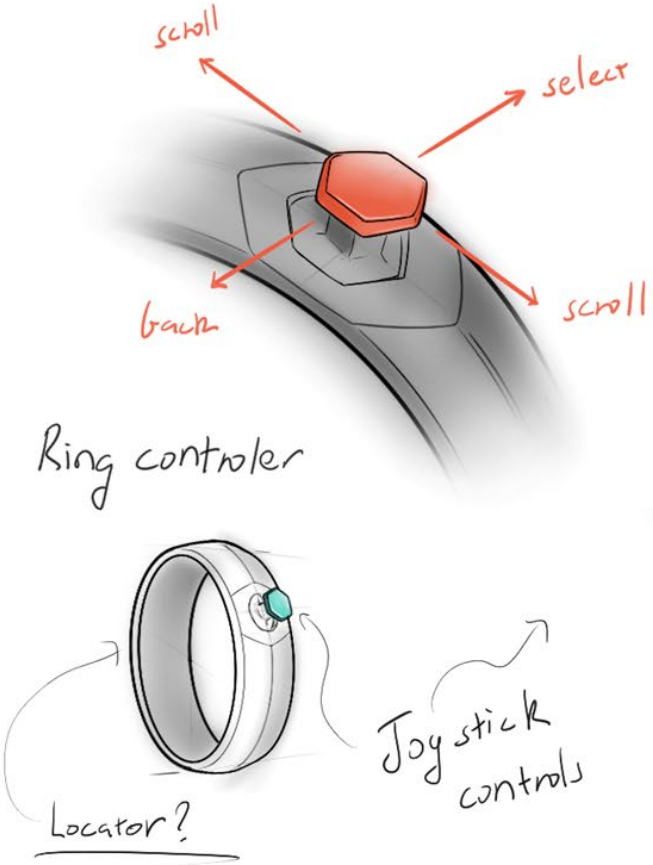
Selected Form Directions: Watch

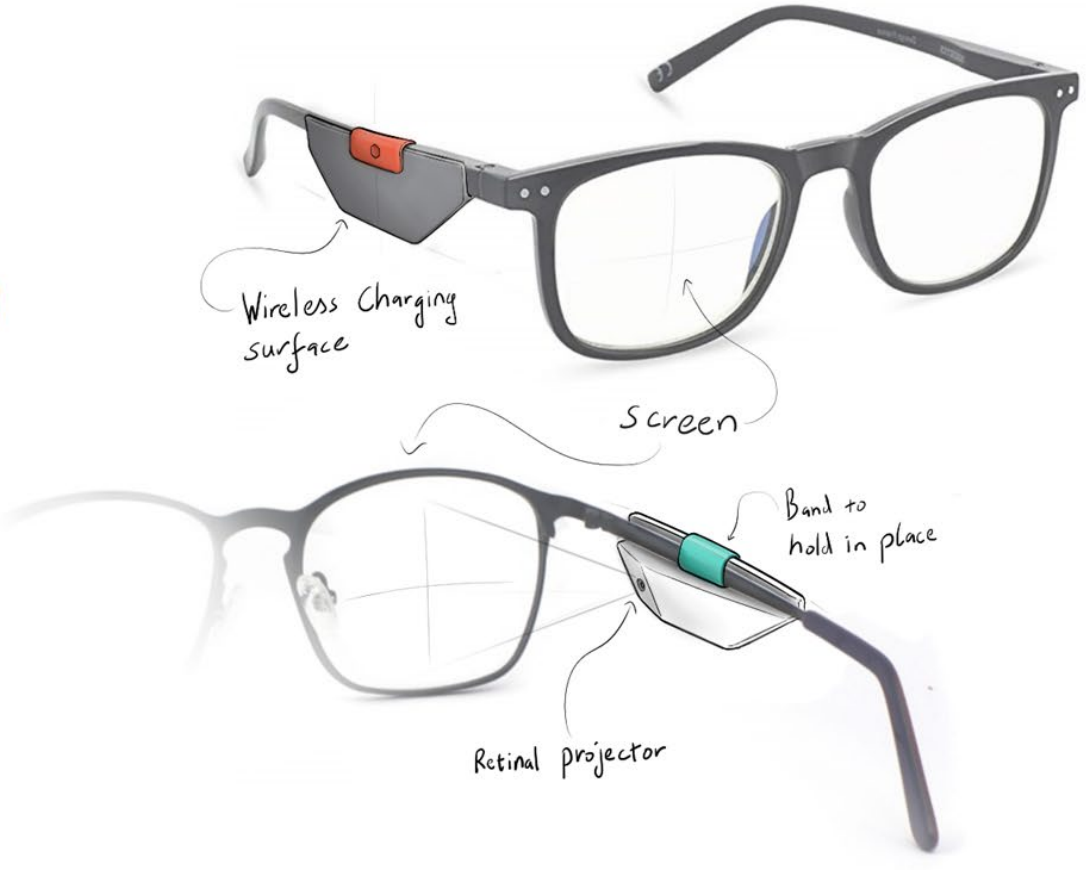


Selected Form Directions: Wristband



Selected Form Directions: Projector + Ring Controller





App UI Considerations

Functions of Ecosystem

- Set-up & Edit Ecosystem
- Set-up & Edit H.I. Actions
- Locate Devices within Digital Space
- Control Smart devices

Functions of Ecosystem

Set-up & Edit Ecosystem	Set-up & Edit H.I. Actions	Locate Devices within Digital Space	Control Smart devices

