

AURA

Thermostat

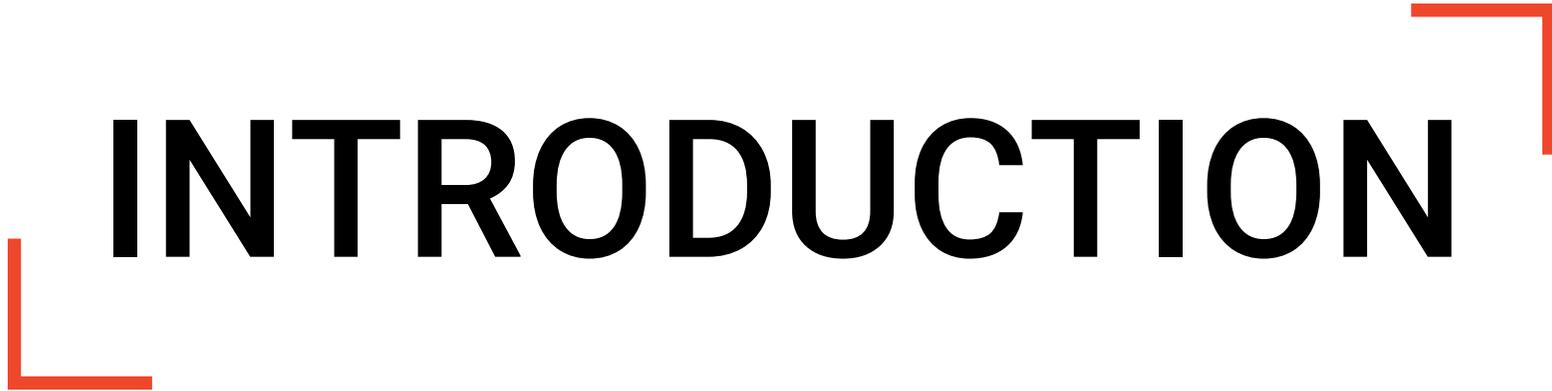


Trane x SCADpro | Spring 2020

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INTRODUCTION



 <p>TRANE scadpro Alex</p>	 <p>TRANE scadpro Esther</p>	 <p>TRANE scadpro Nathan</p>	 <p>TRANE scadpro Amy</p>
 <p>TRANE scadpro Bella</p>	 <p>TRANE scadpro Star</p>	 <p>TRANE scadpro Sparkle</p>	 <p>TRANE scadpro Vivian</p>
 <p>TRANE scadpro Viki</p>	 <p>TRANE scadpro Juan</p>	 <p>TRANE scadpro Christine</p>	 <p>TRANE scadpro Grace</p>
 <p>TRANE scadpro Serena</p>	 <p>TRANE scadpro Goutham</p>	 <p>TRANE scadpro Nick</p>	 <p>TRANE scadpro David</p>

Our Team

We are a SCADPro team comprised of 14 students, spanning 5 nations, and 4 different majors, all with the goal of redesigning the physical and digital components of Trane's Pivot Thermostat. Our experience was particularly innovative due to the different working conditions the pandemic brought.

Come join us on our journey!





Nick Dine
Industrial Design
Professor



Alex Whitman
Industrial Design
B.F.A.



Goutham Thirumalesh
Industrial Design
M.F.A.



Shuning Fan (Serena)
Industrial Design
M.F.A.



Yan Lyu (Sparkle)
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B.F.A.



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Guanzhi Kou (Grace)
Interactive Design &
Game Development M.F.A.



Amir Ahmadi
Interactive Design &
Game Development M.F.A.



Yoojeong Chol
Graphic Design
& Sequential Art B.F.A.



Our Partner

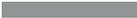
Trane® is a world leader in air conditioning systems and services. They provide help for customer success by providing innovative solutions that optimize indoor environments through a broad portfolio of energy-efficient systems: heating, ventilating, air conditioning, building, contracting and energy services, controls for homes and commercial.





TRANE®

PROPOSAL





Project Proposal

Trane asked us to redesign their commercial thermostat, Pivot. The redesign included the outer shell and user interface. The redesign had to match that of the Leaf AirFi Family, created by our sister SCADPro team.





Project Vision

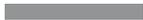
SCADPTO TRANE

Trane's Vision

As a company Trane is focused on sustainability and efficient climate solutions. They are looking for a thermostat that is the leader of 2022 and lasts into 2030 and ultimately supports the user.

Our Mission

To create a commercial thermostat with a universal design language that is user centered and future proof to empower Trane to make a sustainable global impact.



Our Design Metrics

After aligning with Trane's vision and the needs of the users, the Trane SCADPro team proposed three metrics to define their future commercial thermostat.



Modern Design

- Simple Look
- Screen Oriented
- Trane Identity



User Acceptance

- Longevity
- Flexibility
- Sustainability



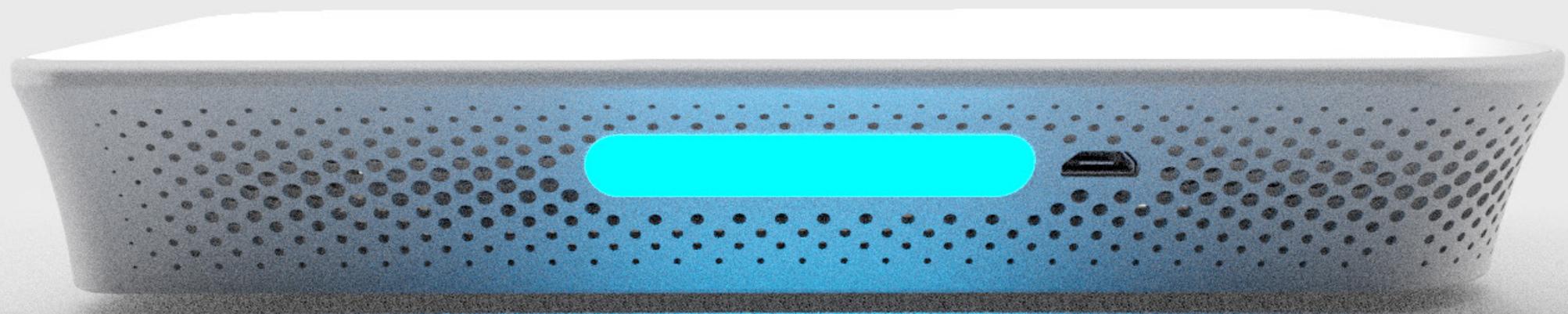
Futureproof

- Ease of Access
- Improve Efficiency
- Remote Control



The **AURA**





Modern Design

SCADPTO TRANE

Simple Look

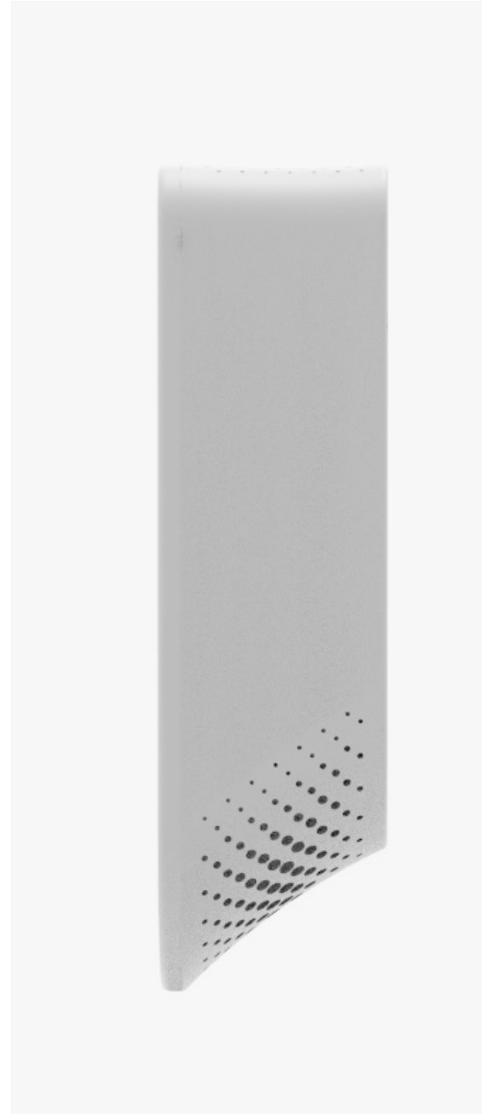
Clean Curves

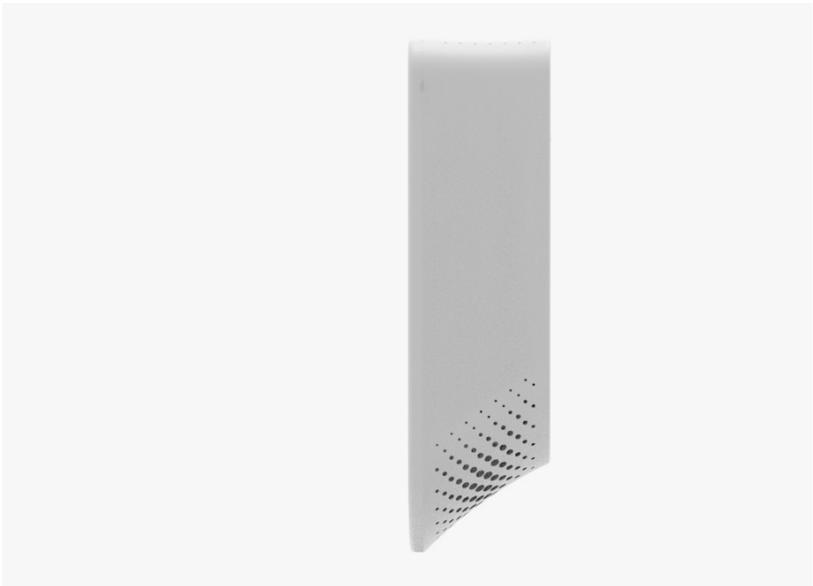
Screen Oriented

Full Touch Screen

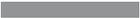
Trane Identity

The Leaf Family





SCADPRO TRANE



User Acceptance

SCADPRO TRANE

Ease of Access

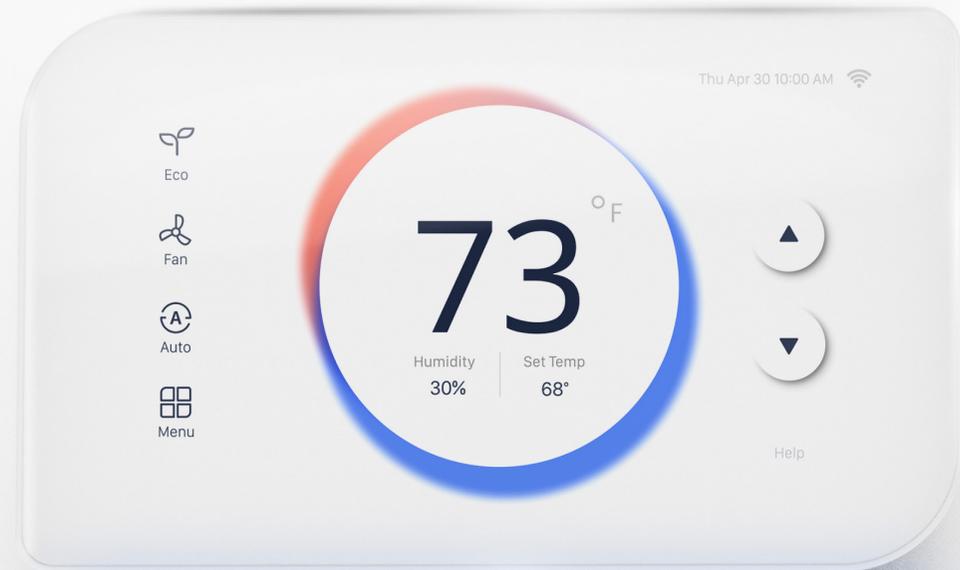
Home Screen

Improve Efficiency

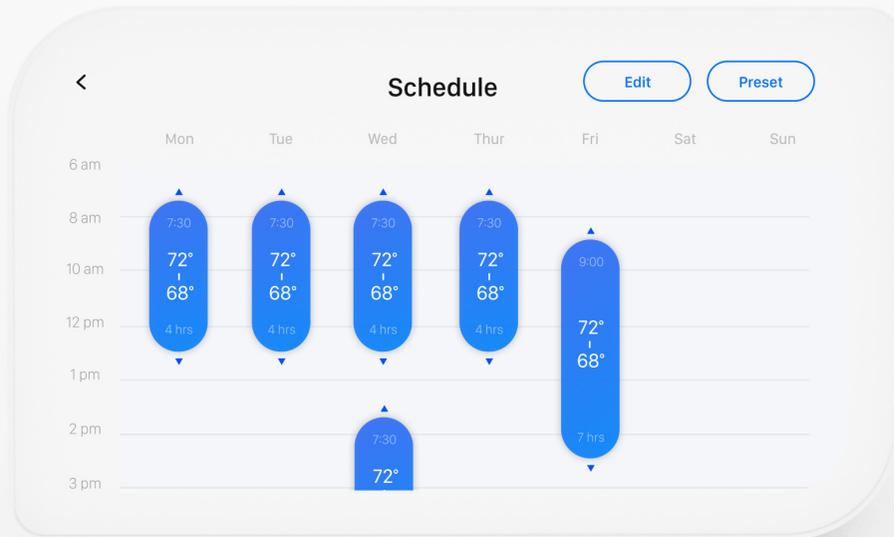
Schedule

Remote Control

App



Home Screen



Schedule



Remote Control

Future Proof

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Longevity

Light / Dark mode

Flexibility

Color Options

Sustainable

Environmentally Conscious Material

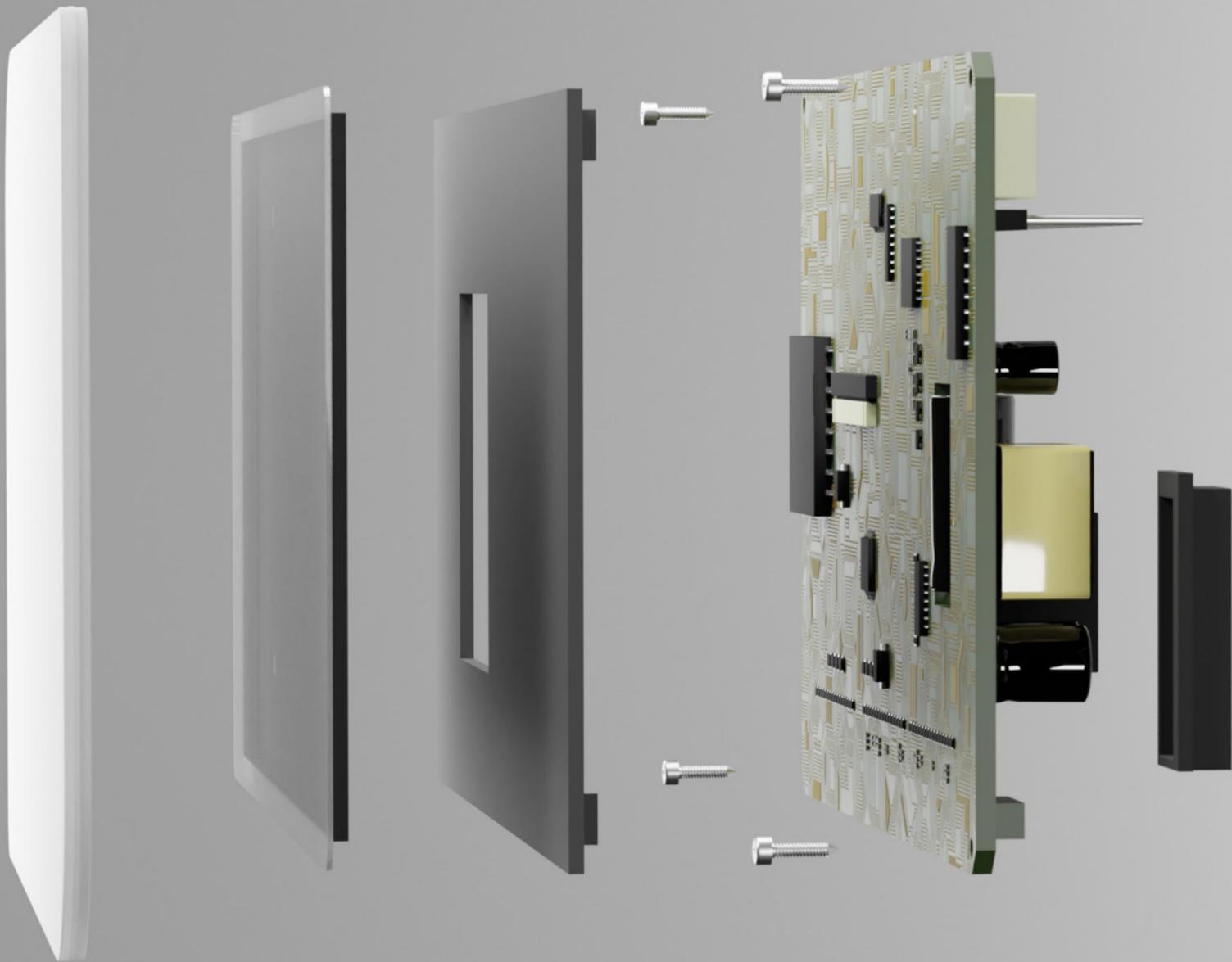
Light Mode

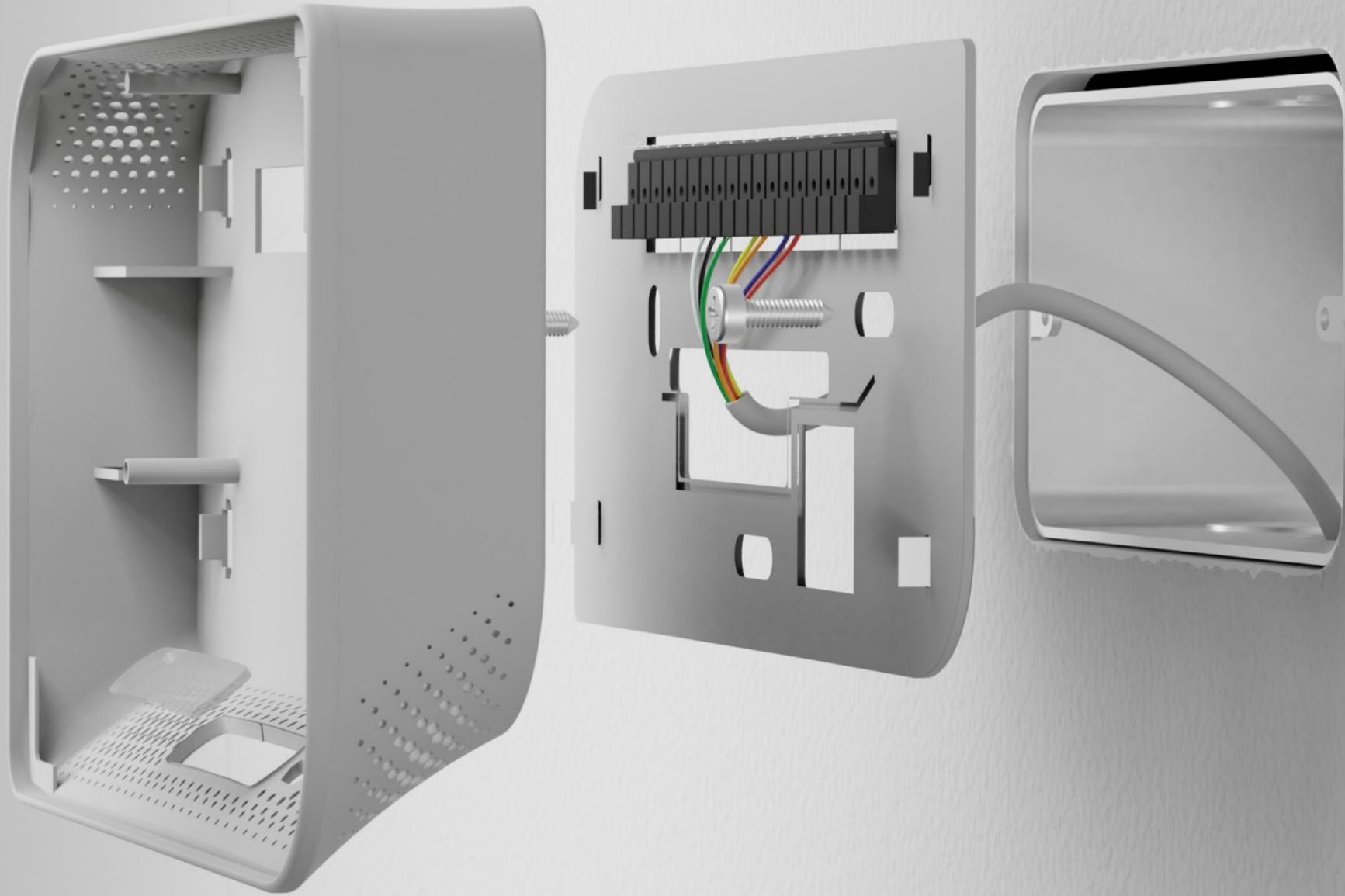


Dark Mode









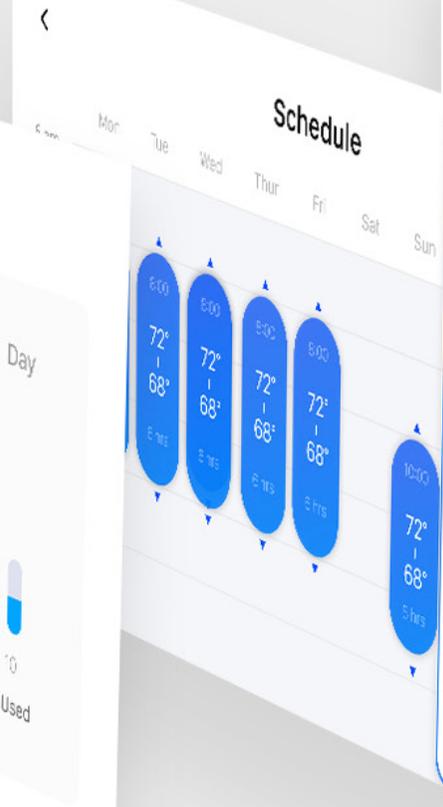
Energy Saving



Energy Saving



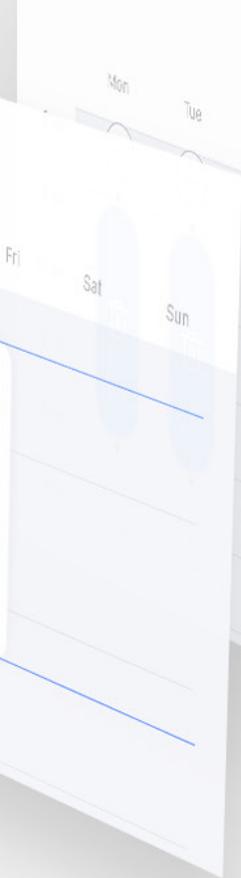
Schedule- Preset



Schedule- Edit Temperature



Schedule- Delete Schedule



Schedule- Add New Schedule





Process





Discover

In the Discover phase, the team worked together to understand the goal of the design, the requirements of the client, the trends of the market and the needs of the users through research and analysis.





Search results for Architect

1. [Link]

2. [Link]

3. [Link]

4. [Link]

5. [Link]

Architect

Yeah, it's crazy.

My master's applying to UC Denver.