App Functions

All these functions can be performed through the central command app

Functions of Ecosystem

Set-up & Edit Ecosystem

Set-up & Edit H.I. Actions

Locate Devices within Digital Space

Control Smart devices

Wear Functions

These are specific to the WT device in order to control the ecosystem

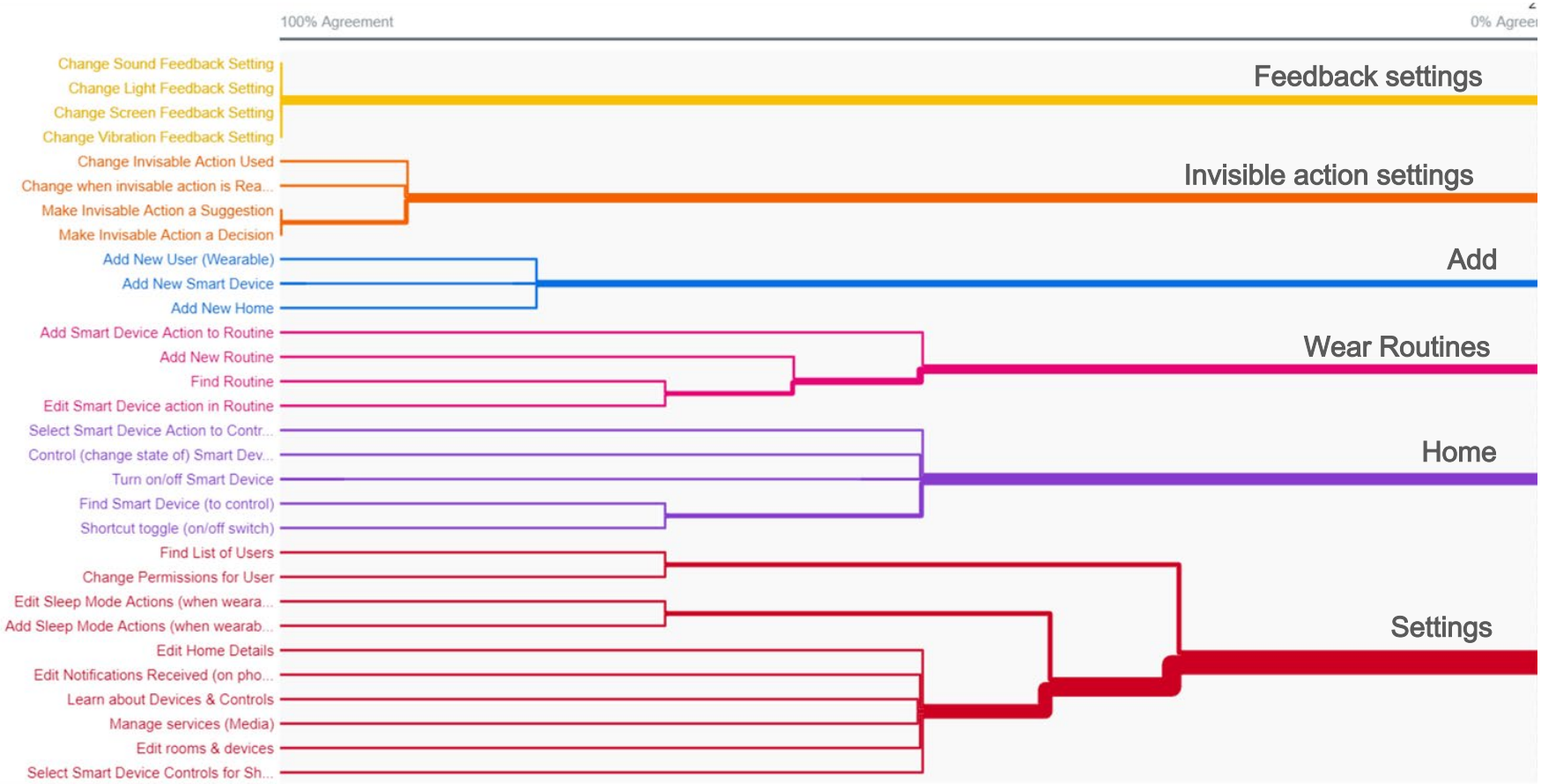
Open Card Sort

To gain an understanding of user mental models when interacting with the system.

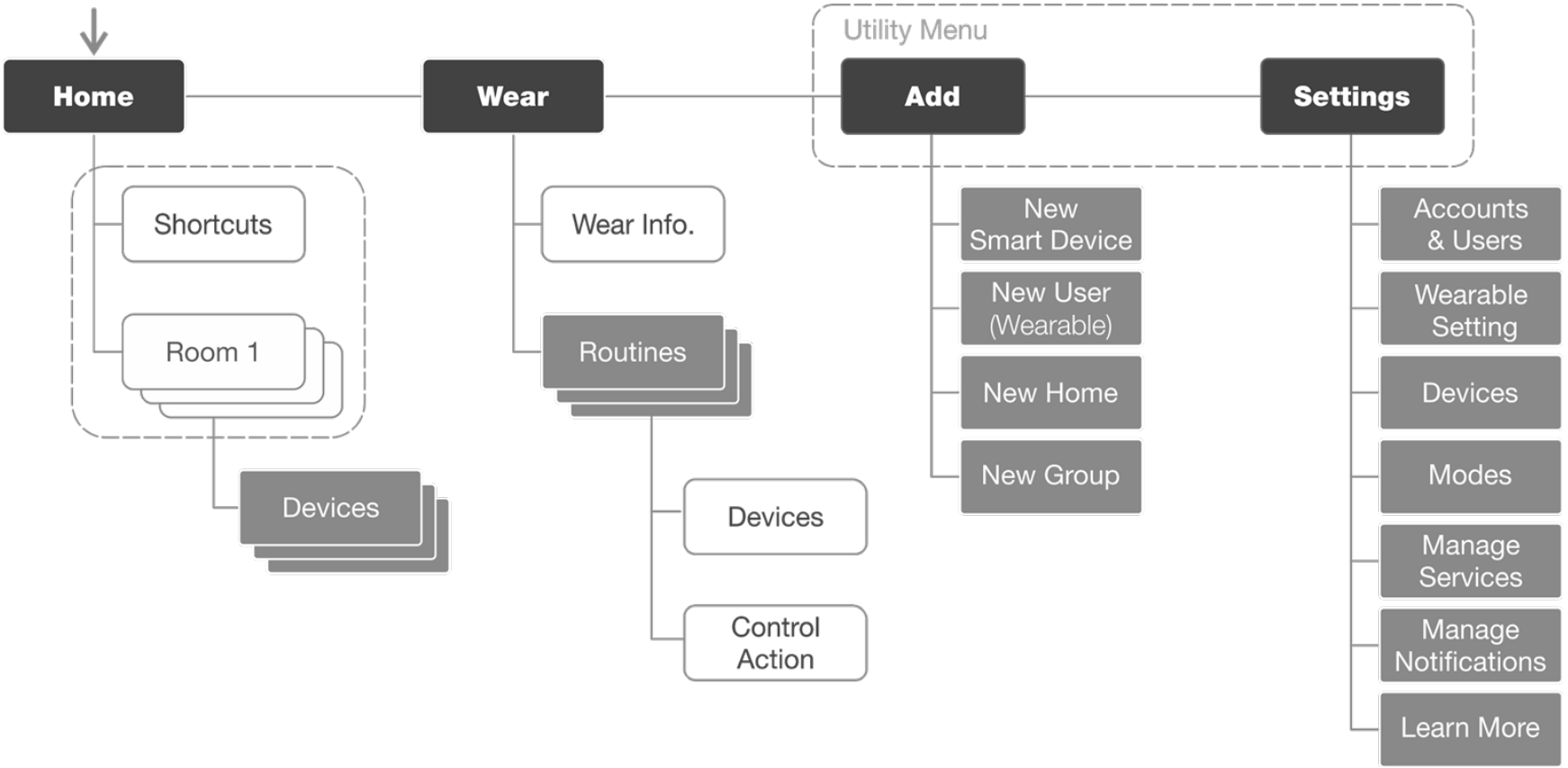
31 Cards (features)

Optimal sort was used to make the process digital and far reaching.