Speaker 2

Okay, this is great. Okay, awesome. Um, so, um, one of the things we found was like architects are one of the people who are purchasers for thermostats. Do you ever or have you ever purchased thermostats for your architect purposes.

Speaker 1

Typically it depends on if it's a design build or a design you want like kind of industry standard answers is what I'm assuming. So, and also my personal experience so industry standard is that the architect. Typically, if there's a larger commercial project that's going to be an architect, an engineer and there's going to be a mechanical, electrical and plumbing professional. And the architect does do the design work for the air conditioning, which is considered mechanical, electrical, plumbing system. So we plan out the general path of systems we can do some base load analysis as well on how big the system needs to be but obviously the larger a building or facility and wall complex will become, and the more zones and the more conditioning requires. So from that employ directly purchasing for commercial projects I would imagine that that's typical of an architecture firm that has design and build arm, an arm that is where they're going to have a contract or at least some contracting work out to other people. So that's kind of the full portion of that work. So in our so far small commercial I would say probably common for an architect to recommend what it's going to be very rare that an architect purchases anything unless they actually have a contracting company arm within their firm directly, but they do make a lot of recommendations and they check out what both can be put in.

Okay, that's interesting. So for record Oh, yeah, yeah.



Design Requirement

Industrial Design & User Experience/User Interface

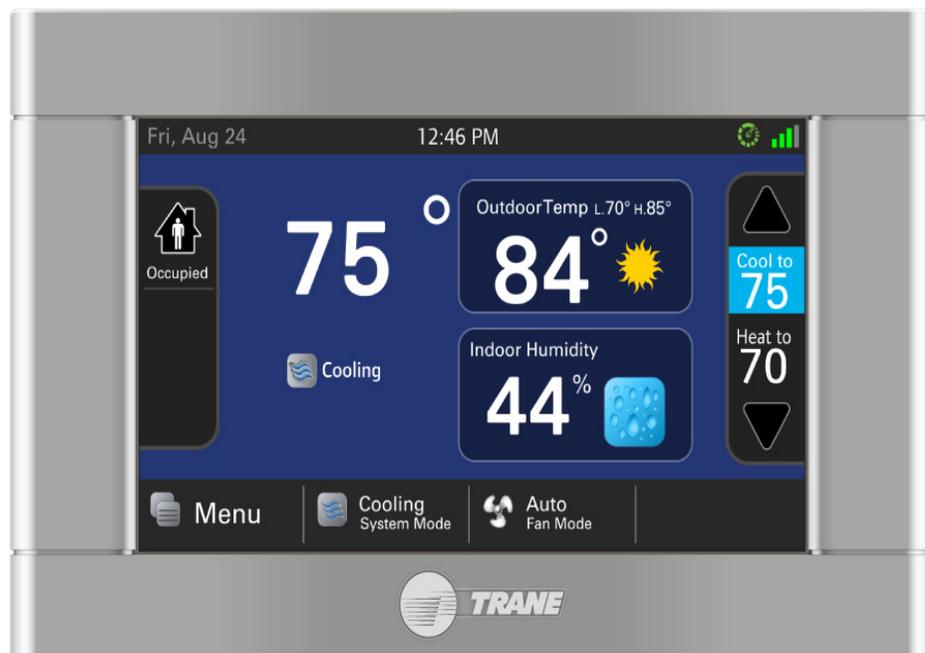
ID needs

The thermostat must fit in the 8-10 year life span and must match the simplicity and capabilities to be well received by its market. This new release will need to add greater and higher value for its customers and contractors and lead the market upon release. All the while supporting the highest efficiency products and leading market analytics.

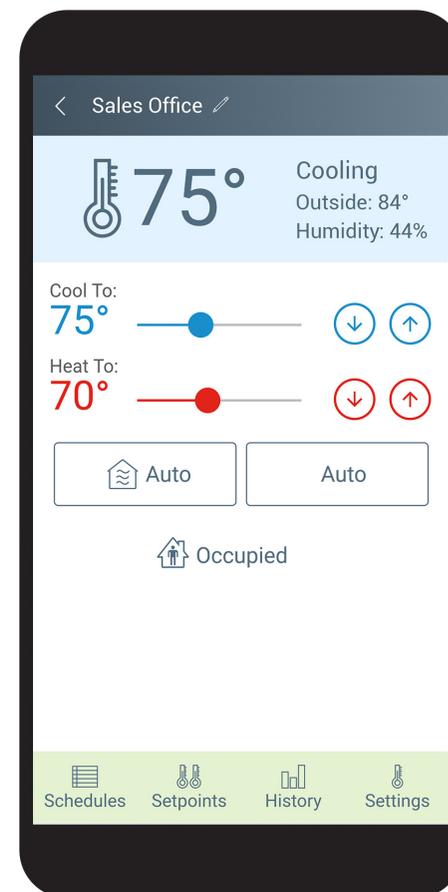
UX/UI needs

The display must consider two target users: the occupant and manager. The occupants are assumed to have no training needed to operate and must be able to adjust the temperature and turn the system on/off after-hours from the main screen. For the manager, they need to be able to configure limits and schedules. The schedule screen will most likely dictate the size of the screen. Error messages must be visible should problems arise. There is an app provided that can be used as-is, but the size requirement for touch needs to be considered. Smaller touch area saves money but is not a critical need.





Current Pivot



Current App



Current Pivot

Secondary Research

Pivot is one of the five Thermostat Trane products. It is designed for the smallest of the commercial buildings (25K ft²) and targets the building owners, occupants, managers and the contractor.

The Pivot manufactures for 100 US dollars with an 8-10 year life span.





SCADPRO TRANE



Primary Research

The team set out for secondary and primary research to understand the current and ideal experience of using commercial thermostat.

Relevance & Value

In order to narrow our focus, we developed research questions by looking at specific factors of human experience, these are called lenses (shown on next page).

To better understand the unarticulated user needs, we used map work shops. This helped us brainstorm the potential stakeholders of the current and ideal experience of the thermostat.

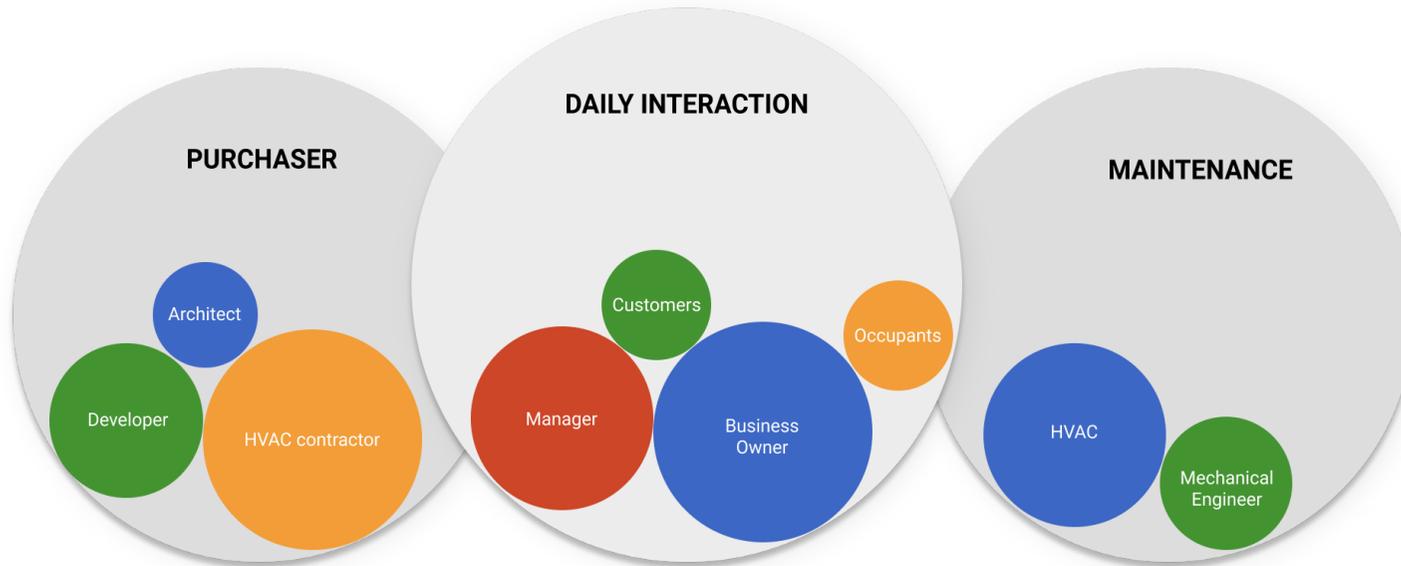
Through this process we identified the relevant stakeholders involved in the redesign of the thermostat to be purchases, interactions, and maintenance. We then grouped them accordingly to how they interact with the lifespan of the thermostat.



Stakeholder Map

It is not easy to recruit participants during this special time, therefore our stakeholder map highlights our thinking process of defining screening criteria when looking for participants.

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For the purchasing decision, the HVAC contractor.

To understand the user painpoints in daily interactions, we were able to talk with a variety of business owners and employees (occupants).

For maintenance issues and technical details, we were able to talk with a mechanical engineer and HVAC Contractor.



Our Lenses & Research Questions

This initial stage is meant to get the team to understand the scope of the project and the value of research.

Environment (Building)

Why do people need thermostats in a commercial space?

How does commercial space affect the thermostat?

What affects the choice of their current thermostat?

Lifestyle

Who is using the thermostat?

How does the geography affect their use of thermostat?

What's our user's current journey when adjusting the temperature?

What would be their ideal journey of creating a temperature/humidity cozy environment?

Behavior

When do they need to adjust the temperature?

How/when does the user interact with the thermostat ecosystem?

What their current pain points?

How would they interact with their thermostat ideally?

Data Collection

We conducted virtual interviews and online surveys to collect data from our user.

We were able to talk to over 15 industrial managers and employees over virtual platform, to understand their current and ideal experience over the commercial thermostat.

Hi everyone, our Scadpro UX team is currently recruiting survey participants for the store manager or occupant to understand the experience of using the thermostat in the commercial space. Here is the link of the survey form:

https://lnkd.in/esjR8_T

If you have any working experience as a store manager or occupant that is valuable to our topic, please feel free to join us and fill out our survey!

If you are interested in providing more information, we would appreciate further contact with you, and your personal information will remain confidential under consent.

We would also like to choose one of our participants to offer you a 25\$ gift card as a thank you for participating in our research. If you are willing to participate, please suggest some options for days and times that suit you. If you have any questions, please do not hesitate to ask!

Thank you for your time, we look forward to hearing from you!

UX Researchers of Scadpro x Trane
hashtag

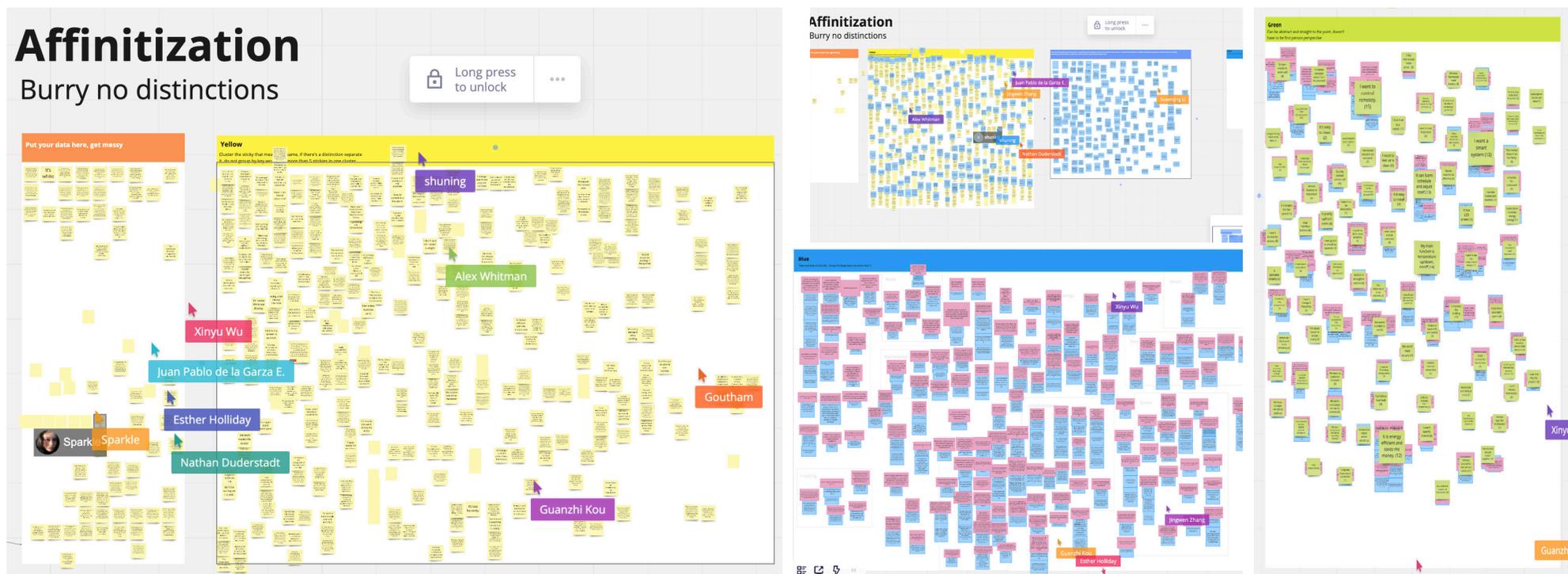
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[#surveyresearch](#) hashtag
[#Trane](#) hashtag
[#SCADpro](#) hashtag
[#UX](#) hashtag
[#uxresearcher](#) hashtag
[#participate](#) hashtag
[#thermostat](#)

Indeed survey



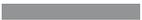
Data Analysis

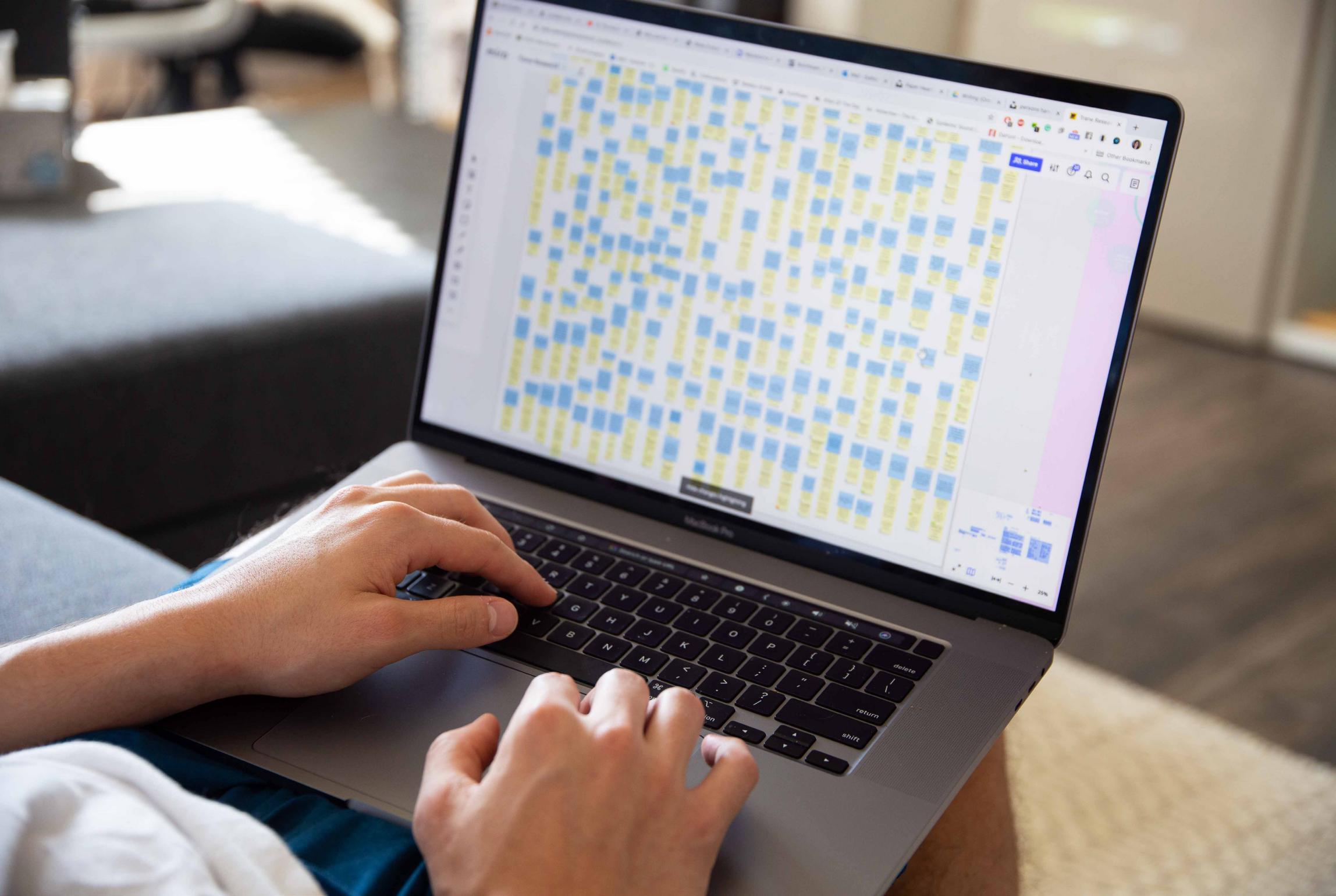
After we collected the data, the team held an affinitization workshop to analyze the unarticulated needs of the users that emerge through our research. Affinitization is a data analysis research method that brings out insights in all the stakeholders on a table. The result formulates as a diagram, a visual representation of consumer insight, called the framework.

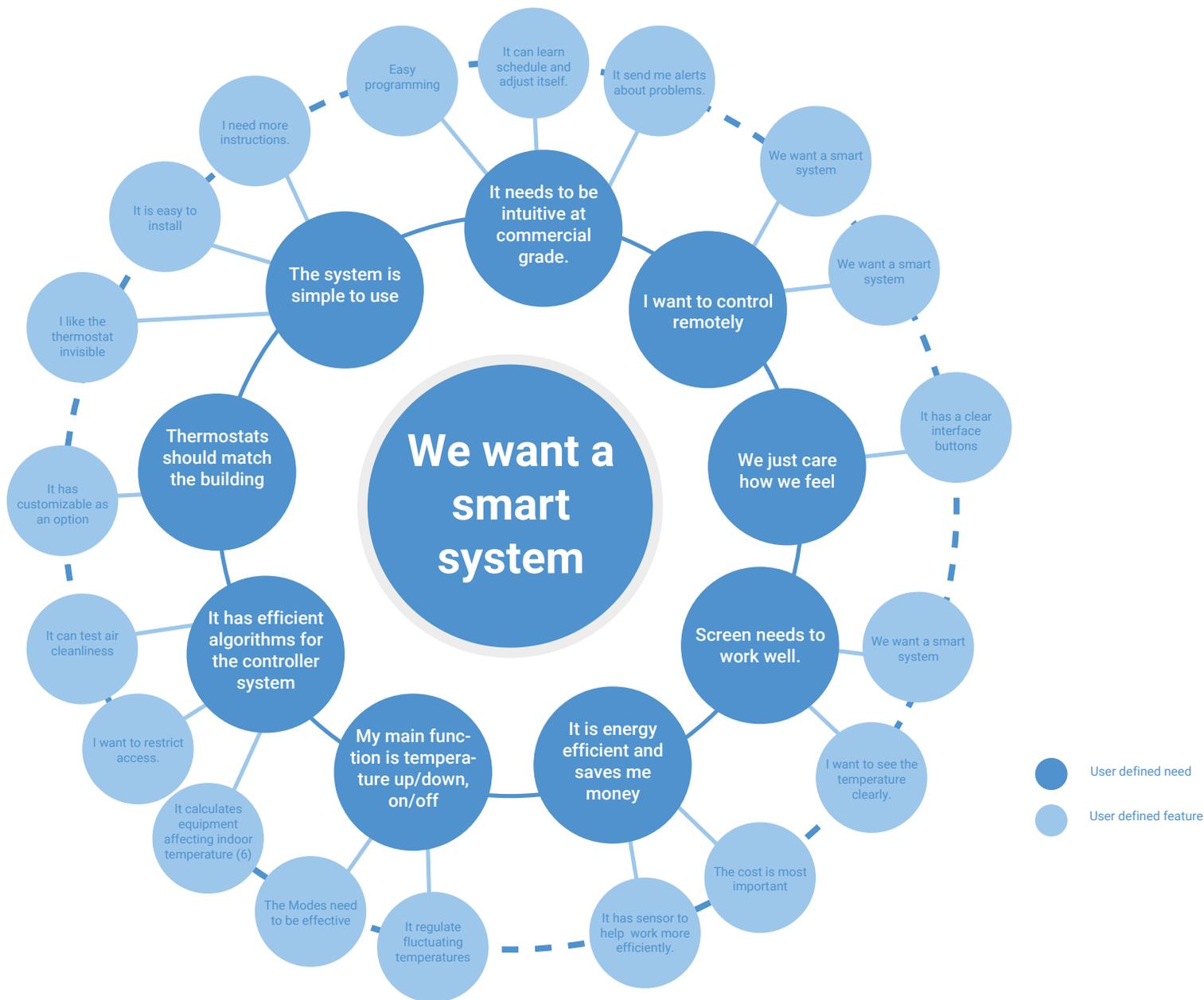


Define

Taking the researching from the deliver phase, the team analyzed the data through affinitization and then created the design framework.







Archetypes

We constructed three user archetypes to illustrate the current experience of using the commercial thermostat for different user groups based on their motivations and goals.

“if you put too much knowledge in the hands of the end-user it can be dangerous because they’ll mess up the whole thing and then they’ll call you saying ‘it messed up.’”



HVAC Contractor

Charlie Styles

Location

Atlanta

Occupation

VAC Contractor

Bio

Charlie is a HVAC Contractor who’s able to sell thousands of commercial stats to small business owner, his client often request low- cost efficient thersotat

User Goals

Provide selected thermostat to the client
Sign up contract with client to set up thermoostat properly

Struggle

Even though he outlines the long-term benefits, his client decides on the manual, low-cost thermostat.
Client return in a month and complains about the thermostat not working properly.



“I run the humidifier unit 24/7 in that space, because rust, corrosion is my biggest enemy, I don't want a metal crude at a rapid rate, so I have to keep the humidity below 40% at all time.”



Workshop Owner

John Smith

Location	Occupation	Age
Columbia	Workshop owner	35

Bio

John is a hard working, no-nonsense workshop owner. He uses the thermostat for utilitarian needs rather than personal comfort.

User Goals

Utilize the thermostat to regulate his equipment and projects.
Maintain equipment, Product

Struggle

Humidity and air flow regulation
Frustrated with software applications
Specific regulation changes for certain projects.

“The AC guy told me he would show me how to program it, but he never did”



Restaurant Owner

Lyndsay Walter

Location	Occupation
New York	Restaurant Manager

Bio

Lyndsay is an ambitious store owner who wants to deliver high quality donuts to her city. She is open-minded and innovative.

User Goals

Saving cost and being energy efficiency
Teach the employee how to use the thermostat
Limit accessibility to certain users
Operate thermostat efficiently

Struggle

Learning how to program the thermostat
Temperature fluctuates based on customer flow and building schedule.
Kitchen equipment temperature and humidity levels affect the products.

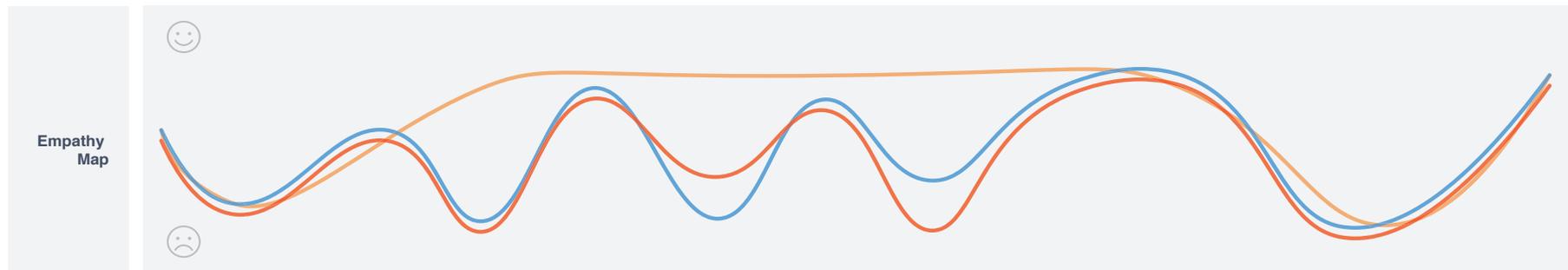
User Journey Map

User's pain-points during the journey of using commercial thermostat.

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Persona • HVAC Contractor • Restaurant Owner • Workshop Owner

	Purchase	Installation	Daily Interaction	Maintenance
Stakeholder Action	<ul style="list-style-type: none"> • Purchase thermostat • Looking at compatibility with HVAC System • Offer a selection of thermostats 	<ul style="list-style-type: none"> • Learn to use the thermostat • Install the thermostat 	<ul style="list-style-type: none"> • Program the thermostat. • Schedule the thermostat. • Turn on thermostat. • Adjusting temperature • Adjusting temperature 	<ul style="list-style-type: none"> • Request maintenance service • Request maintenance service



Pain-points	<ul style="list-style-type: none"> • Even though he outlines the long-term benefits, his client decides on the manual, low-cost thermostat. • Frustrated with user friendly system • Frustrated with understanding cost savings 	<ul style="list-style-type: none"> • Receives complaints about the temperature from customer • Need remote control when working from home. • Unable to figure out the schedule • Came early to kick off the thermostat 	<ul style="list-style-type: none"> • Stays behind to turn off the thermostat. • Owner return in a month and complains about the thermostat not working properly.
	<ul style="list-style-type: none"> • Struggles to program the thermostat. • Unsatisfied customers temperature experience • Lack of remote access • Increasing cost in summer and winter 	<ul style="list-style-type: none"> • While working the kitchen, unable to check the temperature from her station. • Owner change the settings without proper consideration • Lack of simple operation on thermostat • Lack of clarity when reading temperature • Lack of feedback on the screen 	

Empathy map & Journey map are abstract diagrams to illustrate user's feeling

Research Insight

The framework, archetypes and user journey led us to three main research insights which led the design direction for the thermostat.

It is **simple** to use

It is simple to use when it comes to temperature control.

The screen display is responsive and visually clear.

The thermostat has a simple look that can easily blend in the building.

The system is **efficient**

The schedule is easy to arrange/ self adapt.

The system has low learning curve and provides remote access.

The program is intuitive to set up.

The interaction is **intuitive**

It's compatible with the HVAC system.

The thermostat has an efficient algorithm to save energy and reduce cost in the long-term.

The thermostat can provide proof of reducing cost for the customer.



Develop

Based on the user research insights, the team began developing solutions through sketching and wire framing.

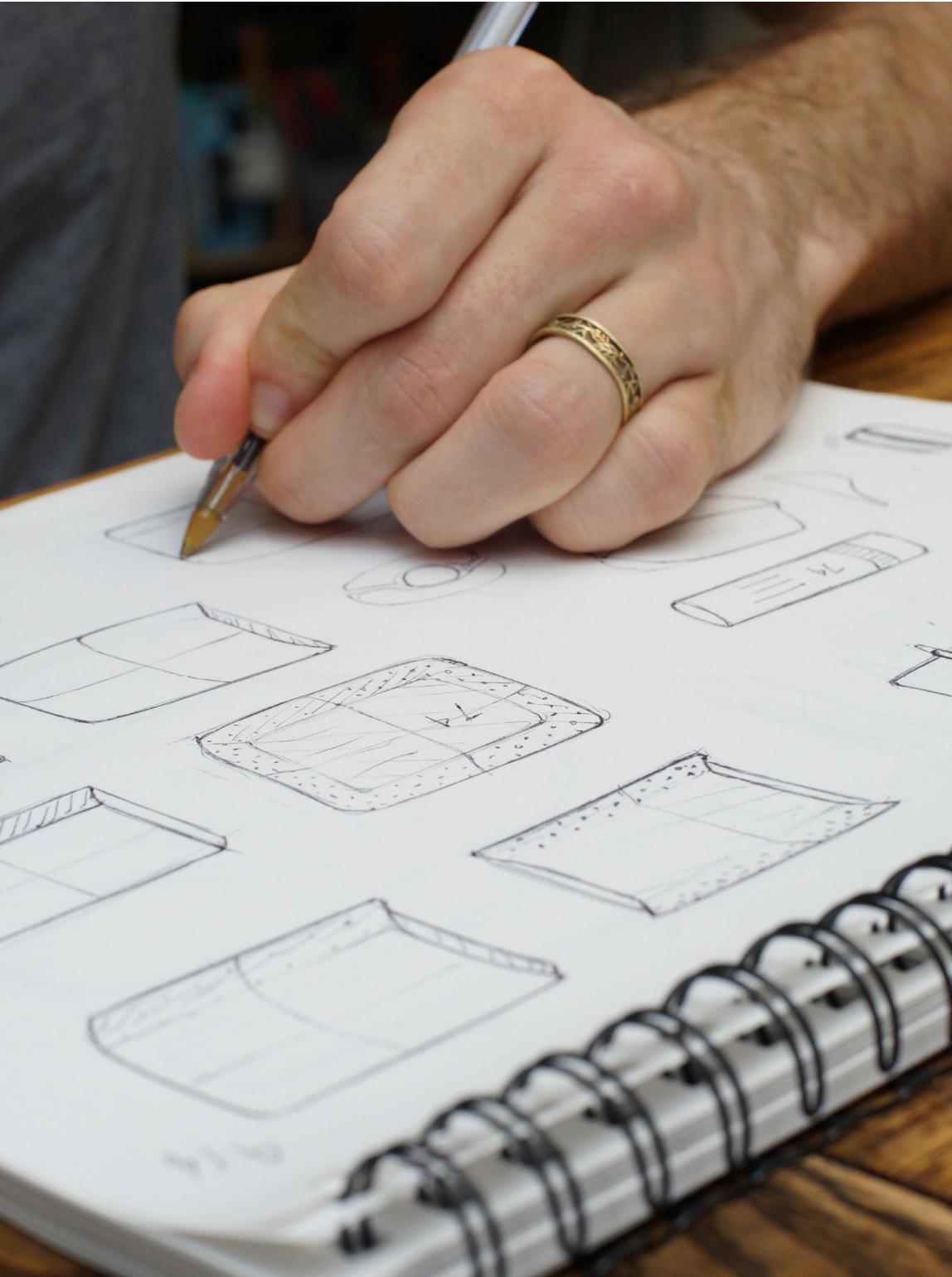


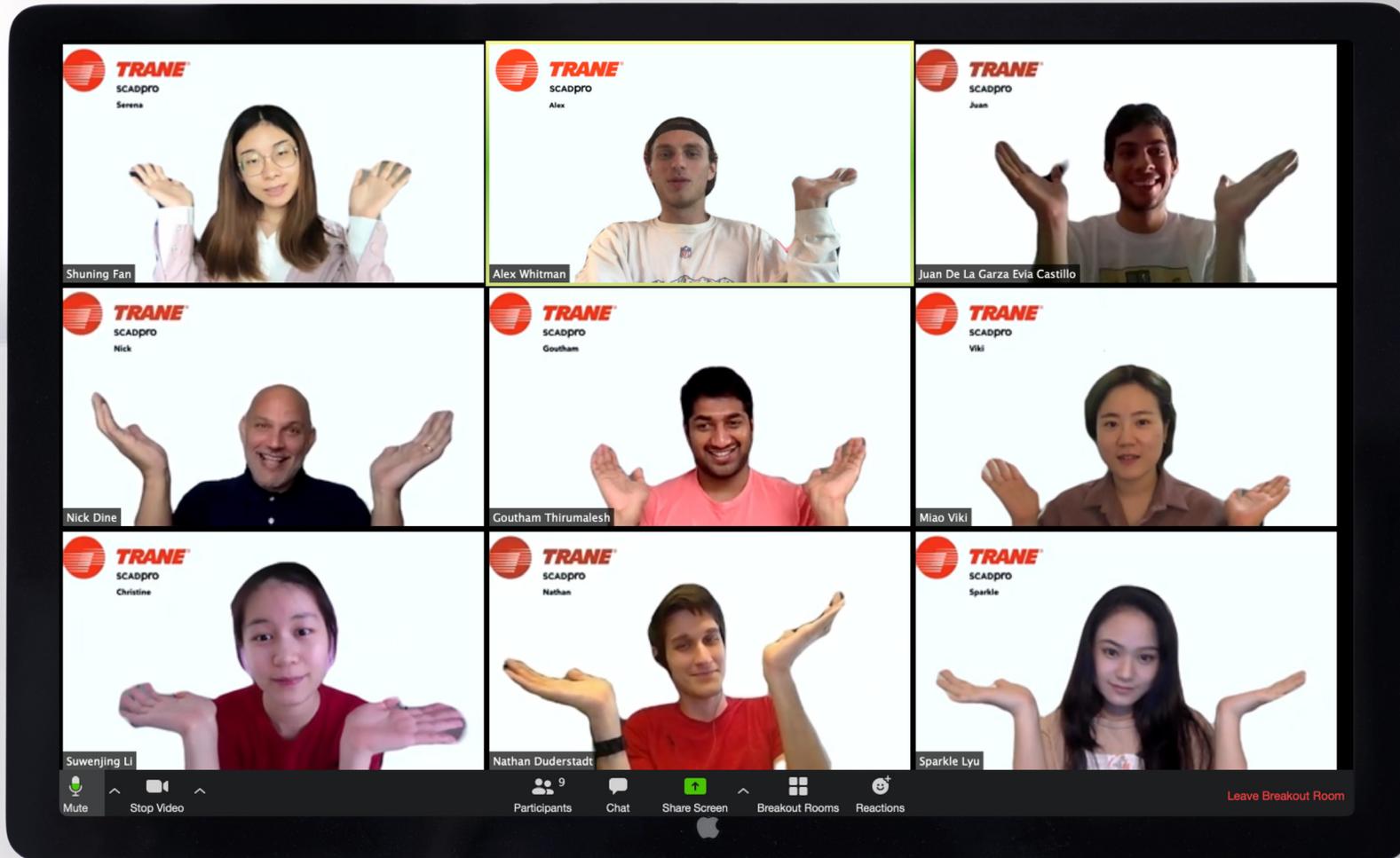


Team Diverged

ID and UX/UI team separated to work on the interface and shell.



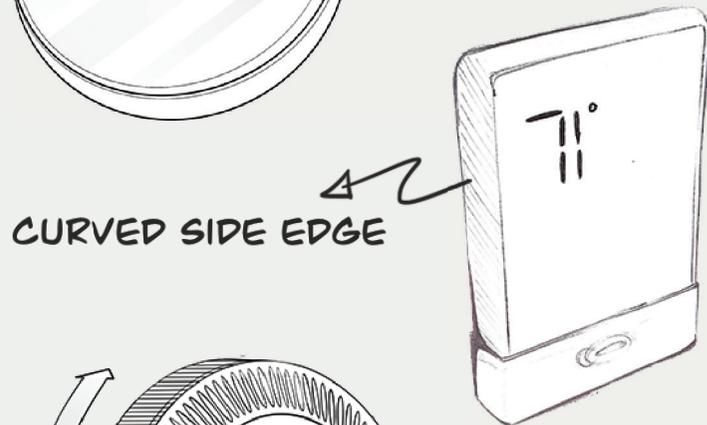
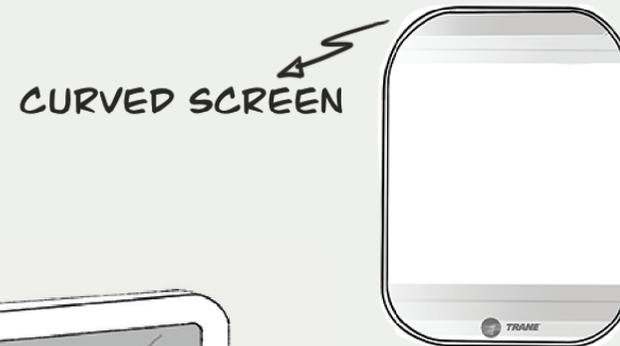
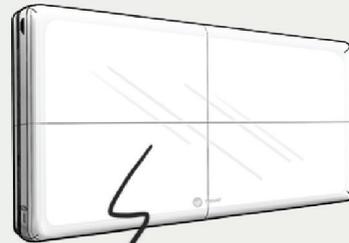
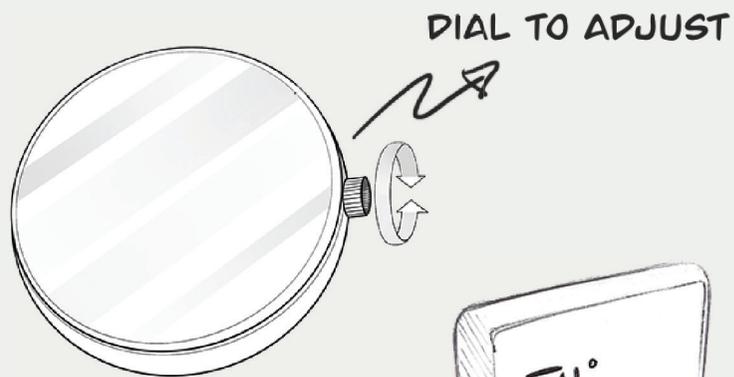




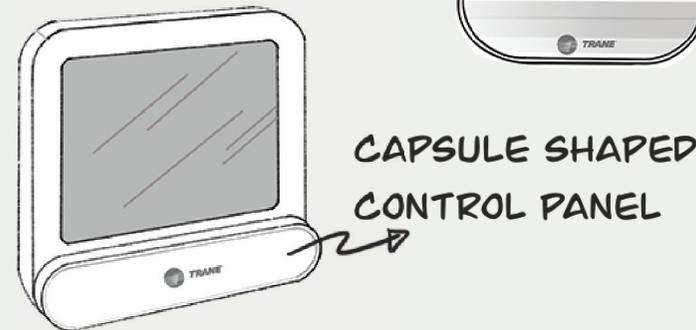
ID team

Brainstormed and developed forms based on functions and aesthetics, represented through over 200 sketches.



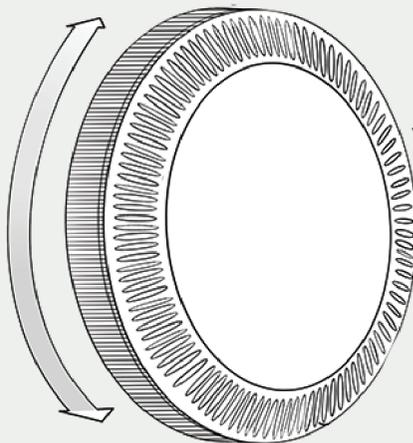


DIGITAL DISPLAY

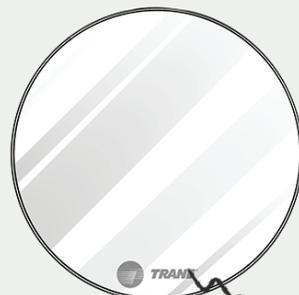


CURVED SCREEN SURFACE EDGE

VENTS WRAPPING AROUND



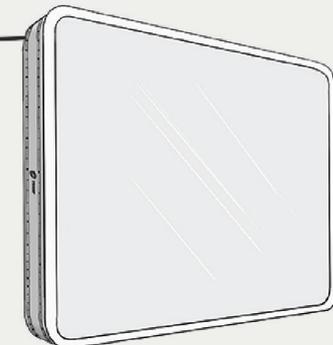
TEXTURED DIAL



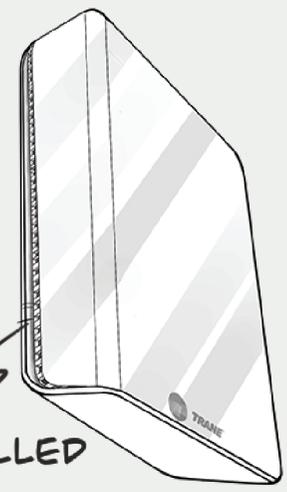
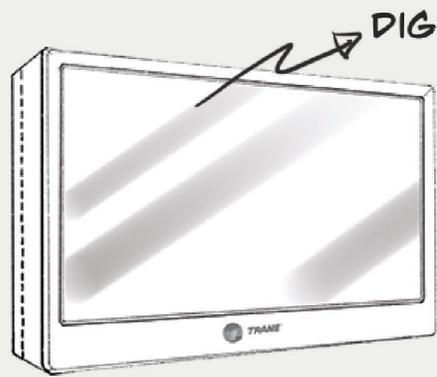
TRANE LOGO AT THE FRONT



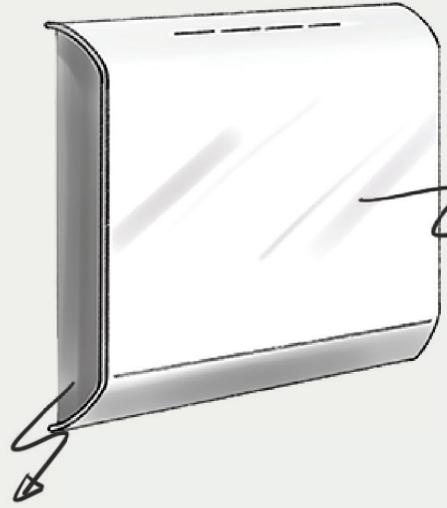
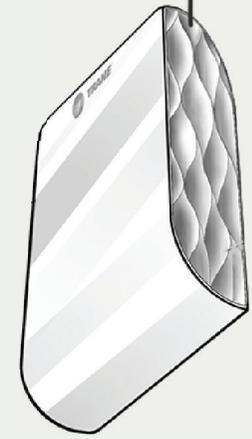
VENTILATION BAR



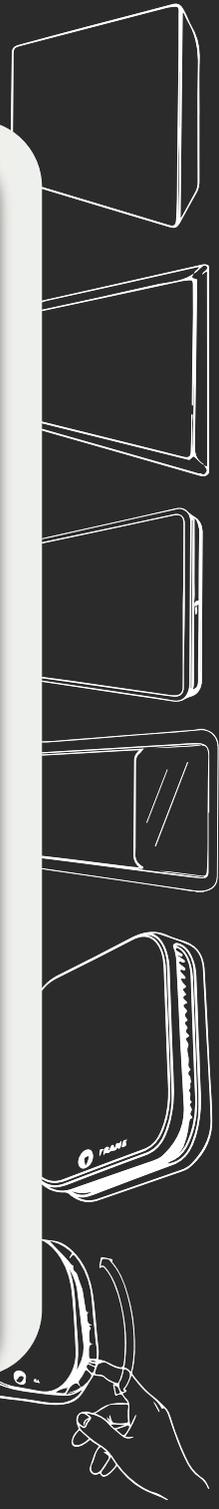
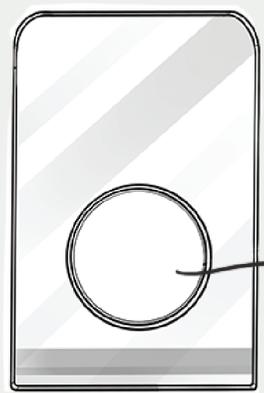
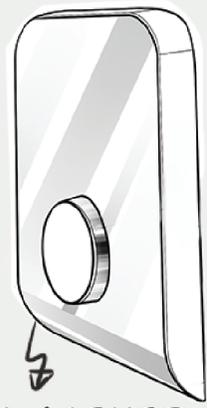
Ideation

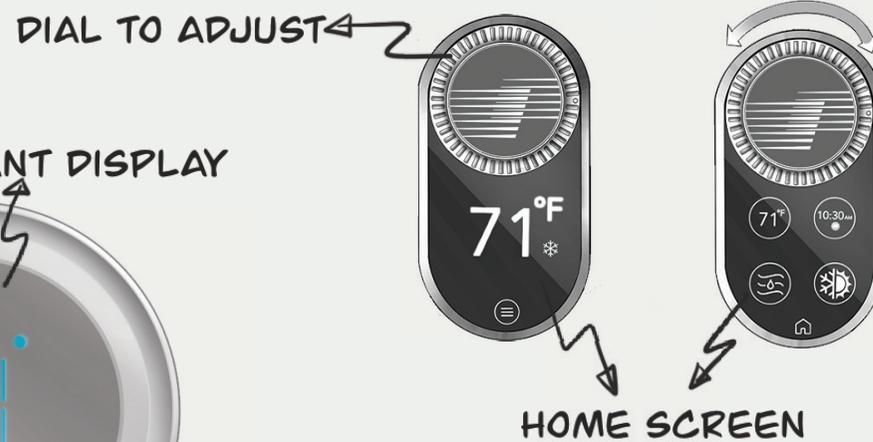
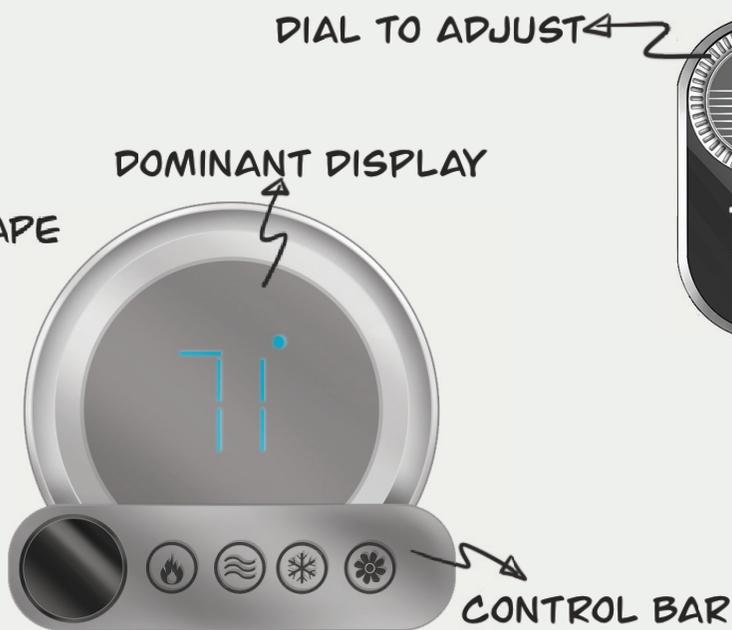
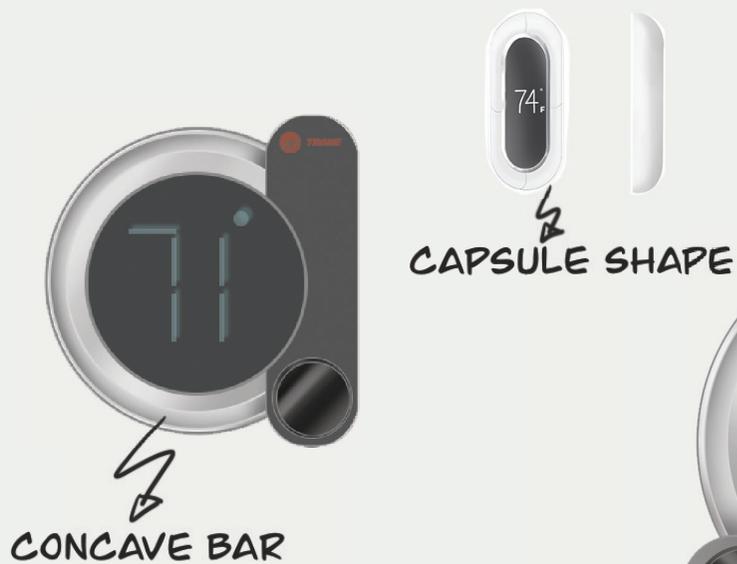
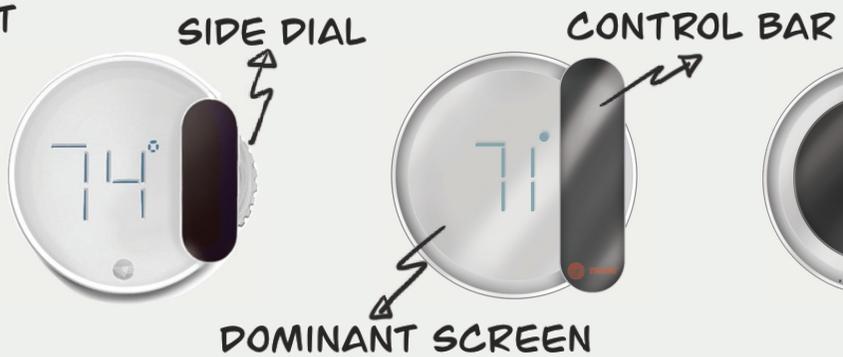