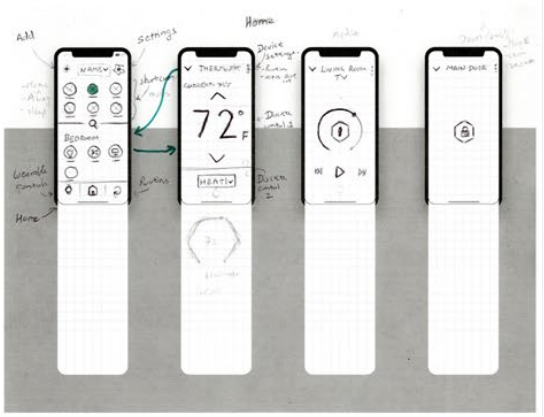
Open Card Sort

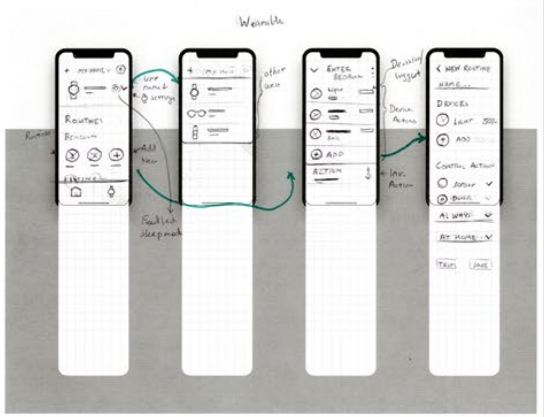


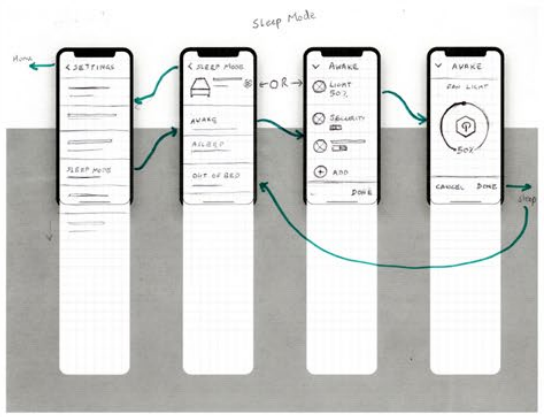
Higher Level Blueprint

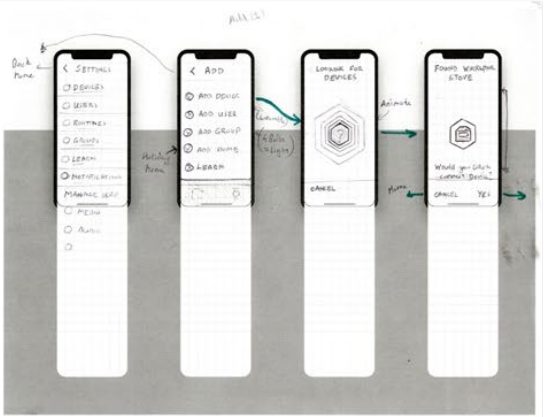


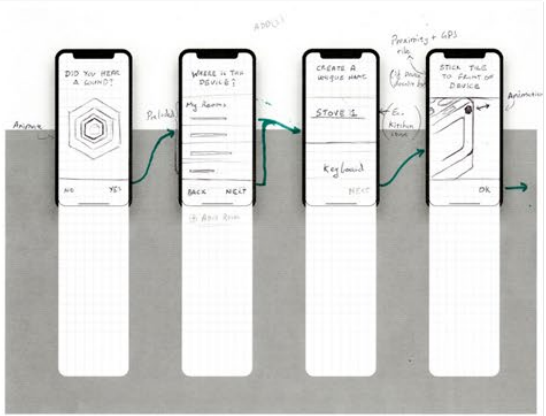
Lo-Fi Wireframing

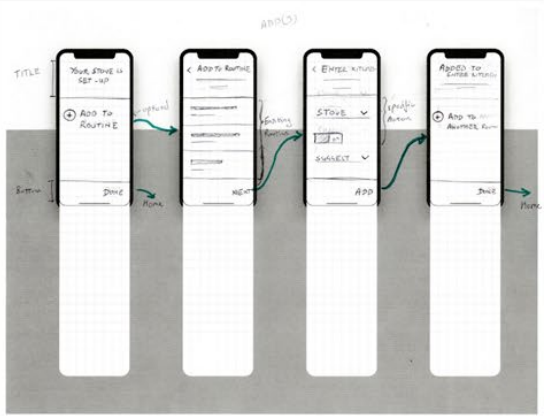












UI Style Guide

Title text	Roboto Regular 28 100% White
Sub Title Text	**Roboto Medium 16 100% White**
Body text	Roboto Light 12 100% White
Body text unselected	Roboto Light 12 70% White
Body Text deactivated	Roboto Light 12 30% White

Background #303030	Overlay #212121	Device ON #25C499
Selected #FFFFFF	Unselected #FFFFFF(70%)	Unselected #FFFFFF(30%)

Hi-Fi Prototype & Quasi -empirical User Test

Complete Tasks

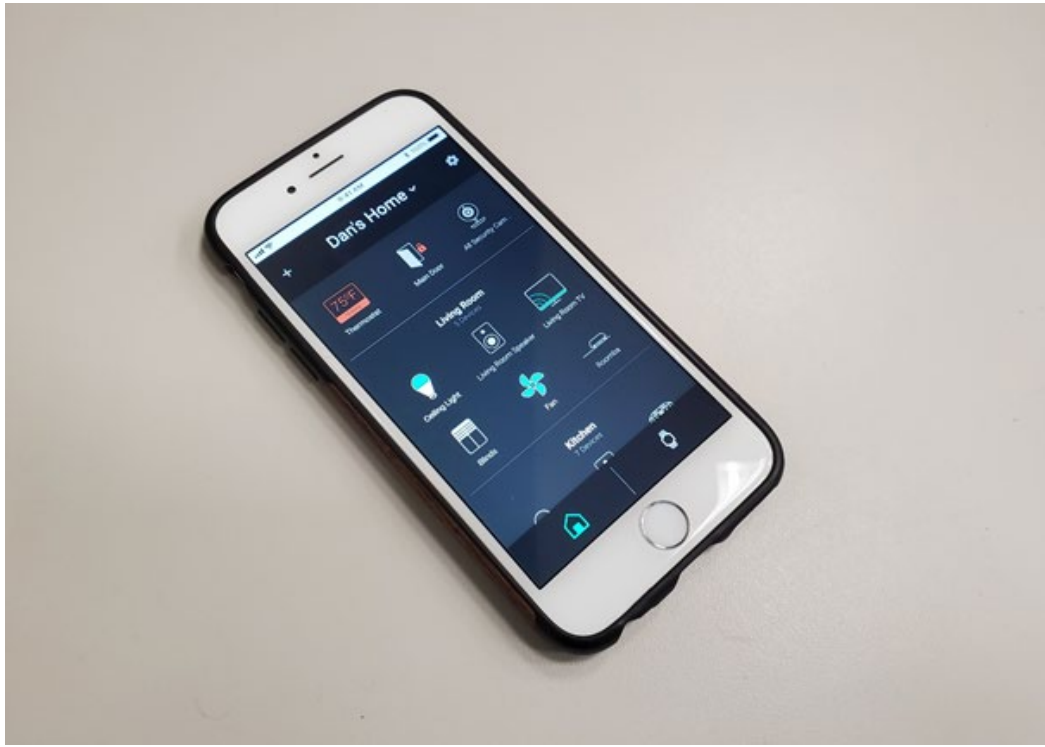
- Open/ close the door and security cameras
- Set the thermostat to cool
- Turn off living room TV