"LEAF" SHAPED VENTILATION



TOUCH SCREEN





DIAL TO ADJUST

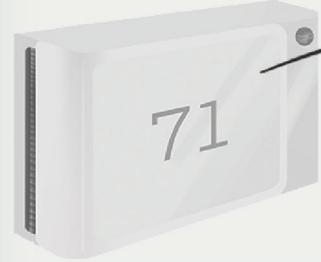


SIDE VENTILATION



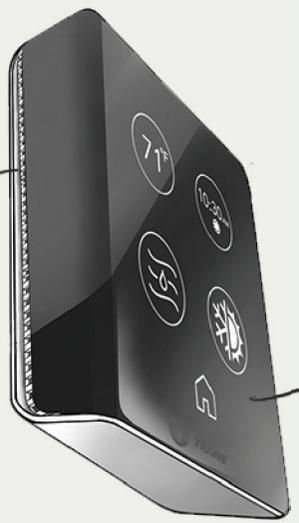
DIGITAL DISPLAY

LED LIGHT STRIP

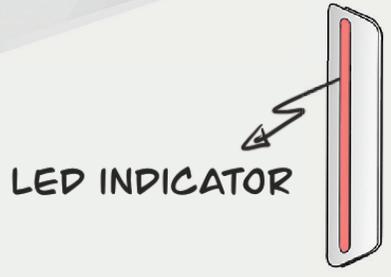


DIGITAL DISPLAY

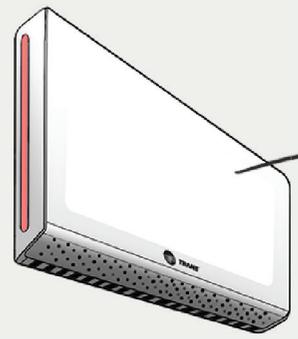
TWO-SHELL BODY



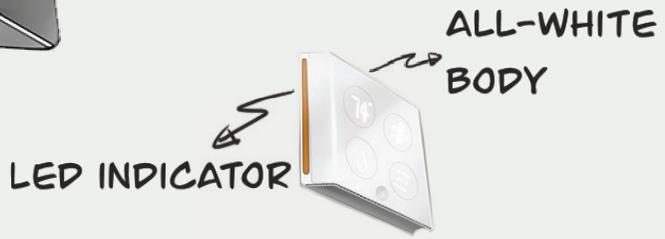
TOUCH SCREEN



LED INDICATOR



DIGITAL TOUCH SCREEN



ALL-WHITE BODY

Concept development

Renders and Midterm Concept Feedback

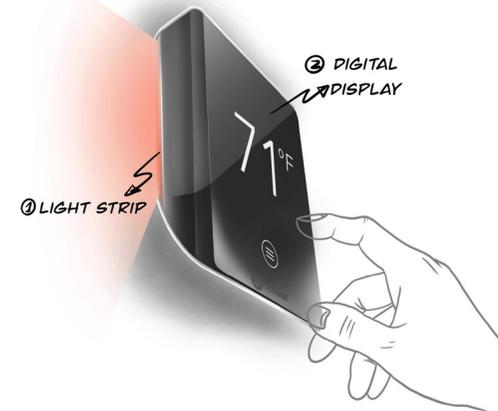
One thing that was requested was to try more of a white color scheme, with options for dark mode. All black plastic and screen background was the trend 5 years ago which looks nice in residences but sticks out more in most commercial buildings. Additionally, even though touching may not be as big of an issue 18 to 24 months from now, we should try to address this.

1A



1A: Looks very much like an iPhone, which has the risk of being very dated in a few years as phone design can change very rapidly (even though they have been stable the last 5 years).

1B



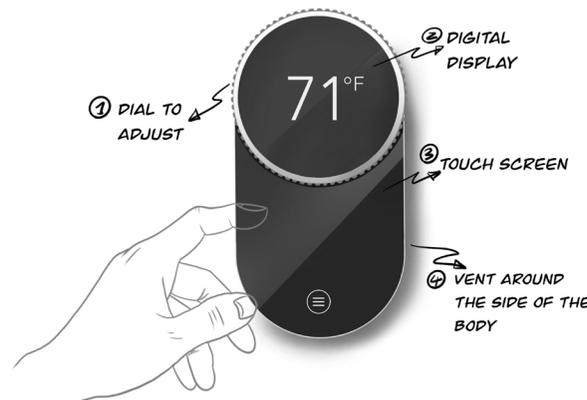
1B: The requirements outlined from the Trane team pushed this design forward, but many wanted a little more tie into the AirFi sensor.

2A



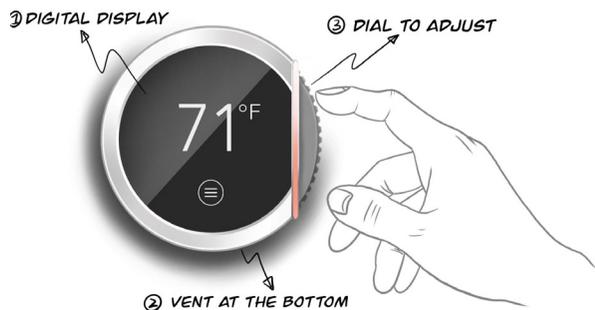
2A: Because of cost, reliability, and touch concern a physical dial has some drawbacks.

2B



2B: There are Concerns about the size of the screen having enough space for scheduling.

3A



3A: Concerns about the size of the screen having enough space for scheduling.

3B



3B: Round shape thermostat is patented by Honeywell and they defend it.



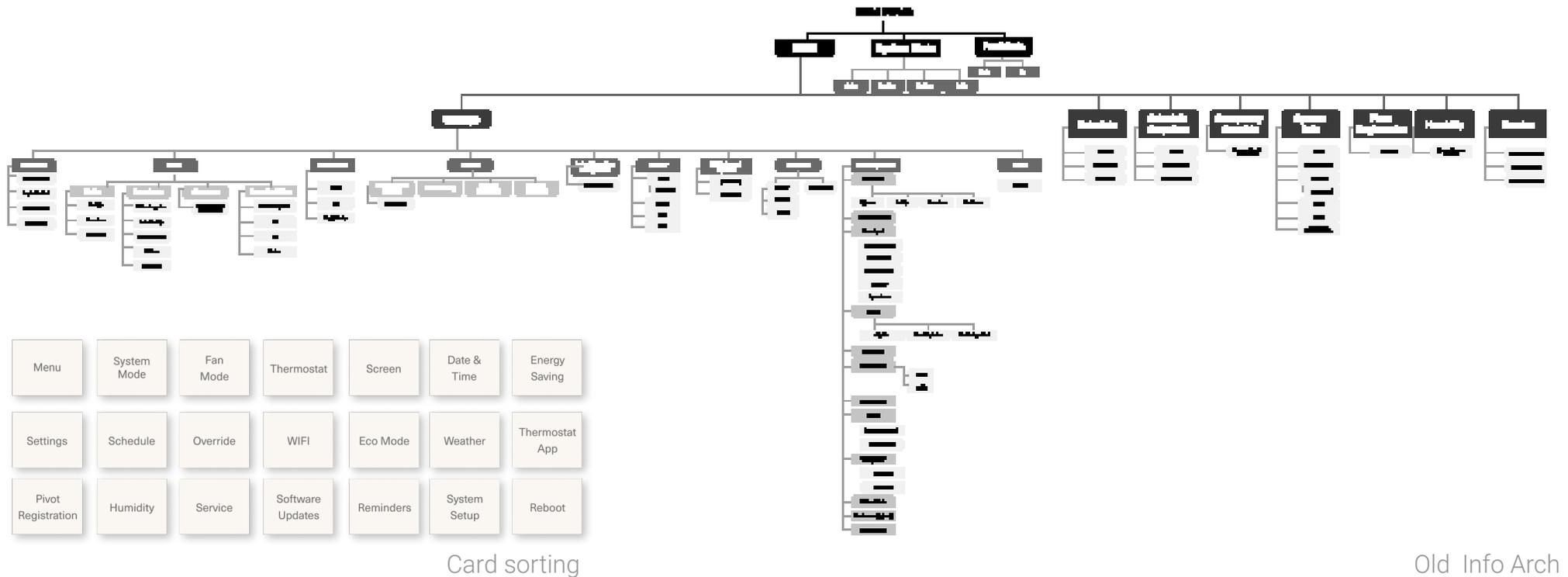


UX team

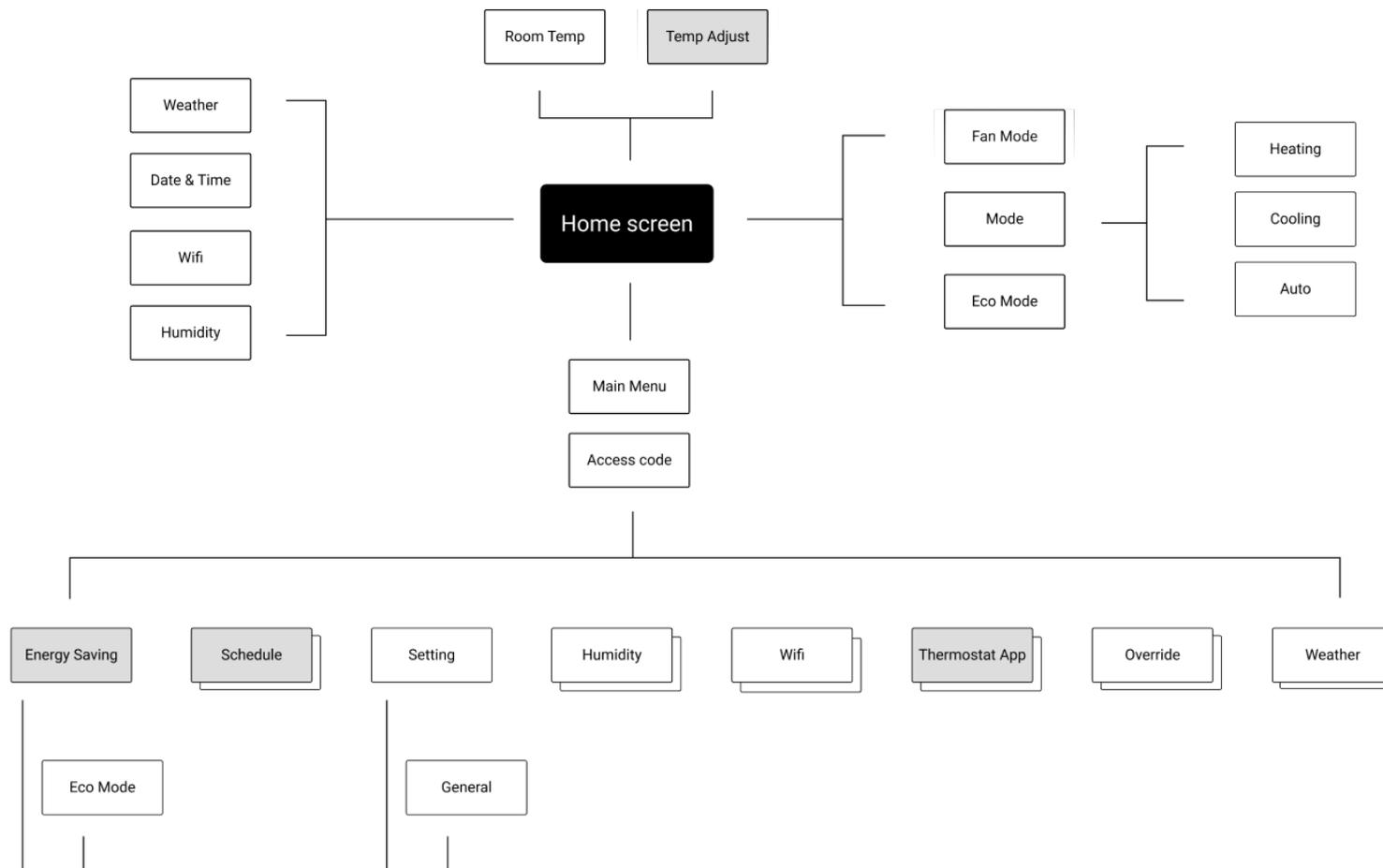
In the develop phase, the UX team developed the user interface of the commercial thermostat based on the research insights, through the process of low-fi to hi-fi. In each process, the team evaluated the solutions through on-line user testing.

Information Architecture

The information architecture stands for the information structure of an existing system. To ensure the thermostat matches with the mental model of the user, the team reconstructed the info arch of the Pivot. The UX team conducted Card Sorting, a research method for constructing info arch, with 20 online participants to build the new info arch.



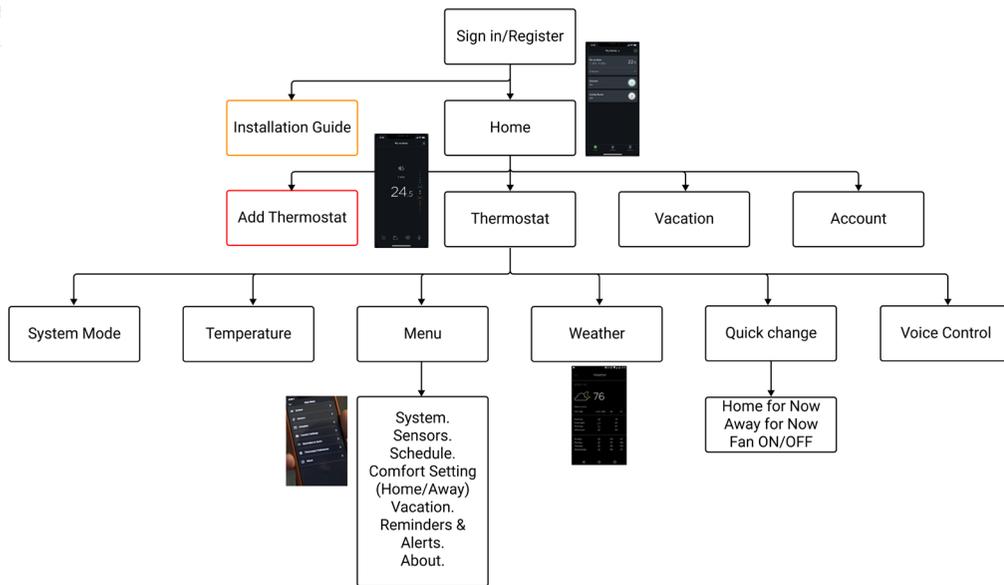
New Info Arch



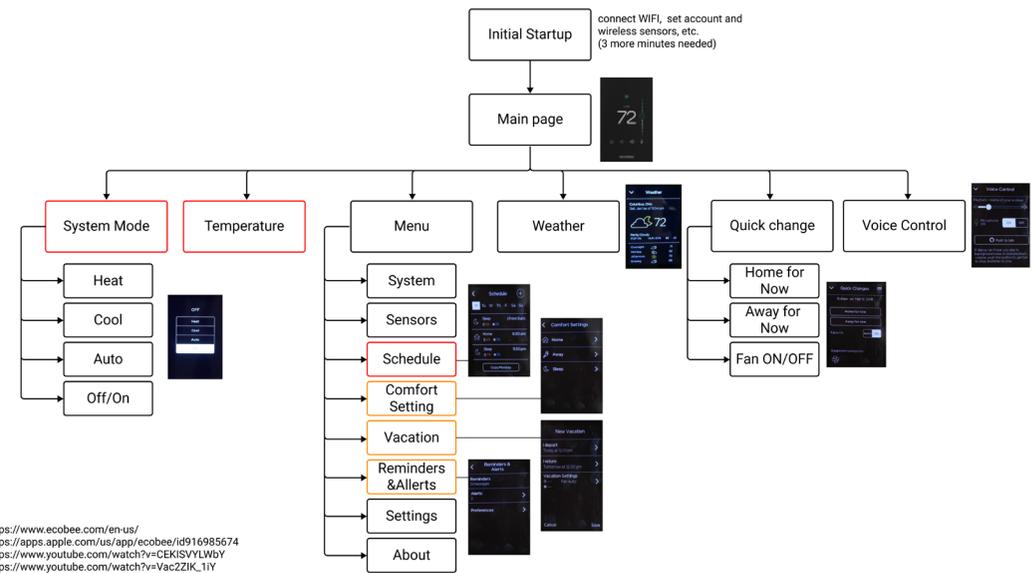
Competitor Info Arch

The UX team also analyzed existing competitor info arch to understand and gain insight the current system structure of thermostats.

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Ecobee 4 Info Arch
Mobile App

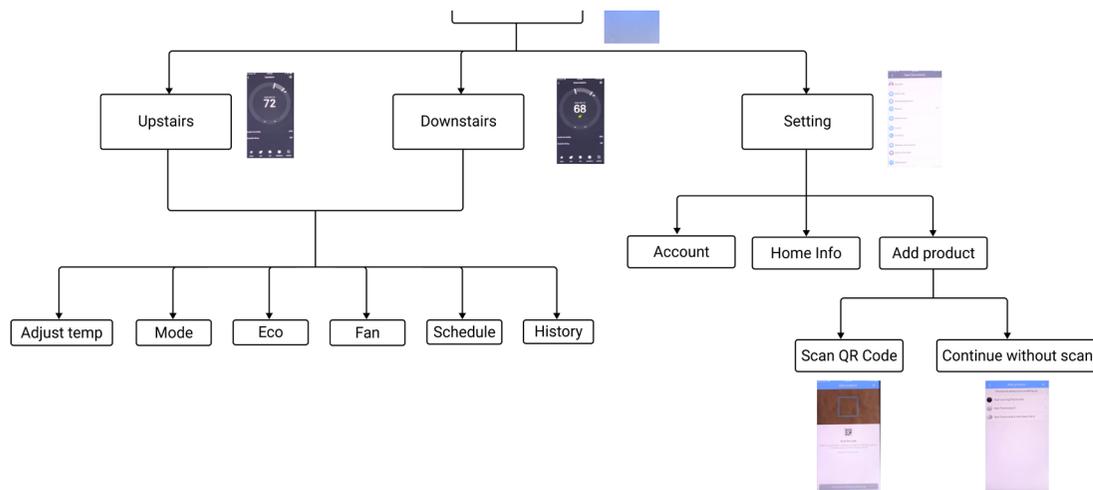


<https://www.ecobee.com/en-us/>
<https://apps.apple.com/us/app/ecobee/id916985674>
<https://www.youtube.com/watch?v=CEKISVYLWbY>
https://www.youtube.com/watch?v=VacZZIK_1IY

Ecobee 4 Info Arch
Controller Panel

Google Nest Learning Thermostat Info Arch

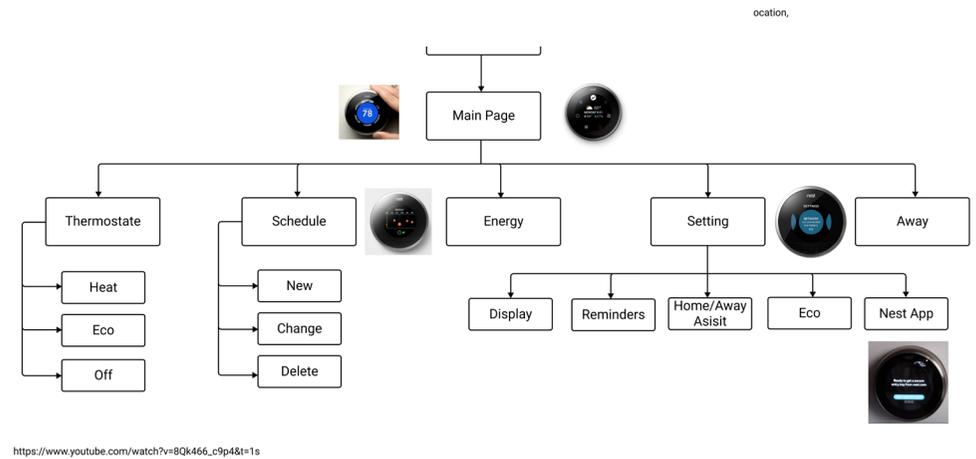
App



Google Nest Learning Thermostat Info Arch
NEST App

Google Nest Learning Thermostat

NEST Controller Panel



https://www.youtube.com/watch?v=9QK466_c9p4&t=1s

Google Nest Learning Thermostat Info Arch
NEST Controller Panel

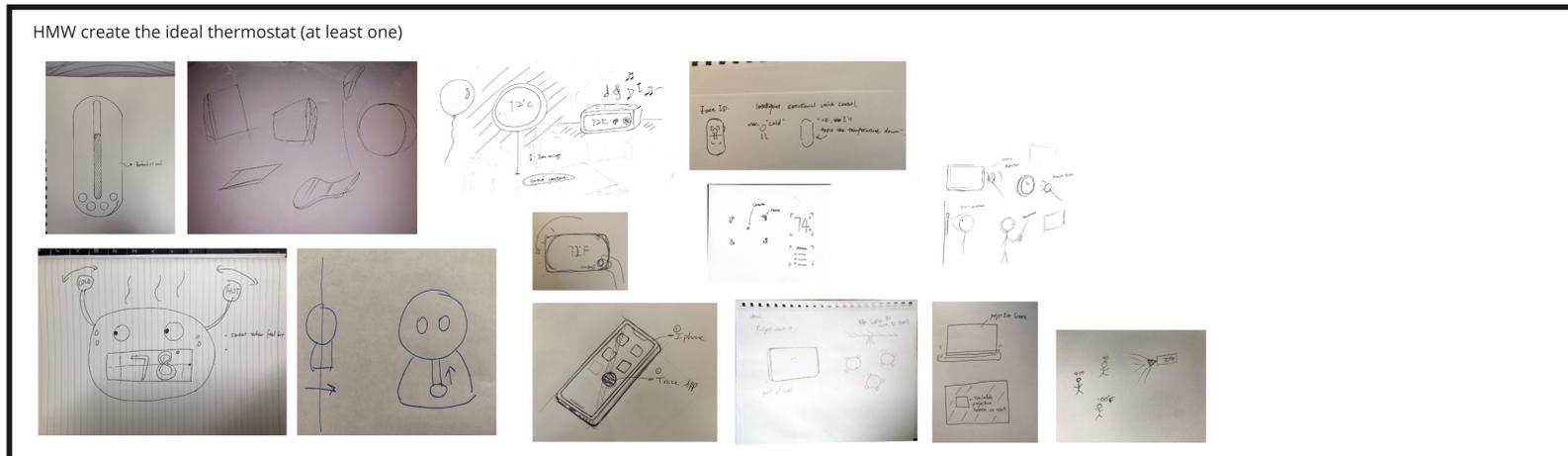


Crazy 8s

Thermostat interaction exploration workshop

1. Warm up (15-20 min)

The workshop contained three rounds of brainstorming sessions. The first round was used as a warmup for the following two rounds.