- Find users in the home and their wear devices
- Change the action used to trigger wake up routine
- Add coffee maker to the wake up routine

- Set up a new smart device
- Add a new user wearable

Respondents

30 participants, 10 min/person



User Test: Insights

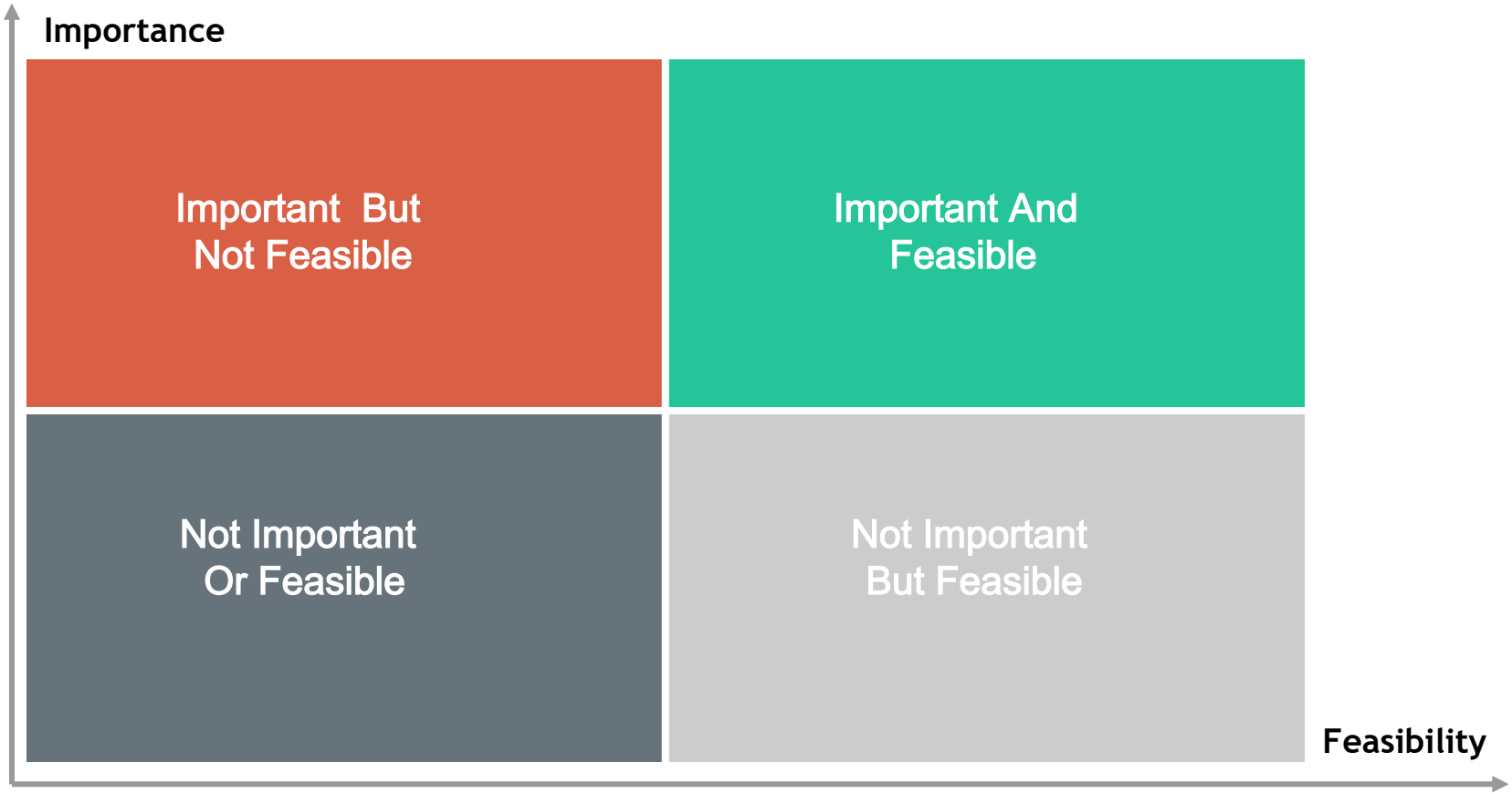
What is good

- Layout and visuals
- Finding information
- Dark theme
- Adding new devices
- Toggle shortcuts for devices