Iteration Exploration Results

Thermostat interaction exploration workshop

Five Results

- Gesture control
- Front gesture recognition
- Full screen
- Full screen + Side sensor
- Kocking

Potential Opportunity

- It is practical
- It is research supported
- It is Trane approved

Two Results of Sketching

- Full screen control
- Full screen control and side sensor



Function Development

Based on the new info arch, the UX team focused in on the 4 key functionalities for future development.

1 Temperature Adjustment

Adjusting temperature and system mode of the thermostat.

2 Schedule

Schedule operation hour for the thermostat.

3 Remote Control

User can adjust the temperature remotely on their phone.

4 Energy Saving

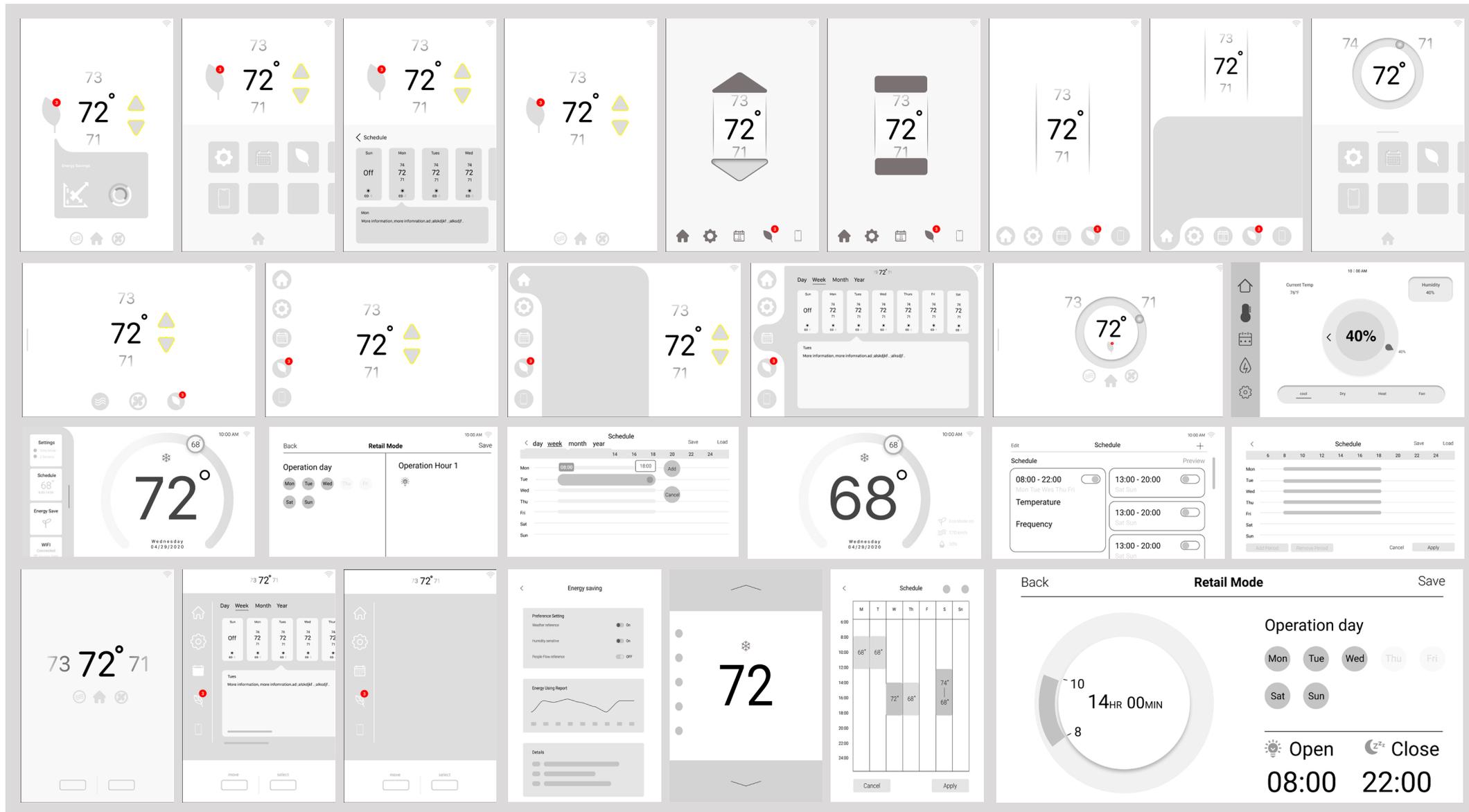
Set up preset to save energy for the HVAC system.



Sketches & Iteration Exploration

After the Crazy 8 workshop, the team sketched basic functionalities of the main interactions the Pivot can accomplish: temperature adjustment, menu, schedule, and energy saving.



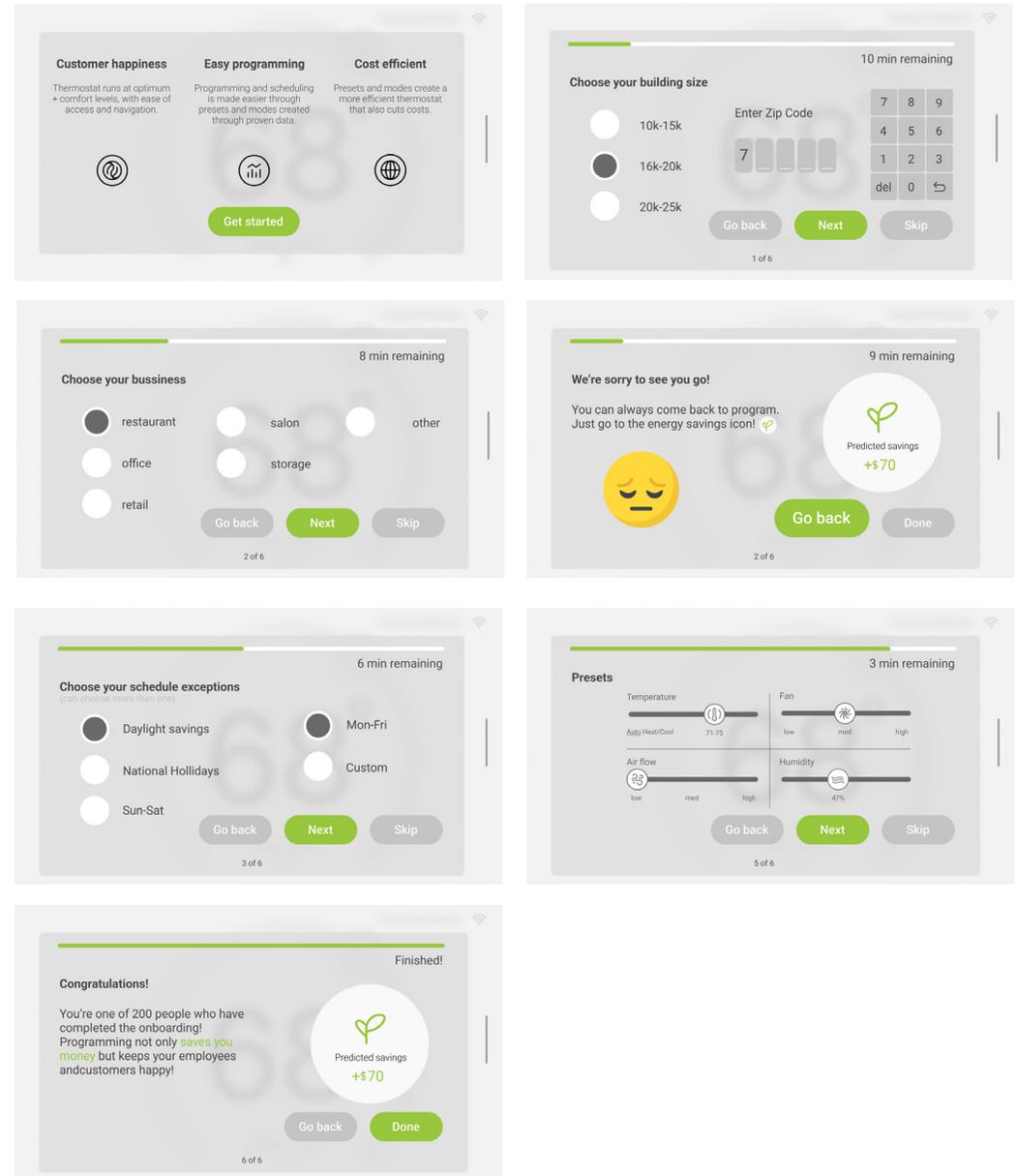


SCADPRO TRAIN



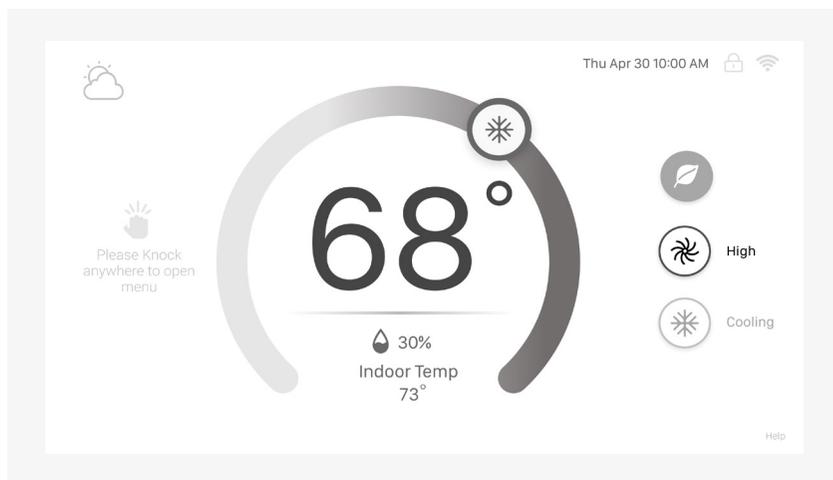
Onboarding Iteration

In the low-fi sketches, the UX team attempt to combine energy-saving, schedule with the onboarding process to simplify the user flow of setting up and programming the thermostat.

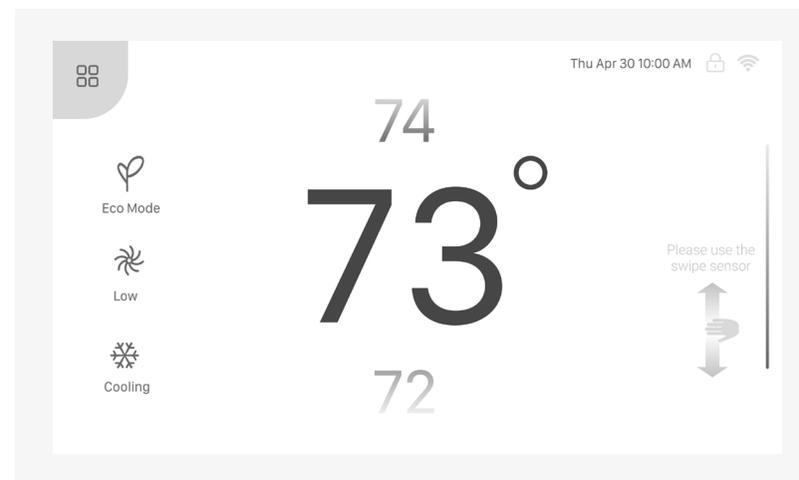


Low-fi Development

Through the sketch process, two sets of concepts emerged, the A Test utilizes the full screen interaction and has a modern design language, the B Test utilizes the full screen plus side sensor interaction and has a more traditional language.



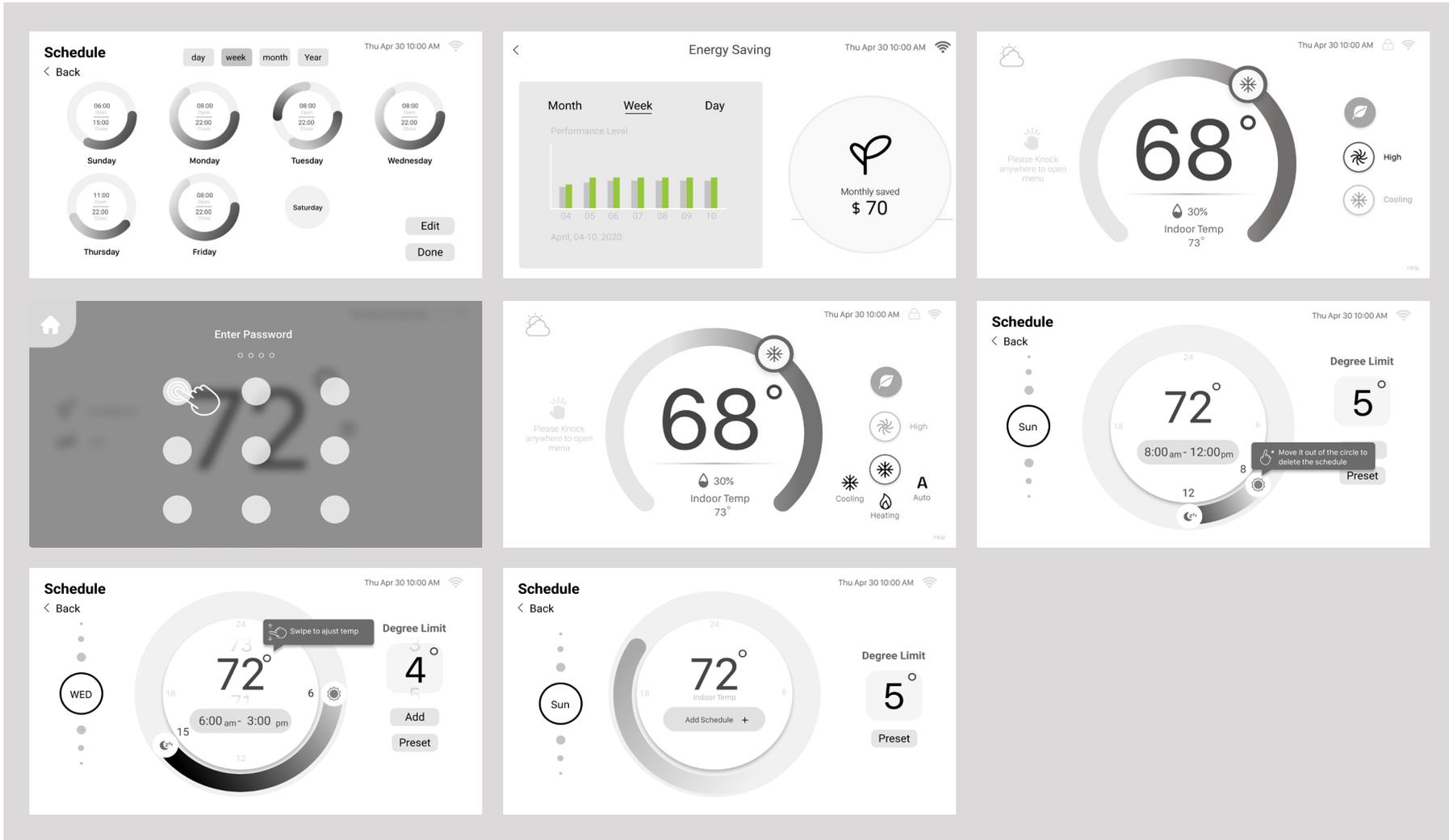
A Test



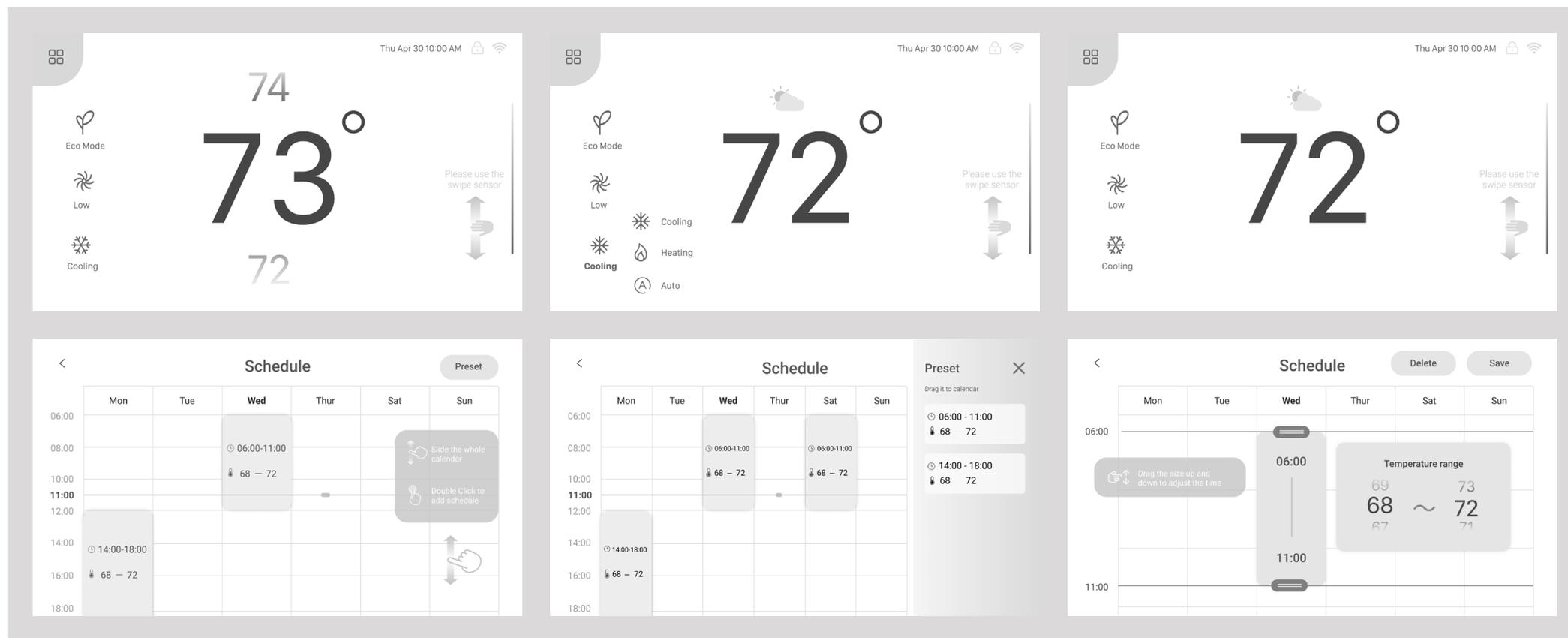
B Test

A Test

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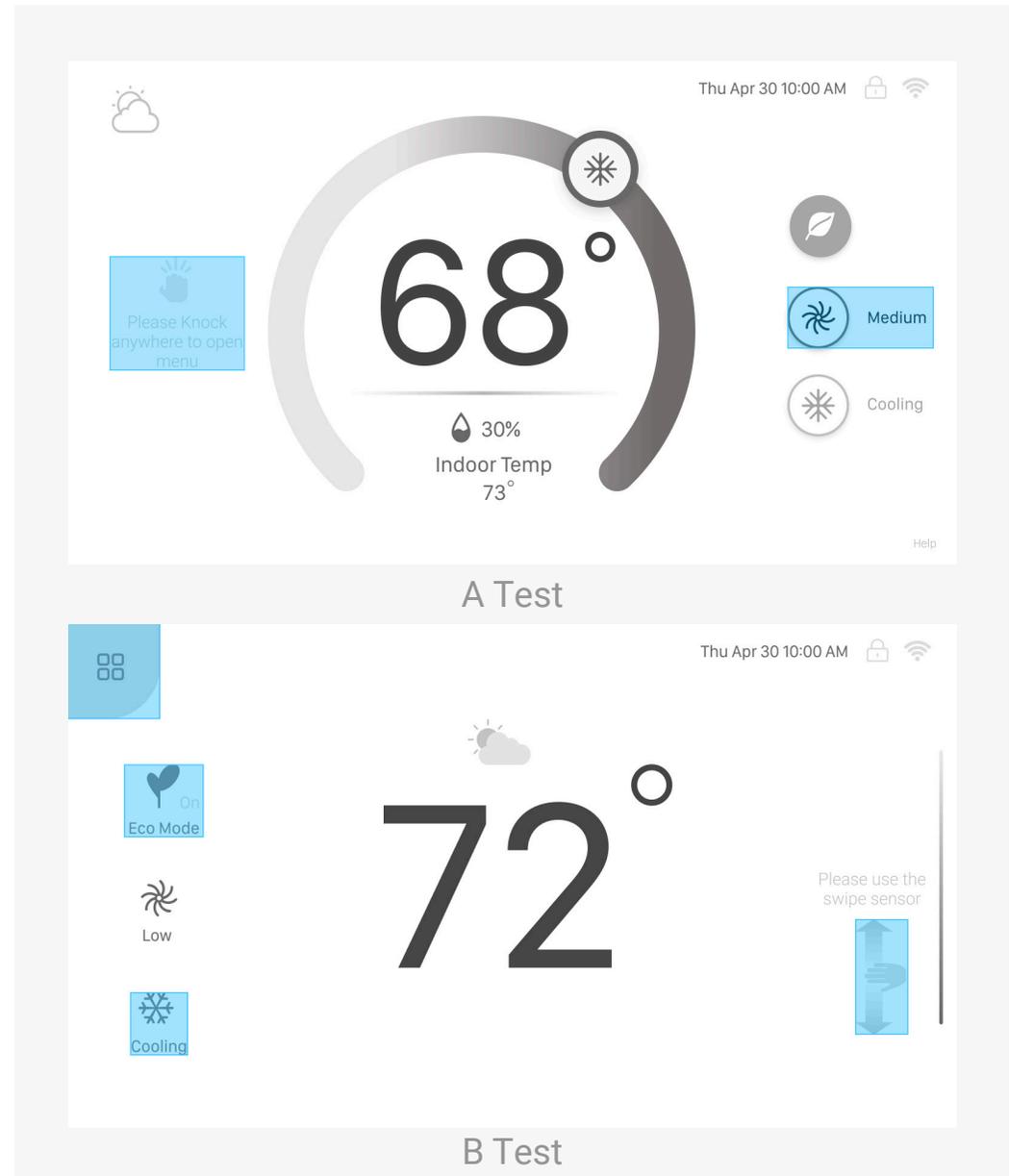
B Test



Process of Test A/B

To determine which concept works better the UX team ran an A/B testing with the 2 low-fi prototypes on Figma with over 12 participants.

1. Participants changed the temperature on the home page.
2. Participants set up and deleted existing schedules.



A/B Test Insights

Users enjoyed Test A, the round interface design however they were unsuccessful in finishing tasks. The second concept is user friendly but can be improved aesthetically.

Fan icon
Fan Level Adjustment in visual

1st Interaction:
Fan icon need to be adjustable (can never be swipe)
Degree limit explanation
schedule icon
Indoor temp confusion
Degree Limit Explanation
Menu side bar?
Open Menu Indicator Confused

Eason
1st Interaction:
Edit & Done in schedule is unnecessary
1st is more clear
more modern, comfortable
2nd is too common

Nathan:
1st Interaction:
Home screen:
- "I don't understand knocking
Fan icon
- Tapping and dragging down
Menu:
- Like tapping and dragging down" (to choose heating/cooling)
- text heavy
- why does calendar have a bar
Schedule
- I didn't understand it at first. It's a lot to see and try to
undo why EB is here?
cate what is degree limit (plus/minus)
- I'd use AM/PM
shor What is swoosh
just - does the swoosh mean it gets hotter and colder?
General:
Really liked the round home screen. He said he understood what to do and liked to change the temp.

Murphy:
1st Interaction:
The hierarchy of schedule circle is not clear enough.
- Justing the
- The hierarchy of schedule circle is ill move
- not clear enough
- I prefer the second one, the first one looks good but usability is low.

Yifan
1st Interaction:
Degree limit unnecessary why need that
men Degree limit is unnecessary
Gen:
prefer 1st, 2nd is more common
Menu is not obvious

Harrison:
1. fan icon
2. bug in heating
3. menu conflict with lock
4. adjust schedule conflict with delete
5. degree limit
6. it's a bit confusing because when you go to the menu on Tuesday to Sunday
Maybe a slot design

Jerry:
1st Operation
1. I wouldn't understand eco mode without first learn about it
2. I can't
3. The I don't understand echo mode
instead where is menu
4. How precise of time dragging operation
number tell what day is it today
This is
5. It's a little mismatch when the drag first use for adjust temperature, but then use for adjust time in the schedule. Maybe tell me what day is it today is better.

A/B Test Results

Nathan:
Homescreen:
- I like the round one better.
- I wouldn't use the swipe because the numbers look like the spin ball.
- Is it inside temperature or thermostat? I want it to say below like the first one.
Menu:
- I don't know why but this doesn't look like too much
Schedule:
- Ok, this makes sense. I just drag it.
- Why is it approximate sign? That's not right. It should be low and high.
- Why is preset 6-11? If it says drag it, do i just drag it anywhere? Shouldn't it be 5 hour window?
- I want save to be here [below temperature range] because my steps would be 1 [drag] 2 [temperature] 3 [save]. But it's way up there. Maybe delete up there?

Laeryn (exlibris occupant)
Menu:
- I didn't notice the eco mode in the other one
- like the menu having an icon instead of just touching it anywhere
- but having it depends on the wide range of people using it.
- I want the humidity on the main menu
Calendar:
- I like this better, it's more clear about the time
- but I prefer the other one in that you can see each day at once because you have to scroll for this one if there's one the end of the day
- the other one it's all available up front, but this one is simple
General
- second one is better for commerial I like the other one for my house. I think the other one is cool in person, but this one is quicker since you just walk about and swipe and it's more natural.

Jerry:
1st Operation
1. It took me second operation to change the fan mode I want instant feedback
2. Prefer icon feedback for fan mode
3. Swipe on side is interesting, is fashion but lack of control
4. Prefer touchable feedback
5. Menu is not clean enough, logo and text is overwhelming
6. When change schedule during morning and afternoon, it's cross screen and not very intuitive. and for the preset, the X looks like cancel, maybe use "okay"

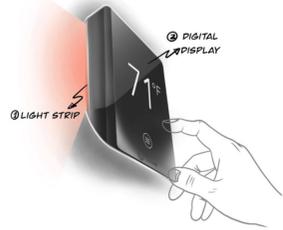
Paige (Six Pence Pub starting waitress, old thermostat):
Home:
- I like this better. I like both options of eco mode. But I like this one more since it says on
- This weather icon makes me think of weather i guess since it looks like the iphone one
- I like this option better if i'm just changing several clicks, but i like the other one if i'm changing like 75-65. It would take me a long time scrolling through.
Menu:
- ok, I think the app makes more sense since I don't know what pivot means.
- would like to see just one wifi
- ooo, I like seeing how much money i saved [energy save]
- it's too much to have "go back to home page" I know that's what i means by home icon. It's not necessary.
Schedule:
- I like this one better since i'm not a numbers person. I'm a words person. I like to see the full week.
- I like temperature range. that make sense. the other one should be range. It should be hyphen tho.
- Preset make sense for restaurant since we have a set schedule. that would make things a lot easier
- I would like hyphen between the numbers [temperature] since it was like that before. For consistency.
- does it mean drag to any day? I would like to see that there [in the directions]
General
- I like the second one better since it's less stimulating in a good way. More minimal. Because the menu has the other information i don't want to see it here.

Update

1A



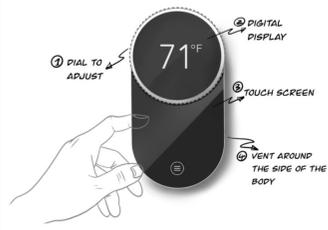
1B



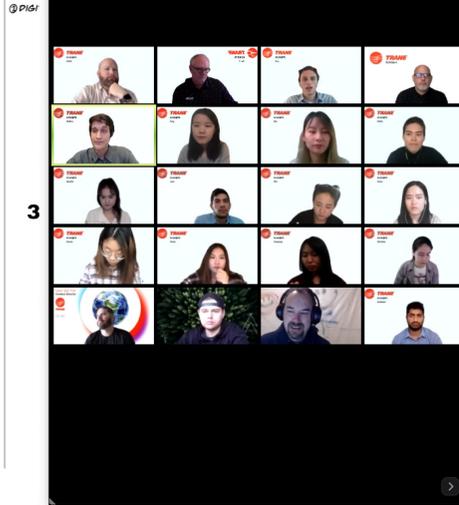
2A



2B



3



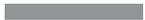
Midterm

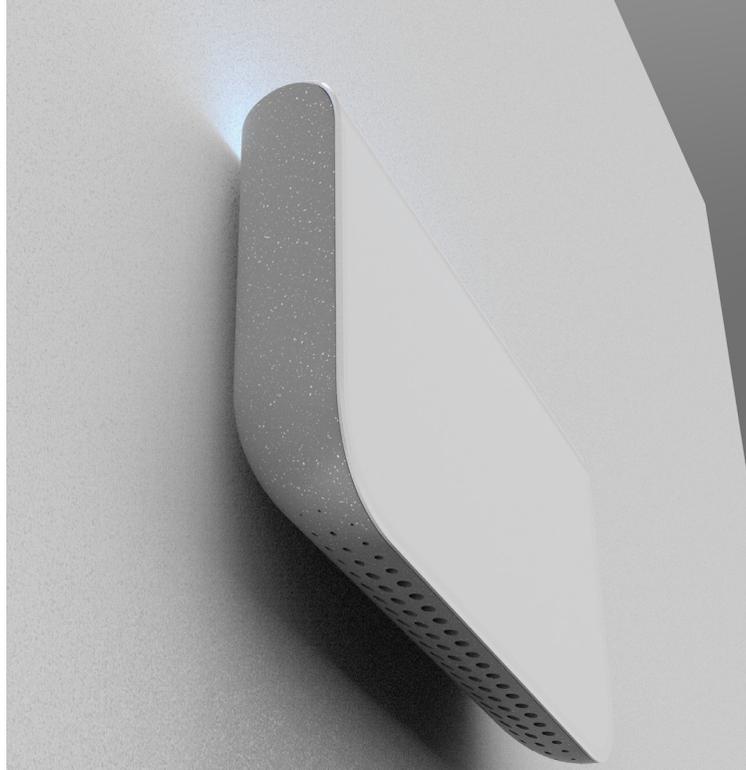
After meeting with the Trane team, we took their feedback and pivoted towards a new direction and entered another round of form development and UI iterations.



ID Development

Moving forward with the Midterm feedback, the team created several form iterations in CAD. Screen size and shape, ventilation, and LED light placement were the main design considerations.



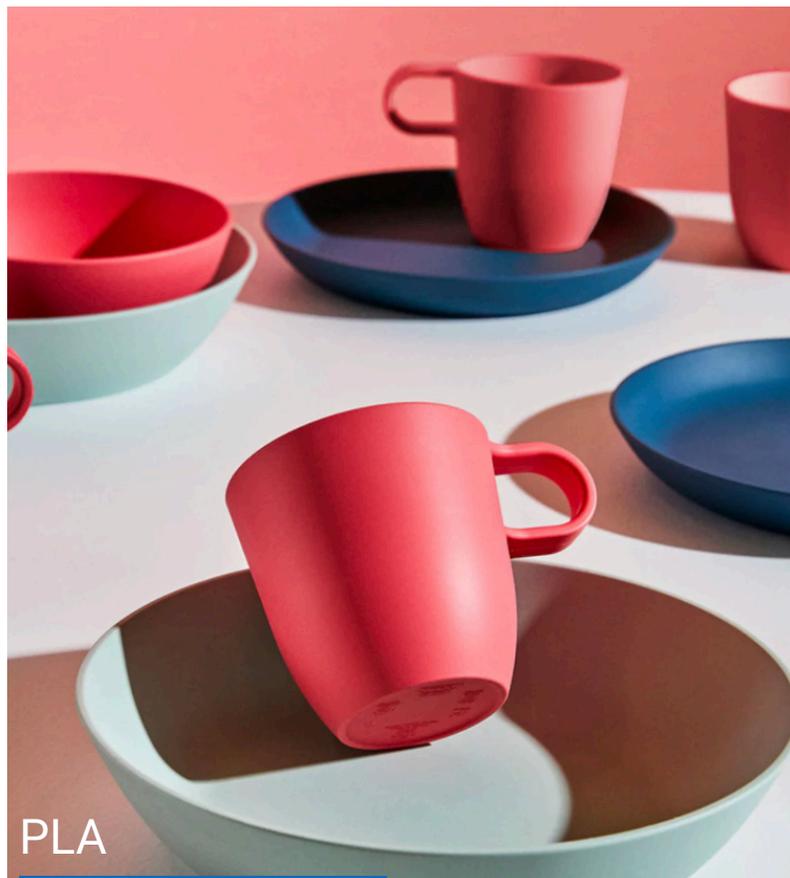


Material Research

The ID team researched materials best used for the thermostat and finalized on the following three.

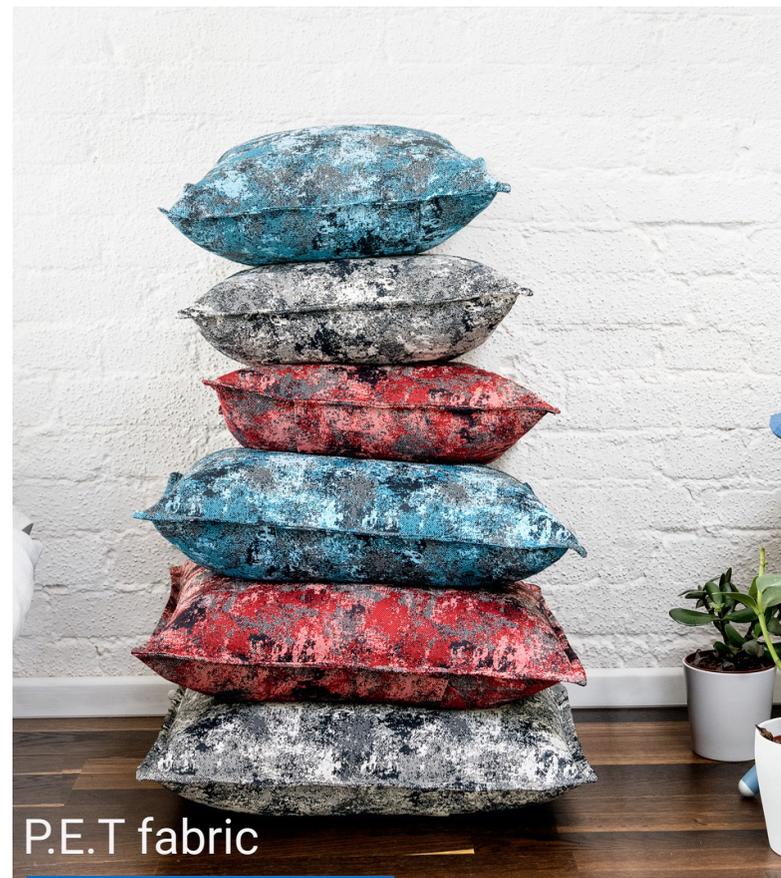


- Require a backlight
- Last a long time
- Can be many shapes
- Cheap



PLA

- Sustainable plastic
- Made from renewable sources like corn, sugar beet and sugar cane
- Can be degraded into innocuous lactic acid
- Be possible to have good heat resistance



P.E.T fabric

- Recycled plastic
- Abundant resources
- Very easy to find waste plastic, like plastic bottles
- Could make beautiful furnishings

Leaf Shape

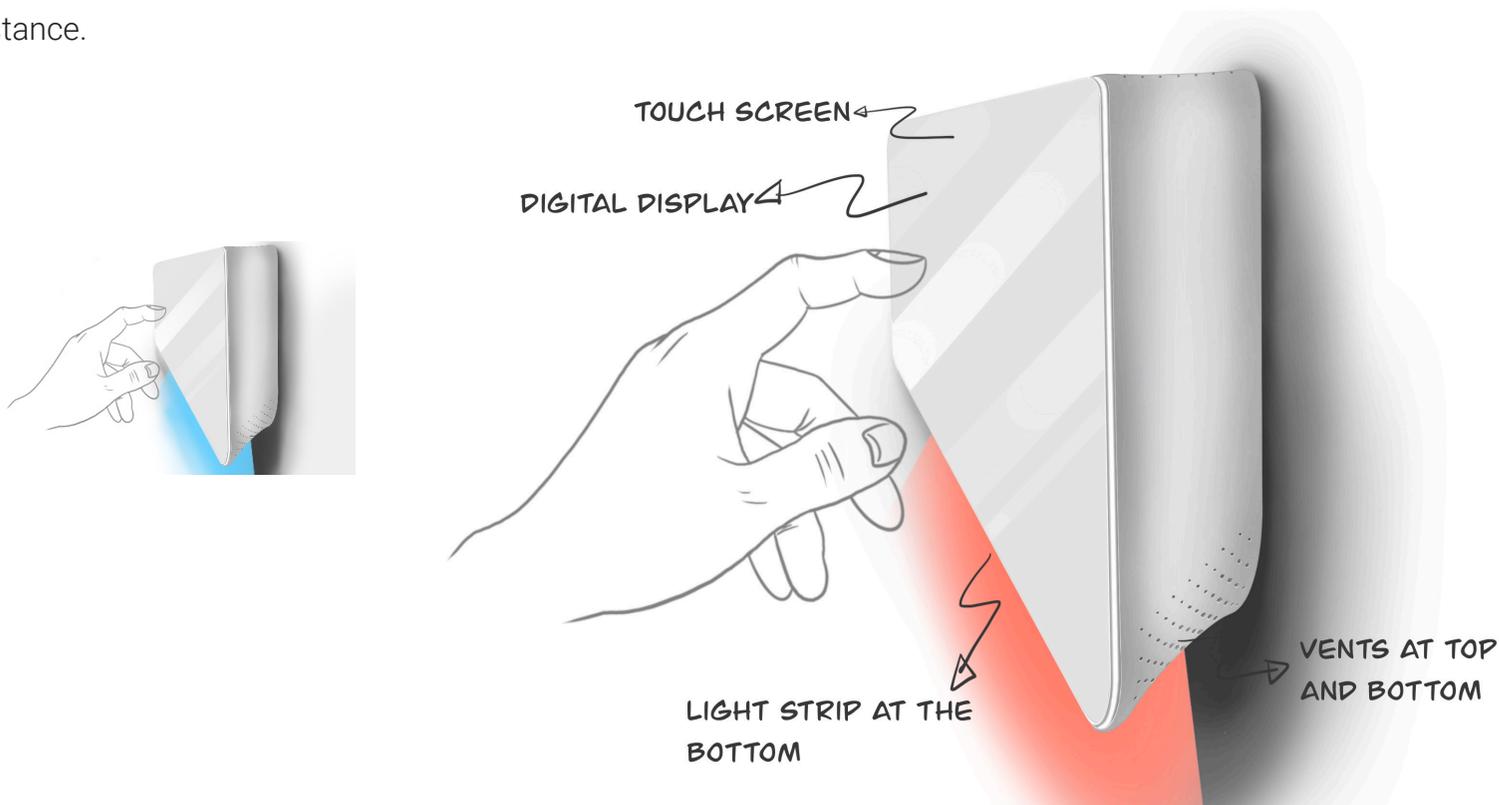
Since Trane wanted a stronger tie with the AirFi sensor which has a leaf shape, we developed a new iteration of the leaf form.



Lighting Test

From our interviews we found that users struggle to figure out whether the system is functioning, so we created system feedback through LED lights. Also, our interview report shows that our users want to be able to observe the status of the thermostat from a long distance, especially for some commercial places such as restaurants, barbers, and bakers.

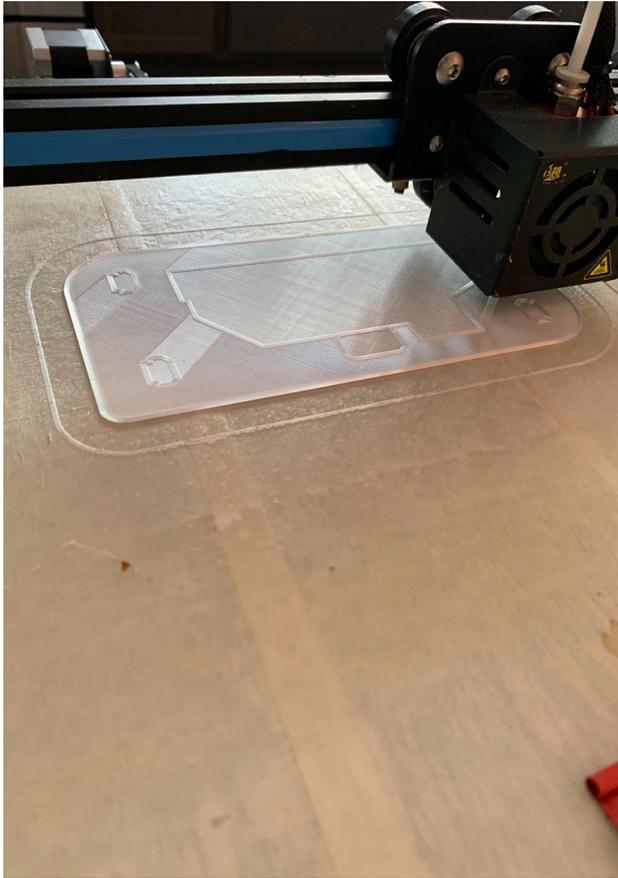
The dramatic curvature from the side, sweeping down away from the wall adds some dynamism to the design. It also serves to enhance the lighting along the bottom. In the shadow cast by the overhang, it's easy to see the splash of LED light, that pop of color, from a distance.

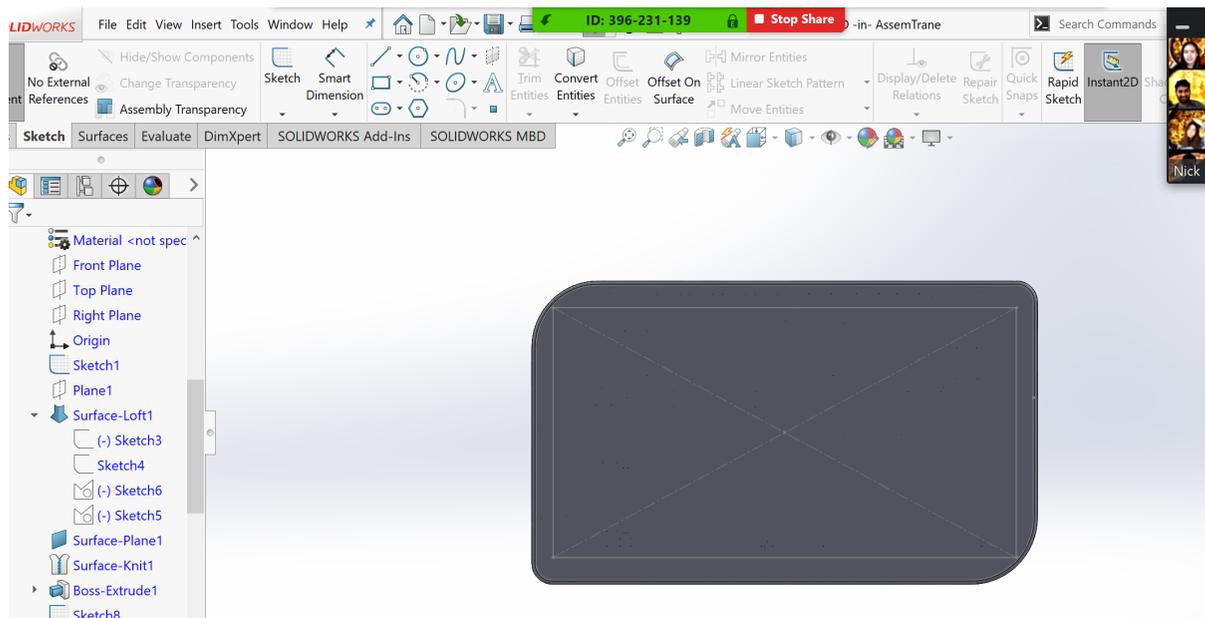


Physical Prototype Process

3D printing

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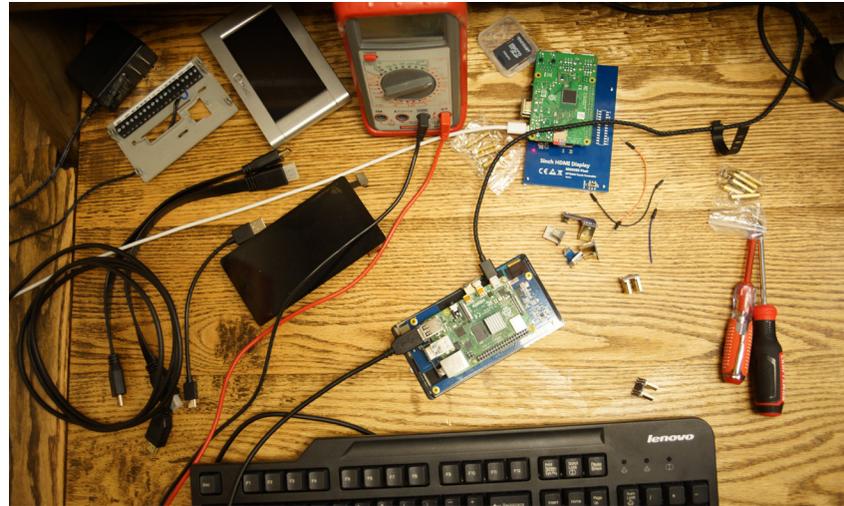
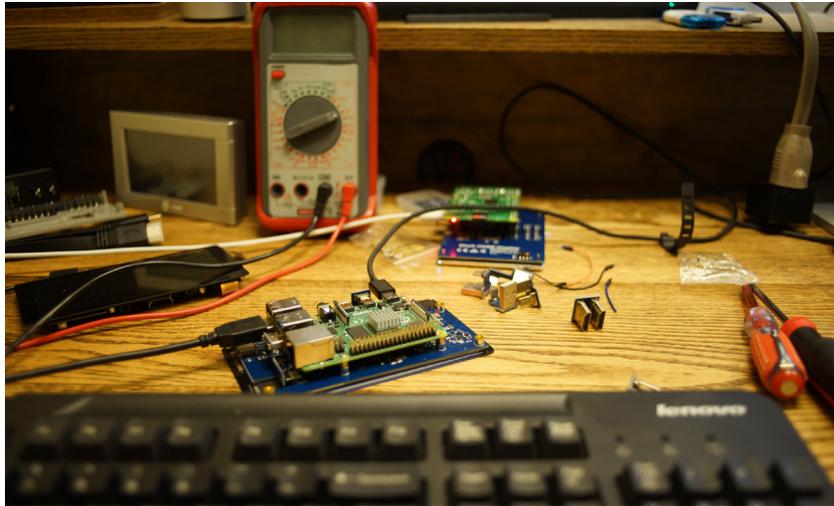


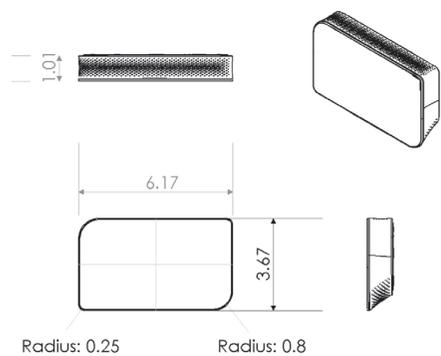


Industrial designers rely on physical models to assist in evaluating a design, so the team worked through several iterations of 3D printed shells to see how the concept would look on a wall.