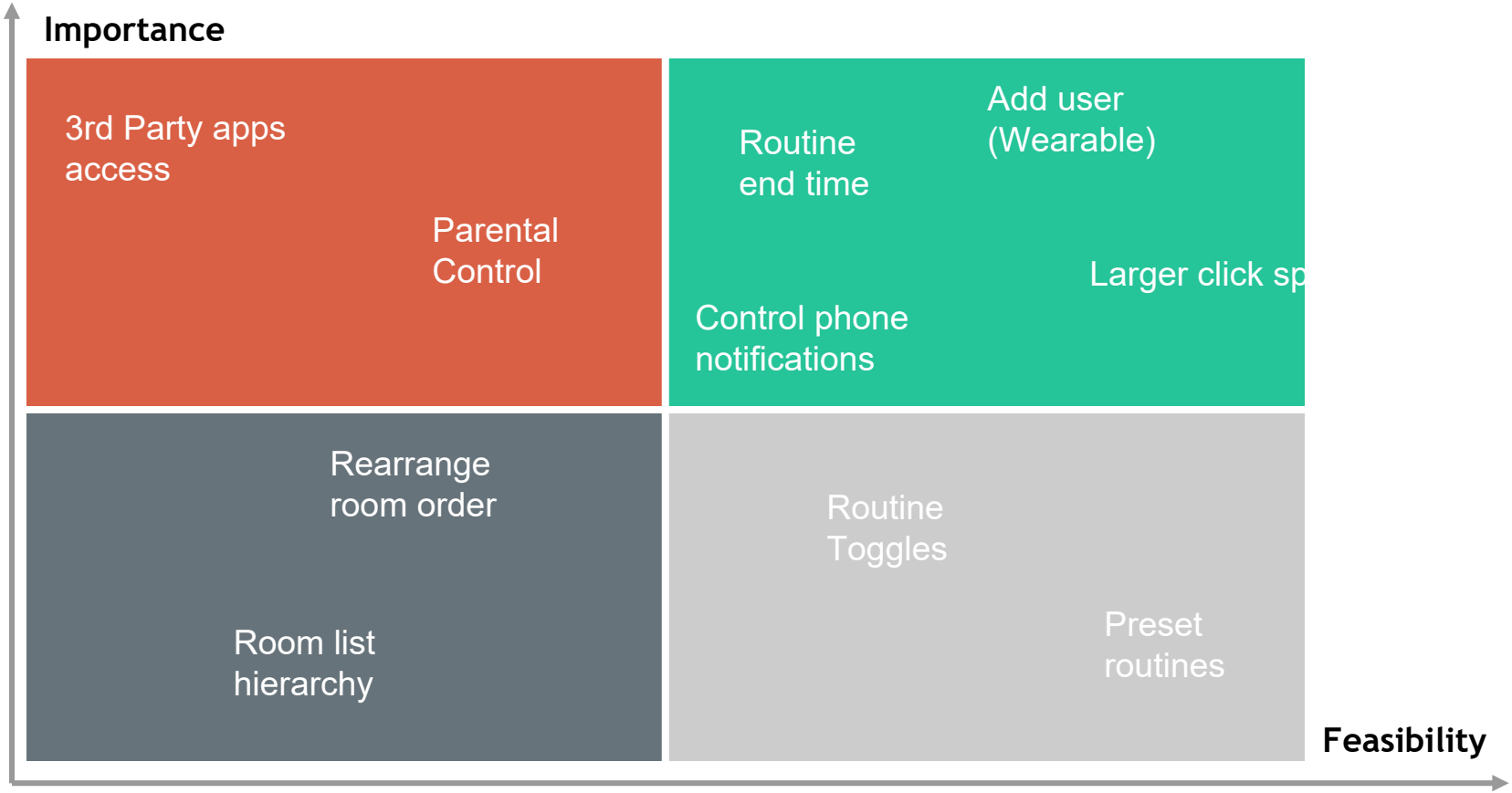
What needs to improve

- Add User (wearable)
- Larger click space
- Parental Control
- Room list hierarchy
- Quick toggles in routines
- Add more device features
- Routine end time

Response Filter



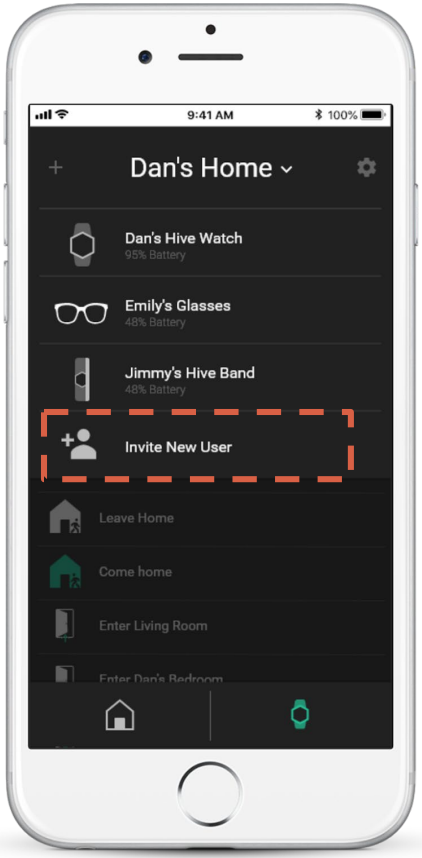
Response Filter

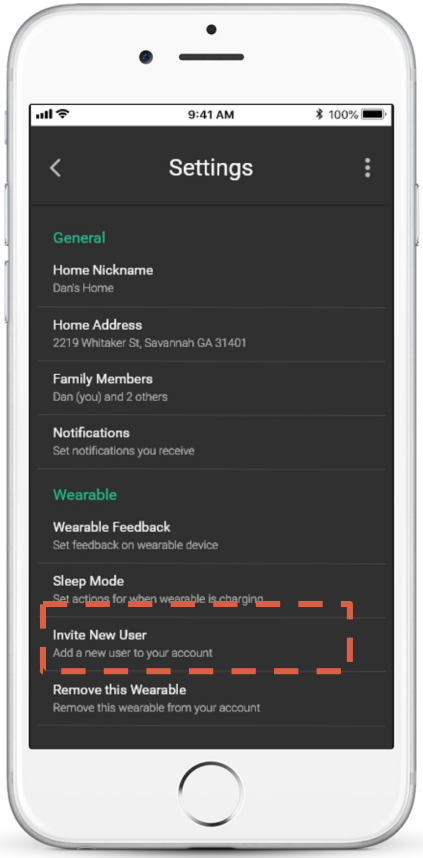


App Adjustments

Participants had difficulty finding the add new user button

Multiple points of access through add, settings and wear pages.

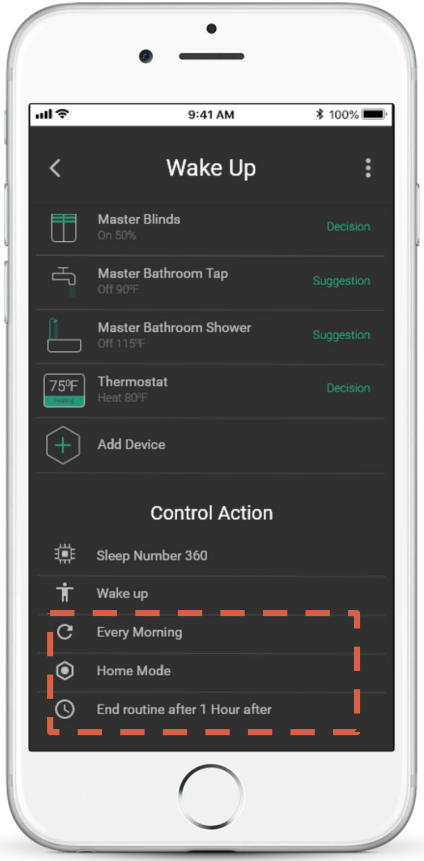




App Adjustments

It is important to have a routine end tim so that the routine does not keep going.