Raspberry Pi Process

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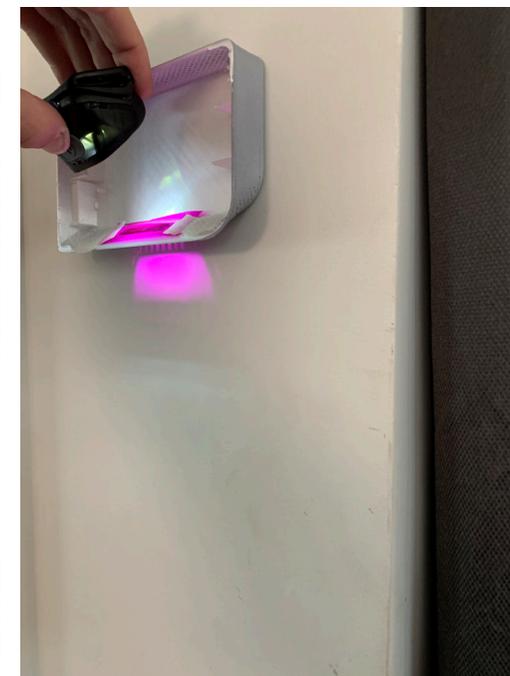


```
File Edit Tabs Help
GNU nano 3.2

#hdmi_mode=1

# uncomment to force a HDMI mode rather than DVI.
# DMT (computer monitor) modes
#hdmi_drive=2

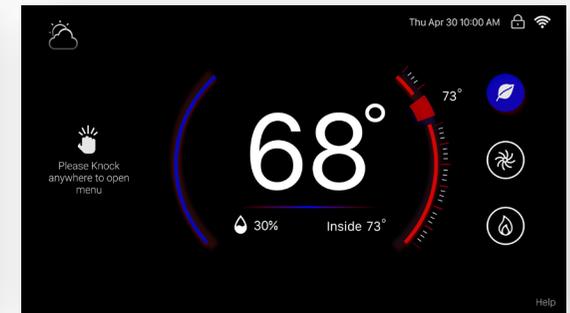
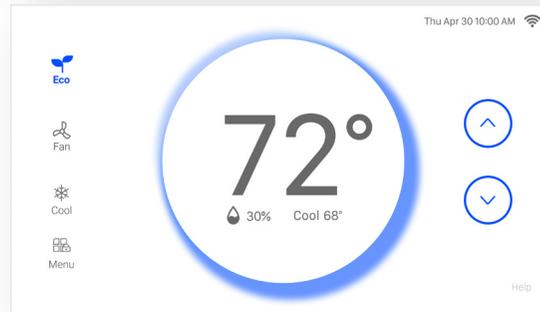
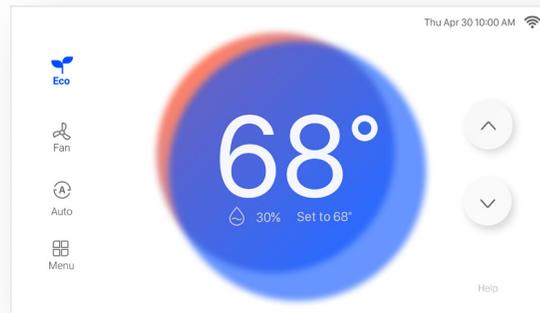
# uncomment to increase signal to HDMI, if you ha
# no display
#config_hdmi_boost=4
```

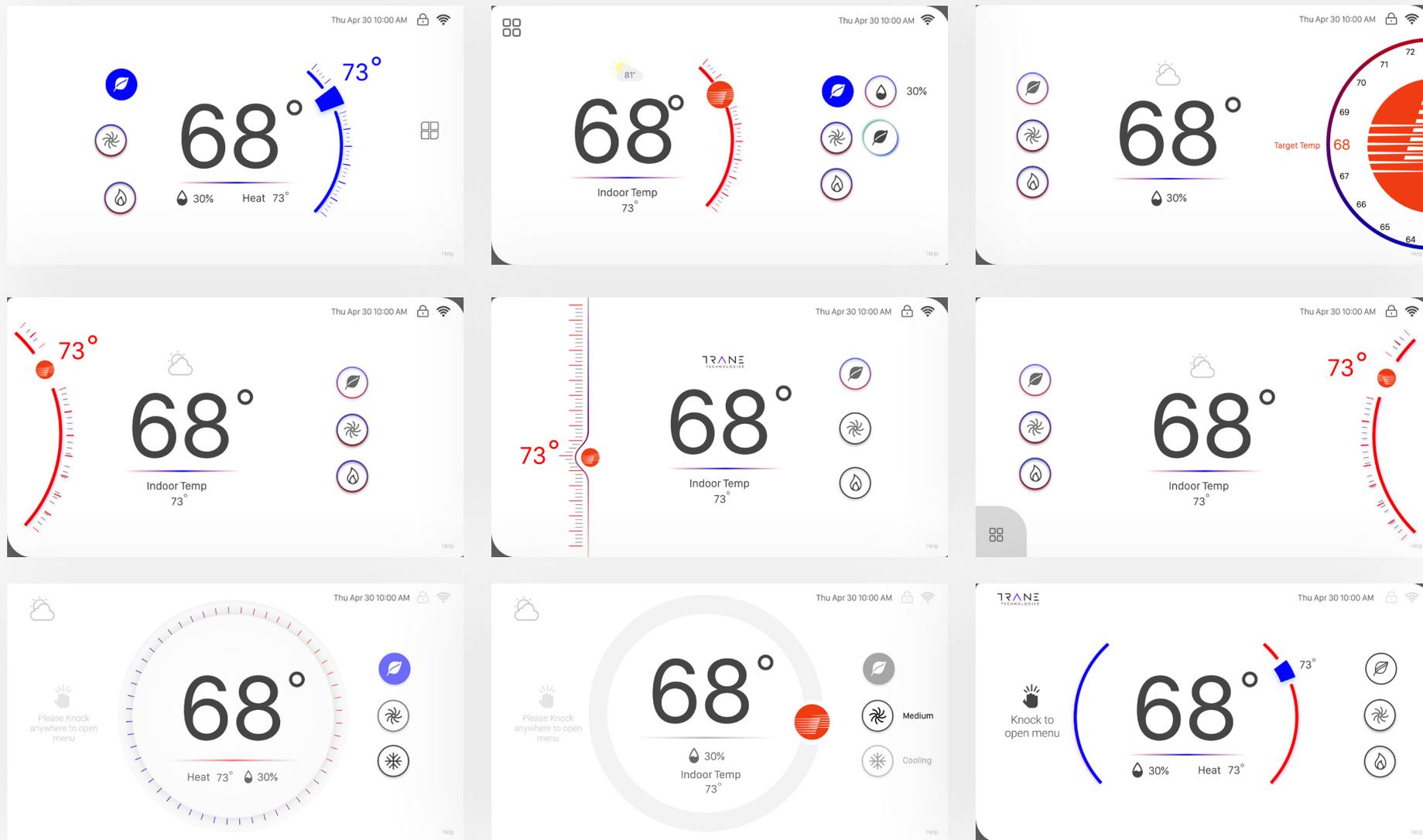


The thermostat was not complete without an interface, however. To that end, the team installed a Raspberry pi single board computer, a touchscreen, and RGB LEDs into the printed shells to better understand how all of the industrial elements could work together with a functioning user interface prototype.

Mi-fi Development

After Mid-term, the UX team moved forward to Mid-fi iteration for the user interface of temperature adjustment, schedule, energy-saving and remote access.

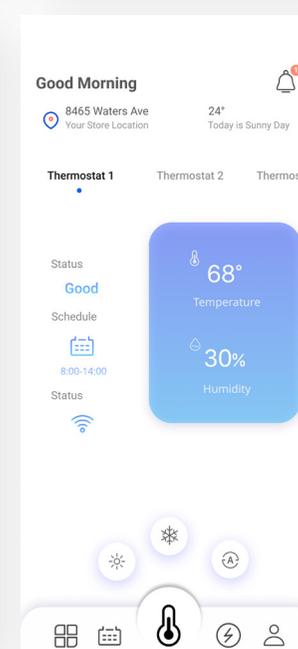
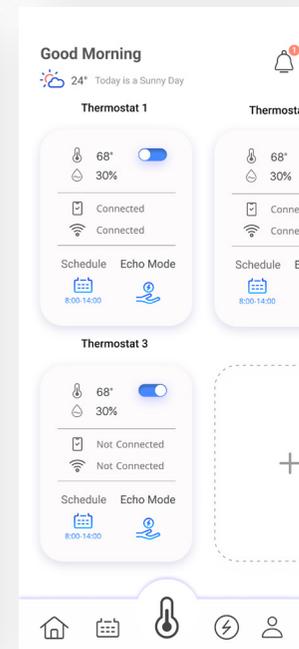
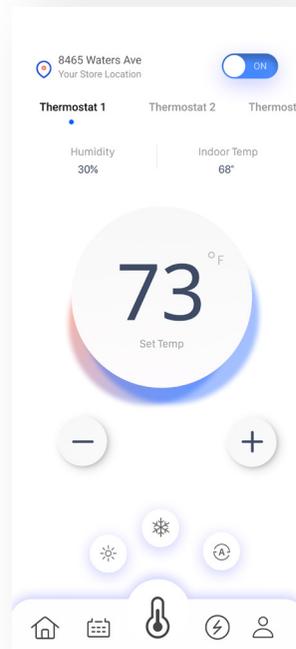
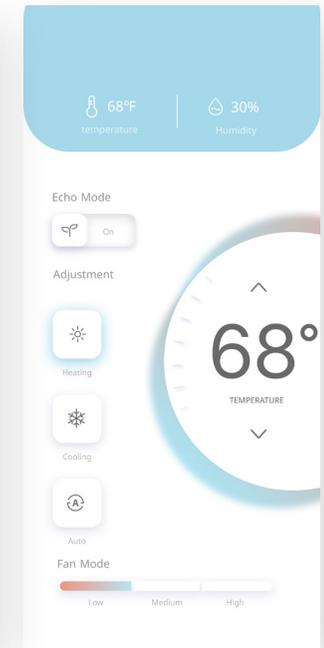
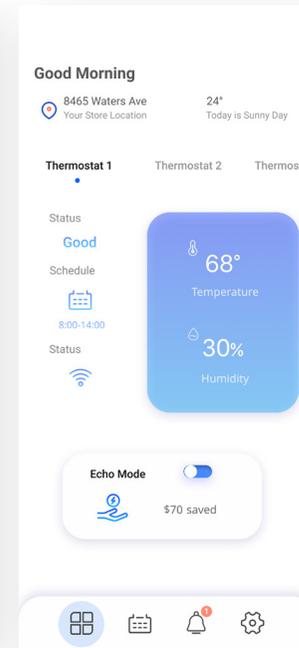
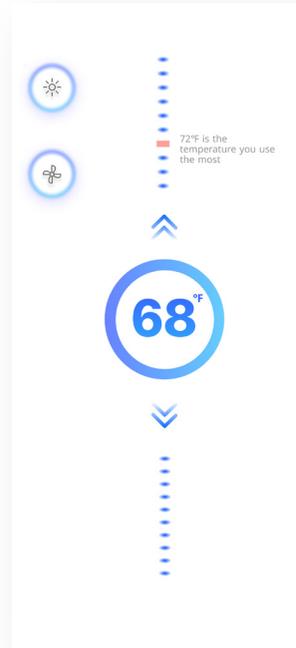




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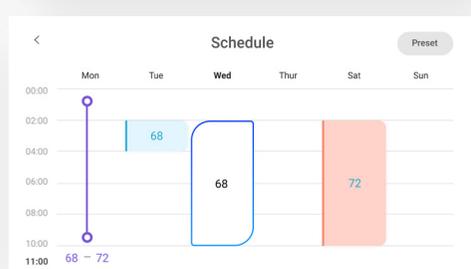
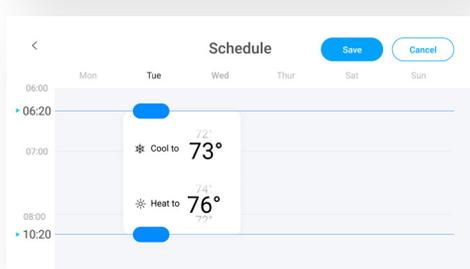
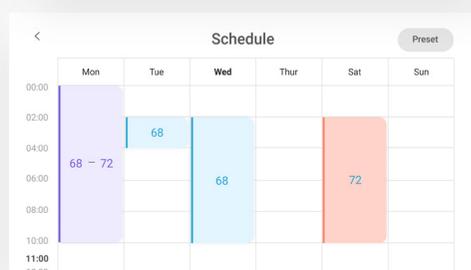
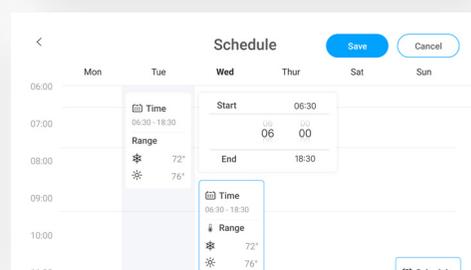
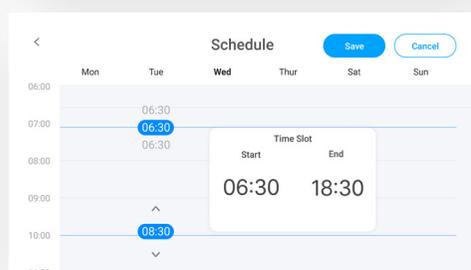
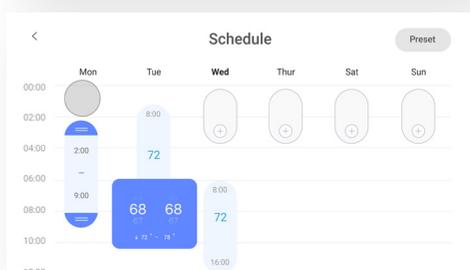
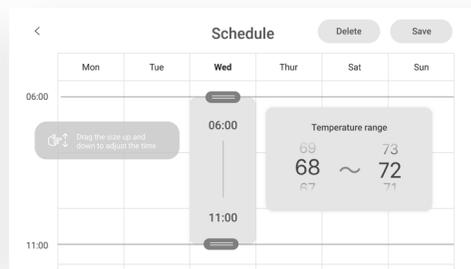
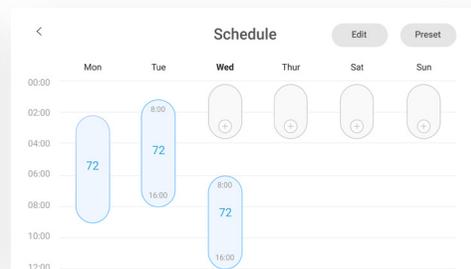
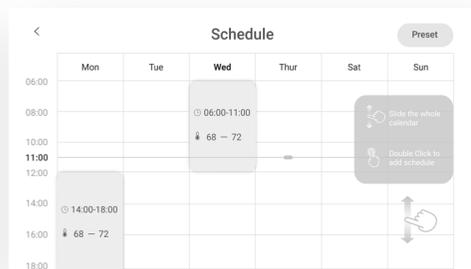
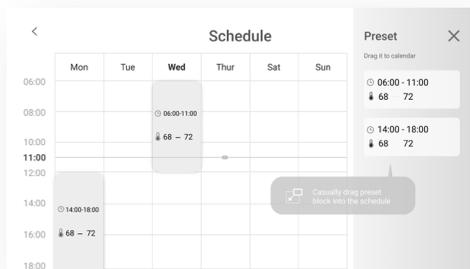
Home Screen Iteration





Remote Access





SCADPRO TRAIN

Schedule



Home Screen User Test

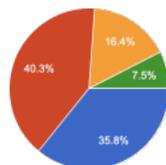
The temperature adjustment is the most essential functionalities of the commercial thermostat, therefore the UX team ran a user test to determine the best usability with 2 concepts and 2 competitor home screens.

The result showed, among 78 test participants, 71% are able to recognize immediately how to operate the temperature on the 4th user interface, which is the highest.

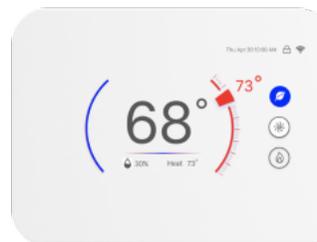
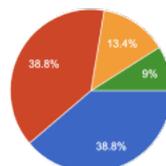


Do you know how to adjust the temperature?

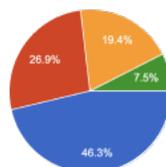
- I absolutely know.
- I might know.
- I'm not sure.
- I don't know.



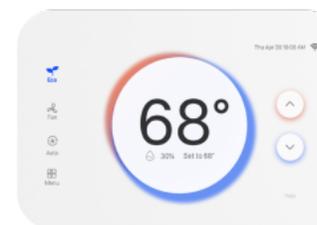
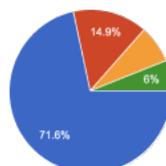
35%



38%



46%



71%



Deliver

Finally, after many rounds of iteration, the hardware and software converged together into our final concept, the Aura, the next generation commercial thermostat.





Modern Design

Being modern means the thermostat is simple, screen oriented, and reflects the Trane identity.

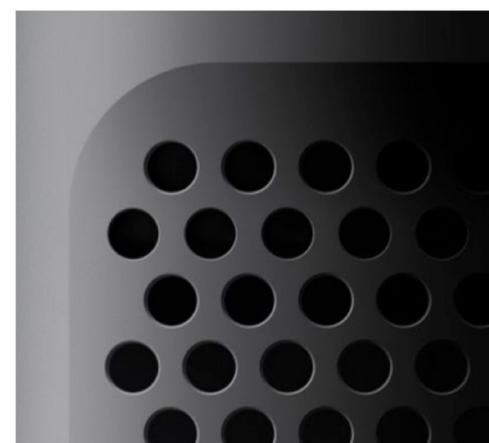
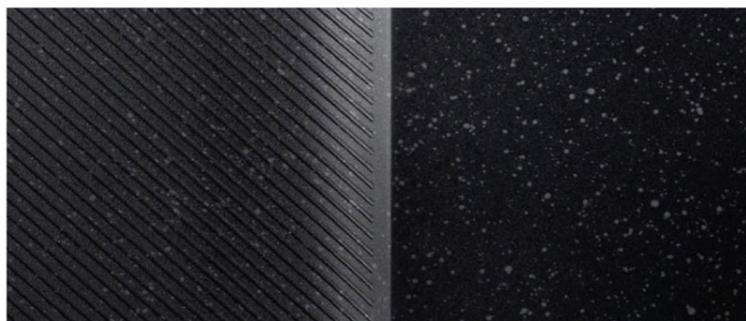
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Simple look