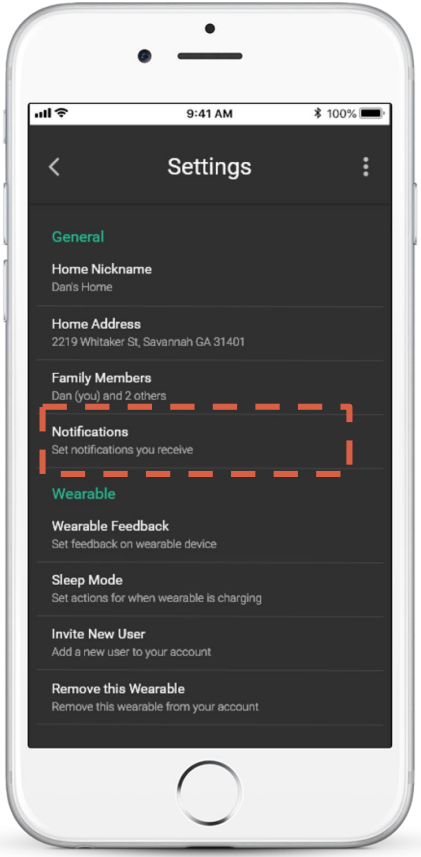
Add end time specification to Actin control settings in routines



App Adjustments

It could be annoying if your phone keeps buzzing every time a routine is performed

Control notifications that you receive on your through settings



Hive Mind

The smart home ecosystem with a human touch

Hive Mind

The smart home ecosystem with a human touch

Hive Wear

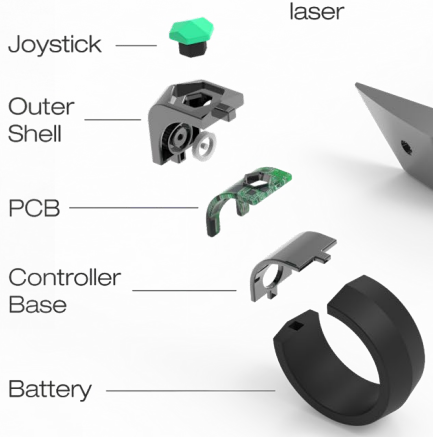
The new key to your smart home

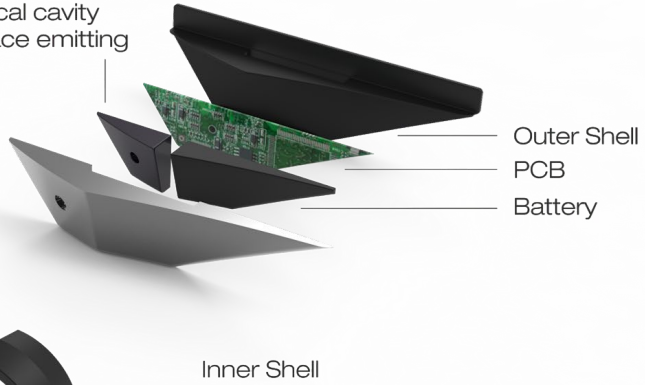
Hive Wear performs smart device tasks by reading invisible human actions and relative position thus making the user the center of interaction.

It also provides feedback of invisible actions and manual control of smart devices to help build user trust in the technology & compensate for human tendencies

Hive Lens

Truly ambient interaction





Human Interface Actions

Decisions *(Enter Living Room)*

When an H.I. Action is performed as an automated decision (without user input), the wearable provides feedback in the form of:

- Vibrational Feedback of Action
- Visual Feedback of Smart Device State (Screen)

Human Interface Actions

Suggestions *(Sit on Couch)*

When an H.I. Suggestion is performed, the wearable provides feedback and allows the user to choose if the action should be performed.

Manual Control

Active Devices *(Someone's at the Door)*

Active Smart devices (Ex. Main Door Lock) can be accessed and controlled by scrolling down to the required device and selecting it to change its state.

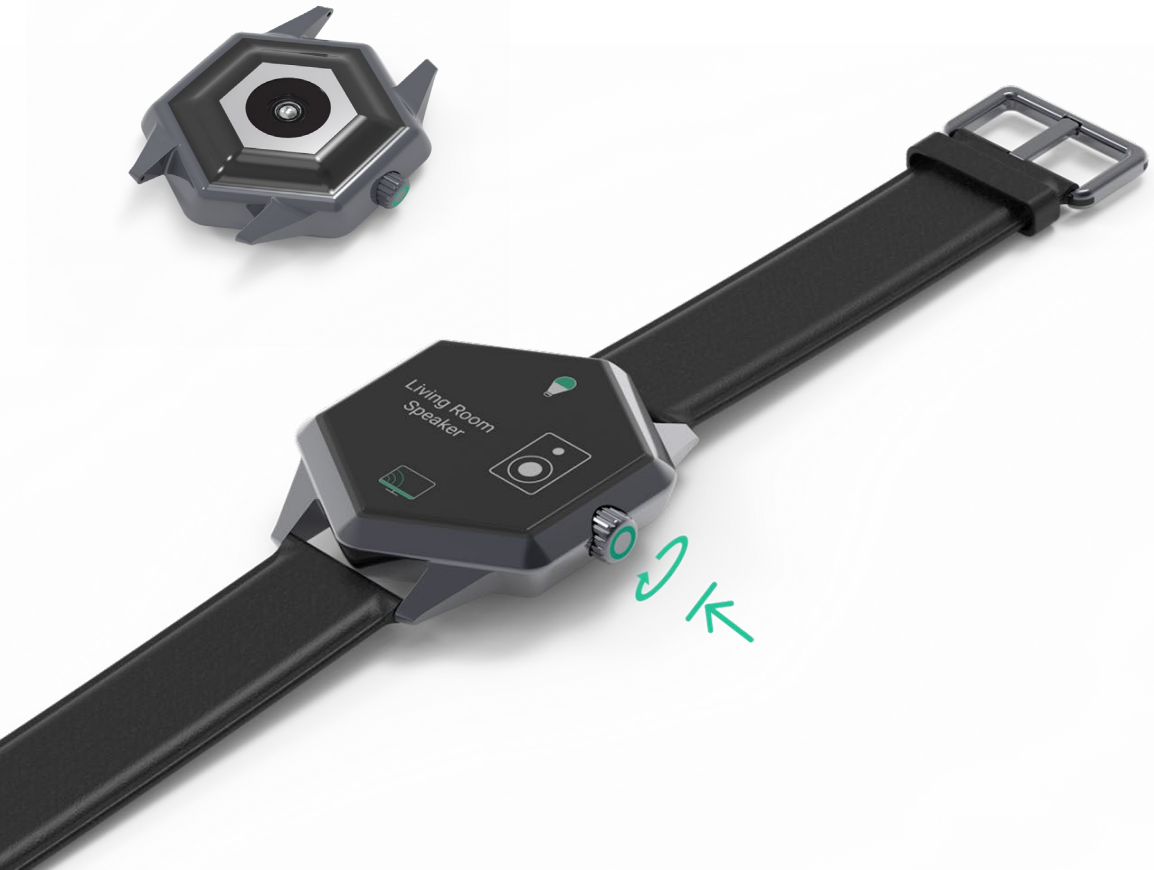
Manual Control

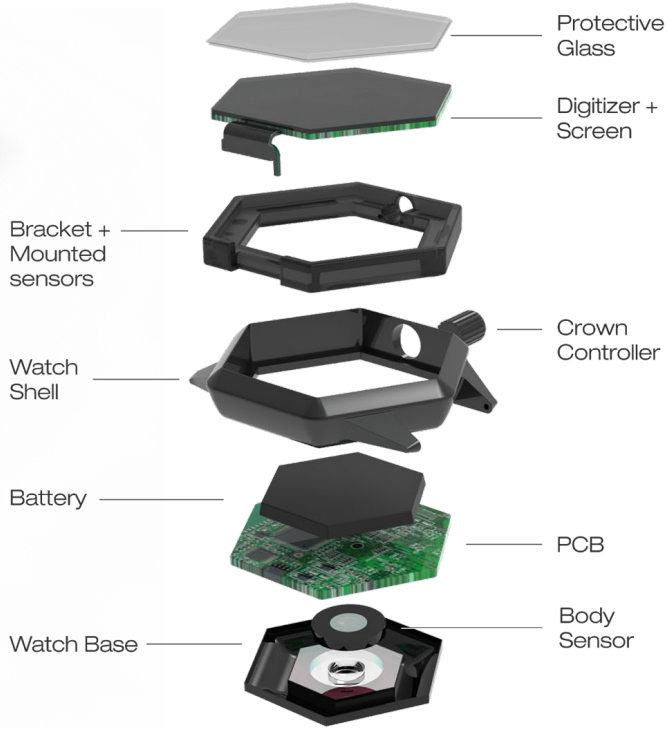
All Devices *(Shut the Blinds)*

If the user is unhappy with the state a particular smart device is in, they can change that device state by searching for the room specific smart device and editing its state.

Hive Watch

More than just another smart watch





Human Interface Actions

Decisions *(Enter Living Room)*

When an H.I. Action is performed as an automated decision (without user input), the wearable provides feedback in the form of:

- Vibrational Feedback of Action
- Visual Feedback of Action (Glowing Edge)
- Visual Feedback of Smart Device State (Screen)

Human Interface Actions

Suggestions *(Sit on Couch)*

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Manual Control

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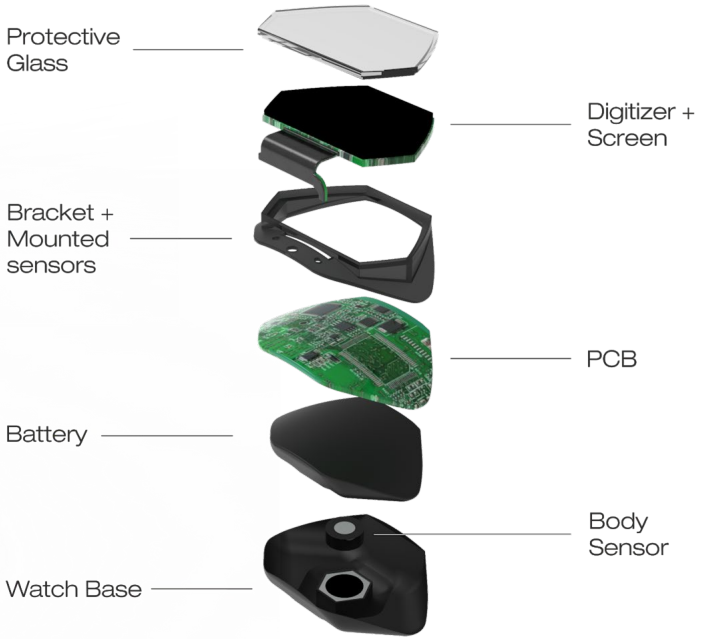
Hive Band

Form that blends fashion & technology



Human Interface Actions

Decisions *(Enter Living Room)*

When an H.I. Action is performed as an automated decision (without user input), the wearable provides feedback in the form of:

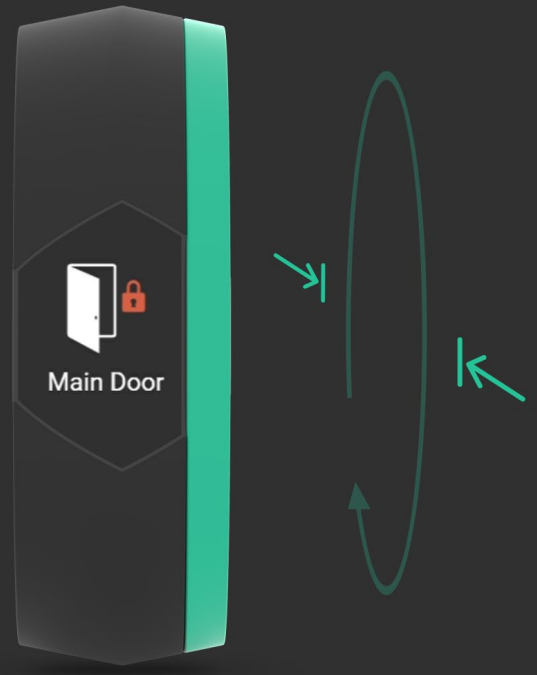
- Vibrational Feedback of Action
- Visual Feedback of Action (Glowing Ring)
- Visual Feedback of Smart Device State (Screen)

Human Interface Actions

Suggestions *(Sit on Couch)*

When an H.I. Suggestion is performed, the wearable provides feedback and allows the user to choose if the action should be performed.

Manual Control



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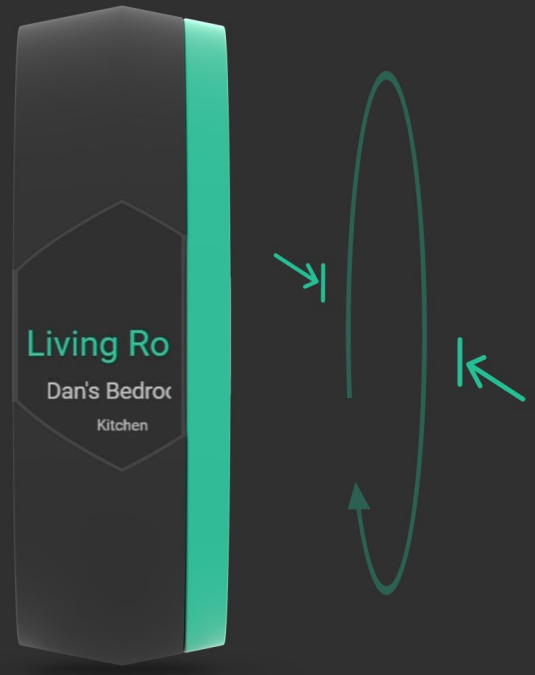
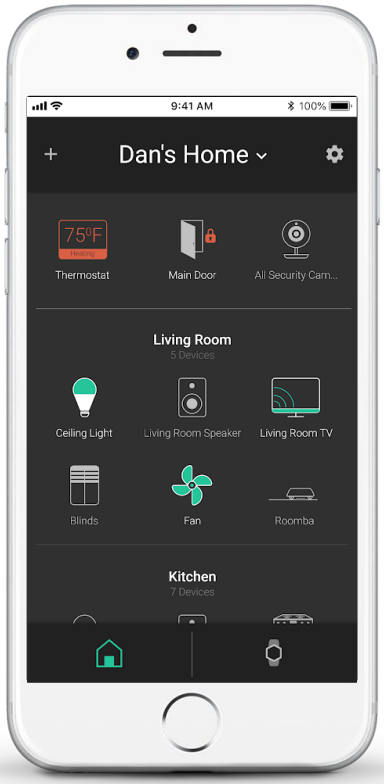


All Devices *(Shut the Blinds)*

If the user is unhappy with the state a particular smart device is in, they can change that device state by searching for the room specific smart device and editing its state.

The Wear comes with an assisting *Hive App* that acts as a fail safe for the Wear and also performs more complex actions like setting up new devices & Wear Routines

Hive App



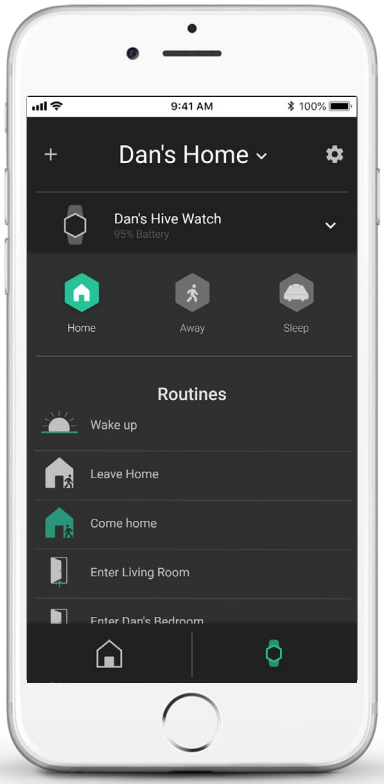
Central Control

The *home tab* displays all connected devices, segregated by room that can be controlled through the app via:

- Discrete Control
- Discrete + Variable Controls
- Discrete + Variable + Media Controls

Additionally, there are (user generated) device toggle shortcuts at the top of the page for quick access to certain devices.

Hive App



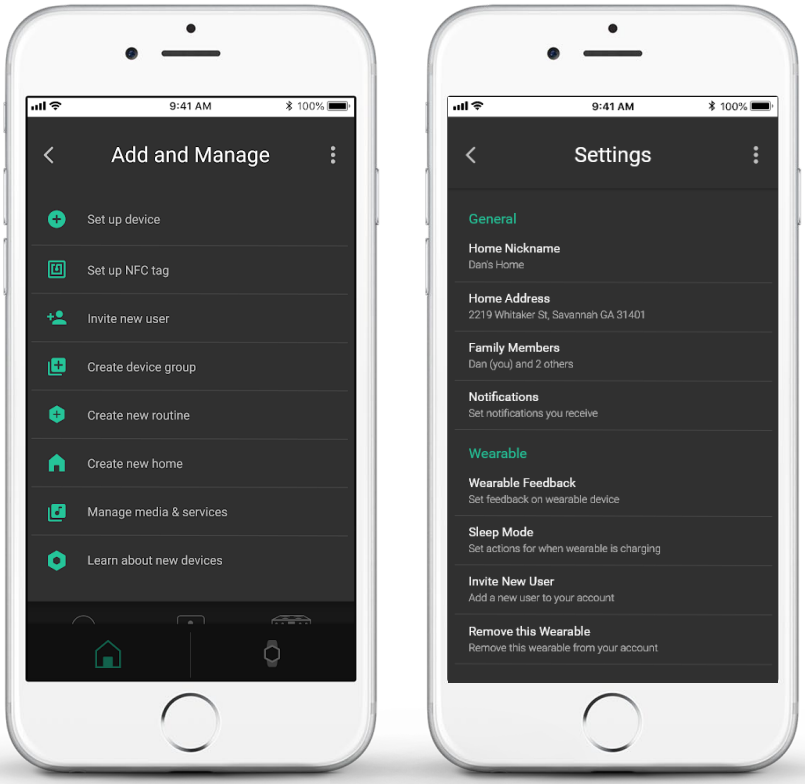
Connected Wear

The *wear tab* shows users (and their wear devices) connected to the home. Next, it shows the mode that the wearable is in, based on its state:

- Home
- Away
- Asleep (charging)

It further shows "Routines" that are activated by the wear device when performing specific actions. These actions, and the devices they control can be set here in this tab.

Hive App



New Additions

The dedicated add button on the top left corner allows for quick set up of new devices, wear devices & routines.

Additionally, devices can be added from settings menu on the top right.

Routines can also be added/imported within the set up process to save time and effort.

Physical Prototypes

Wizard of Oz Prototype

To gauge user acceptance of form, and interaction within this system and identify possible flaws and pitfalls that could lead to failure.

Devices Used:

- One of three WT devices as prop
- Phone with WT screen prototype
- Phone with App prototype

Staged experience prototype:

- A researcher walks with participants and enacts WT feedback
- A second researcher controls smart devices in the space via another phone.

Wizard of Oz Prototype

Irrational human Tendencies

“Will this work with my Alexa?”

Multiple Users

Wizard of Oz Prototype

Irrational human Tendencies

“Will this work with my Alexa?”

Multiple Users

Wizard of Oz Prototype

Irrational human Tendencies

“Will this work with my Alexa?”

Multiple Users

Wizard of Oz Prototype

Irrational human Tendencies

“Will this work with my Alexa?”

Multiple Users

Further Study

Human behaviors when living in a shared space and how decisions are made regarding shared utilities within a home to further understand how to deal with **complexity of actions within an AmI** ecosystem.

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Much more research needs to be conducted before we can **completely move away from the concept of "adapting to the machine in front of you."**

Further Study

Human behaviors when living in a shared space and how decisions are made regarding shared utilities within a home to further understand how to deal with complexity of actions within an AmI ecosystem.

Q & A

fmehta20@student.scad.edu

Much more research needs to be conducted before we can completely move away from the concept of “adapting to the machine in front of you.”