Screen oriented

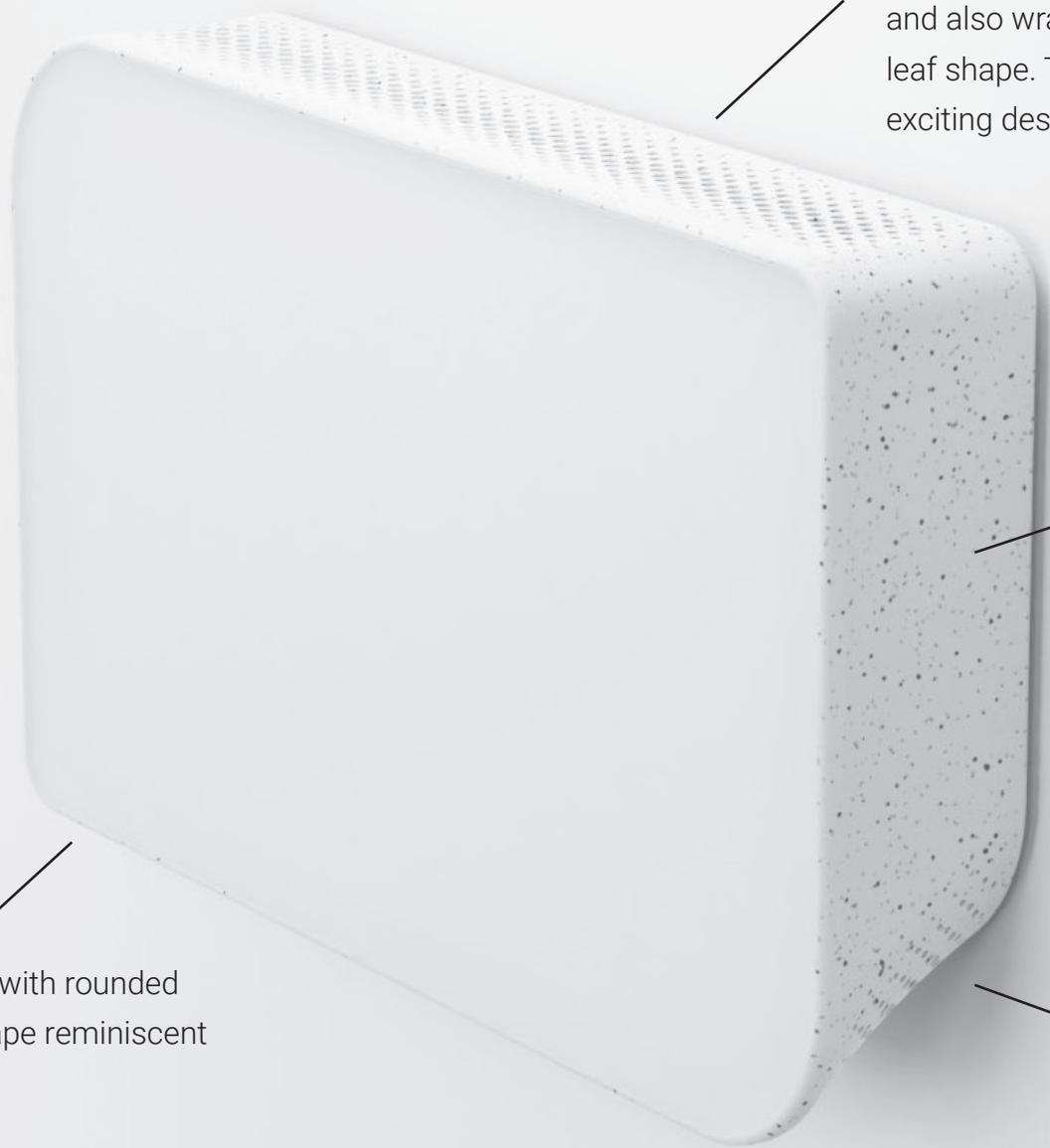
Trane identity



SCADPRO TRANE

Mood Borad



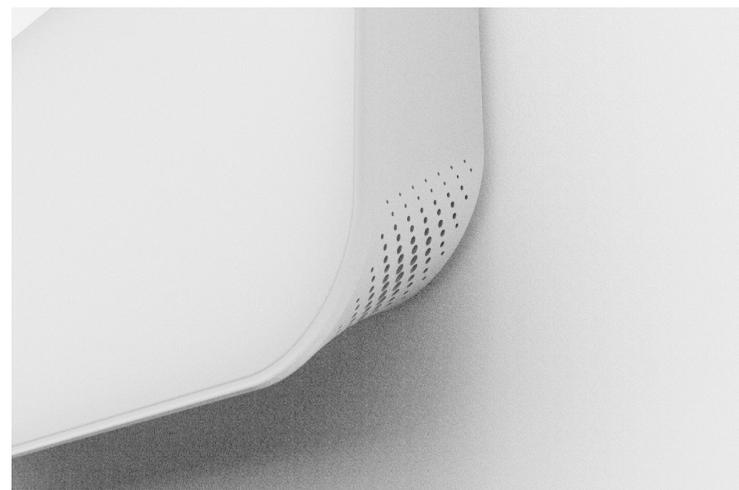
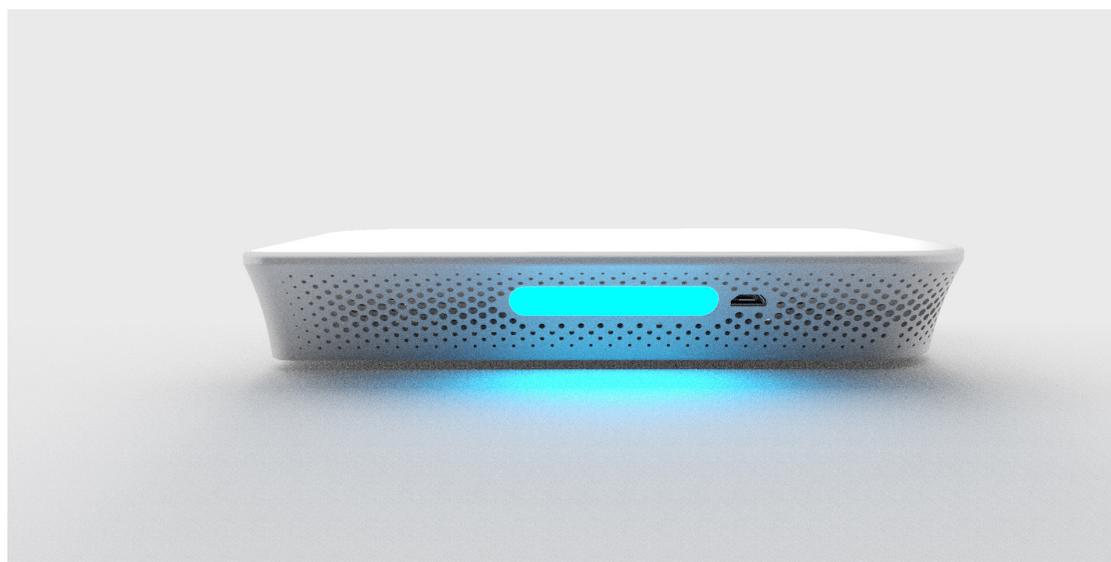
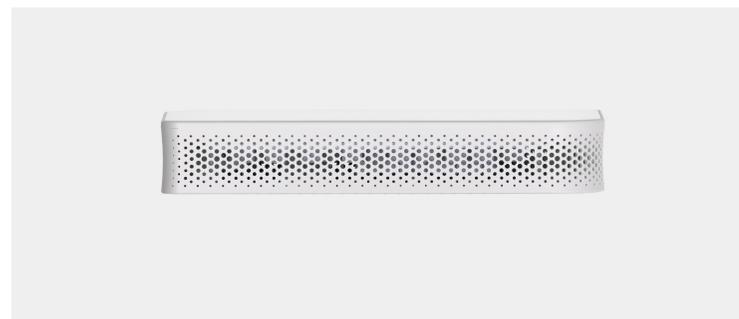


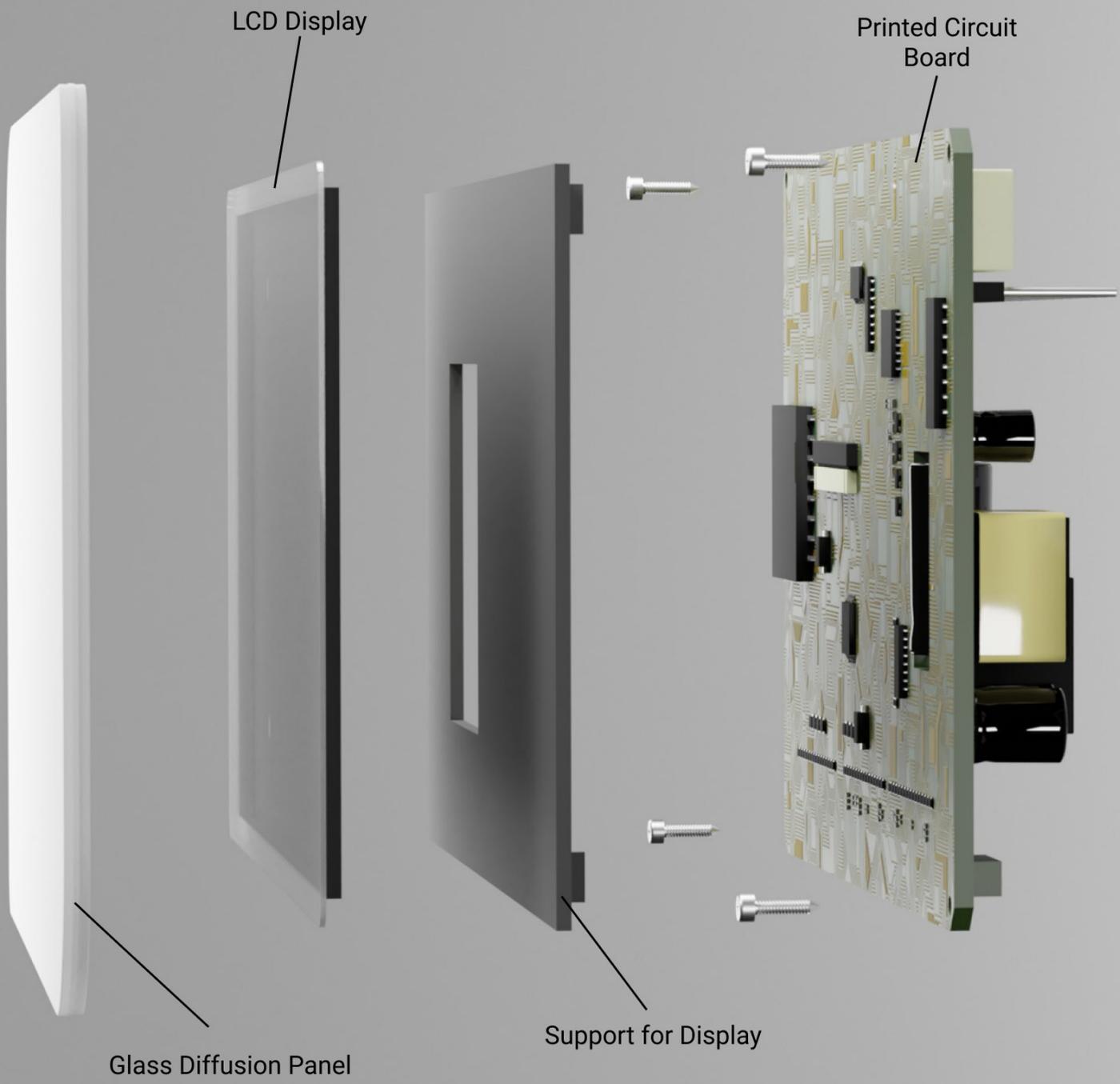
Ventilation holes vary in size and fade across the device and also wrap around the large radii to highlight the leaf shape. This turns an essential requirement into an exciting design feature, not just an engineering one.

Dramatic curvature from the side, sweeps down away from the wall adds dynamism to the design and also serves to enhance the lighting along the bottom.

Clean white front with rounded corners in the shape reminiscent of the Leaf Airfi.

In the shadow cast by the overhang, it's easy to see the splash of LED light, that pop of color, from a distance.



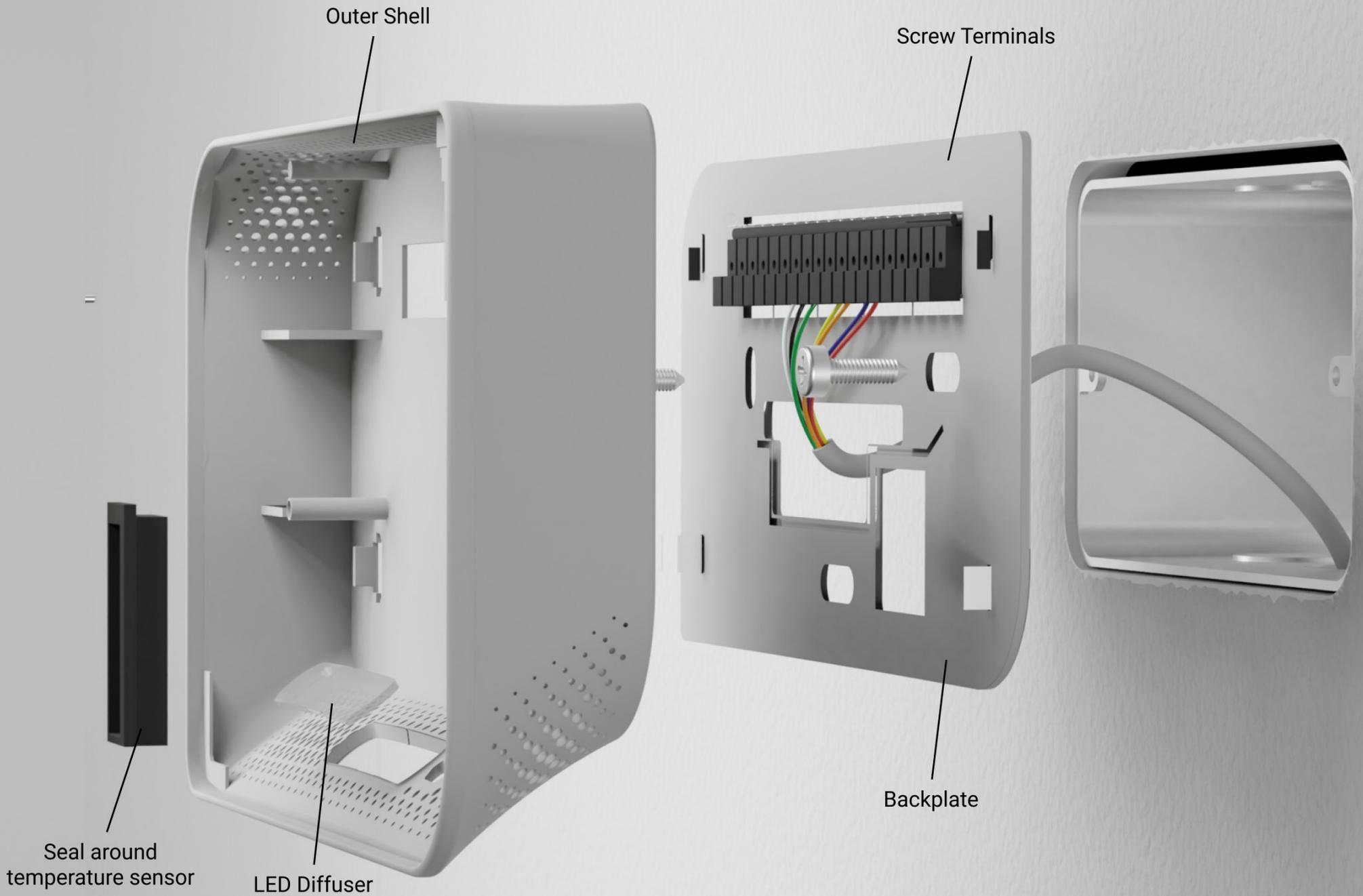


LCD Display

Printed Circuit Board

Glass Diffusion Panel

Support for Display



User Acceptance

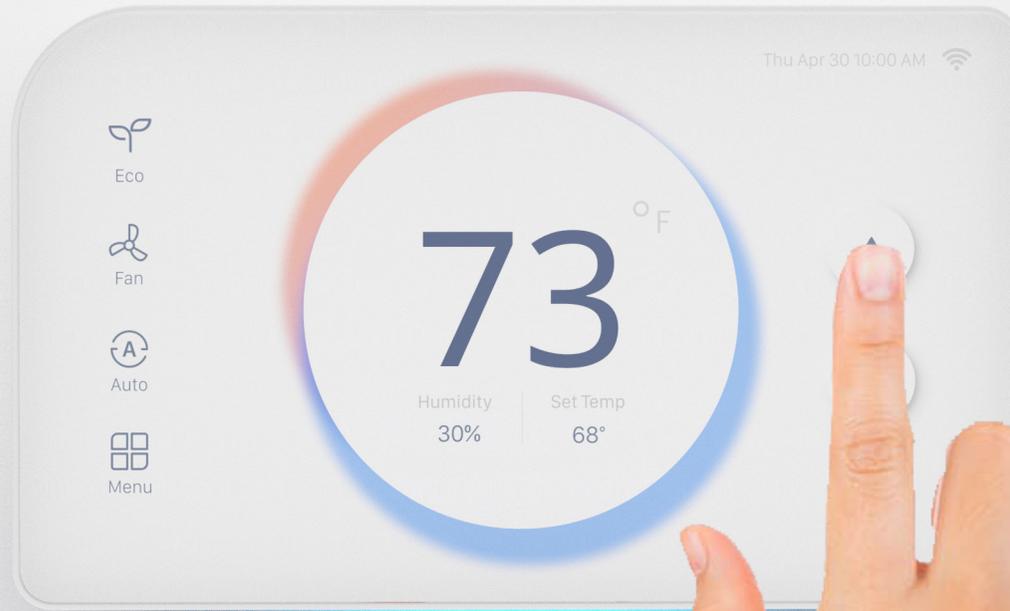
Being accepted by the user means the system grants the user accessible access to features and functions, efficient utilization, and remote control access.



Ease of Access

Improve Efficiency

Remote Control



Eco



Fan



Auto



Menu

73^{°F}

Humidity
30%

Set Temp
68°

Thu Apr 30 10:00 AM



Style Tiles

COLOR



BUTTON



TYPOGRAPHY

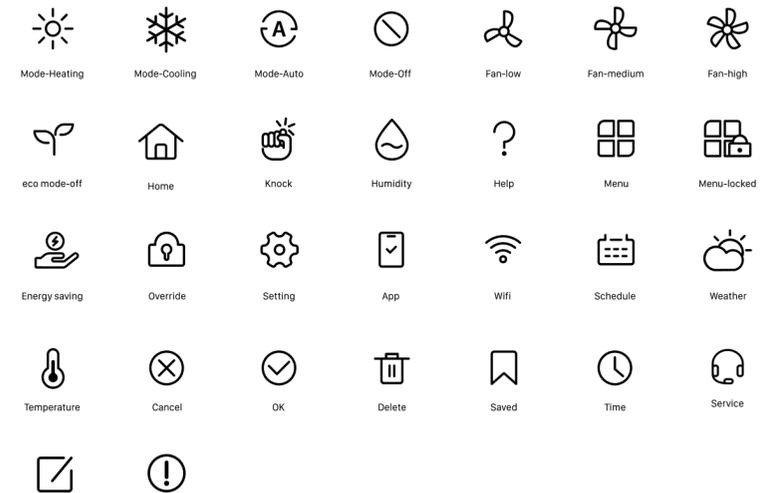
Title



Body



ICON



Hi-fi Prototype

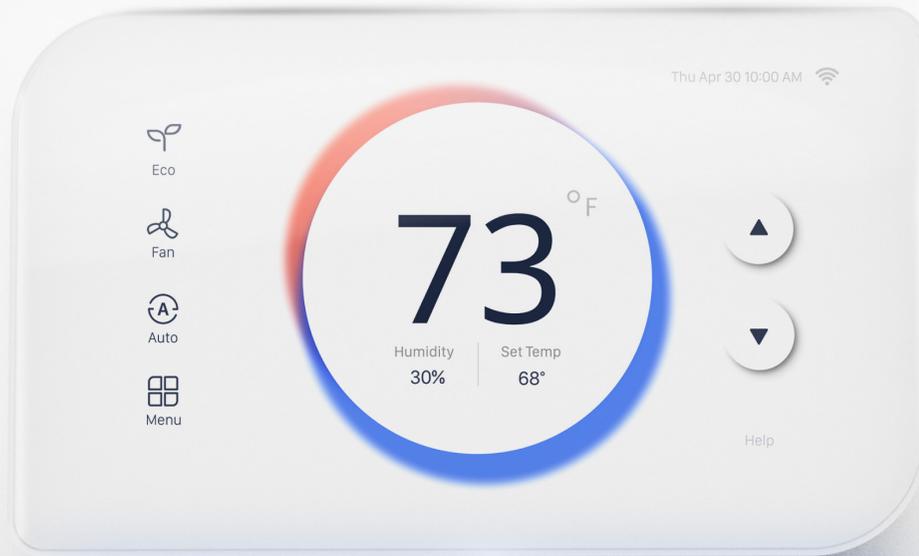
Scan the QR code



Home Screen

In the home screen the user can easily adjust the temperature and system mode.

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Temperature

The user can easily adjust the temperature via the up and down buttons  

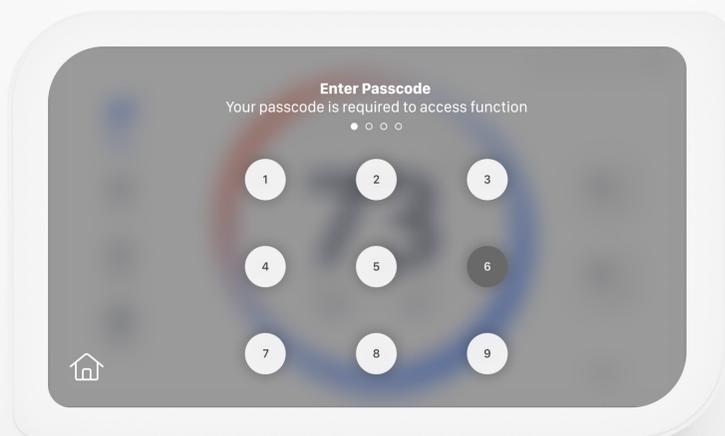
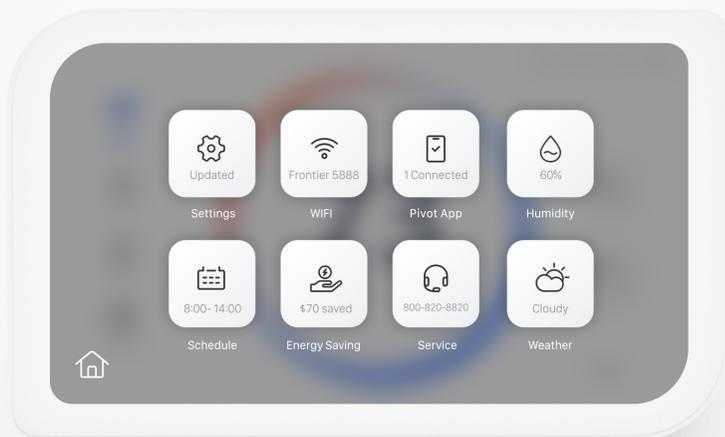
The up and down buttons will give light feedback when the user changes the temperature.

Mode

The user can change the status of eco-mode, system mode and fan mode on the left tap bar.

LED Indicator

While the thermostat is operating, the LED light will indicate system mode (heating/cooling) to the user from afar.



Menu

The user can access the menu to change higher functions after entering the passcode.

Preview

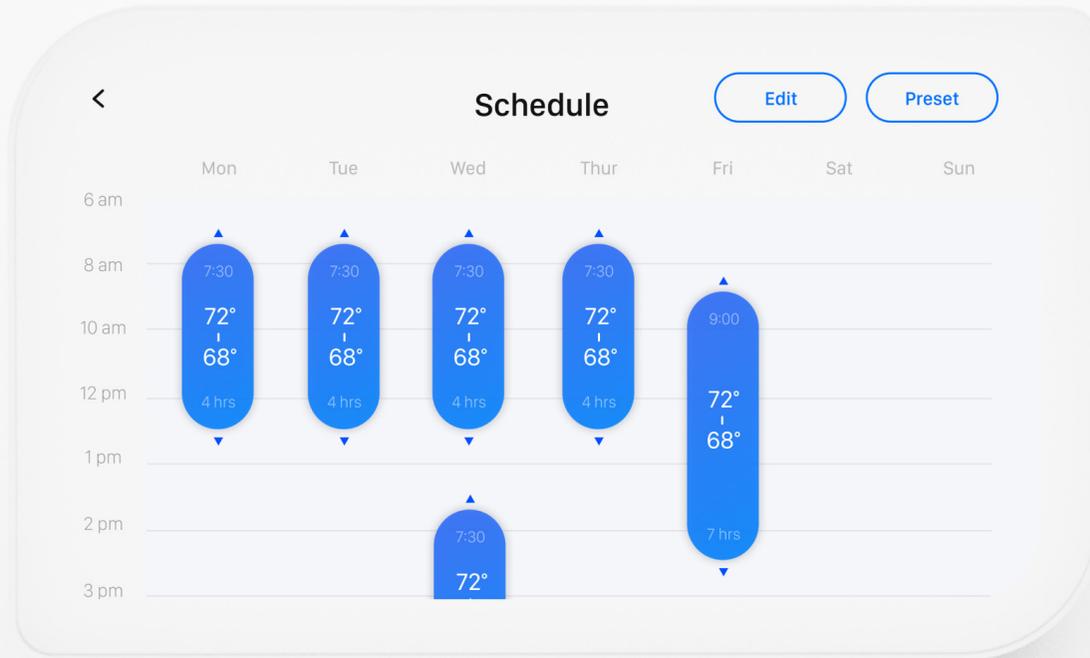
The menu has a preview to inform the user of the system status.

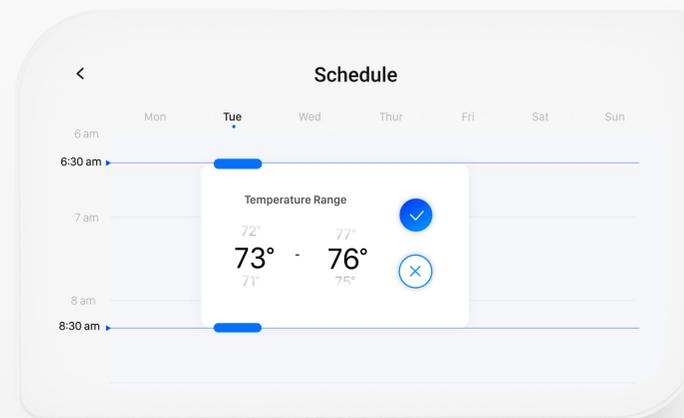
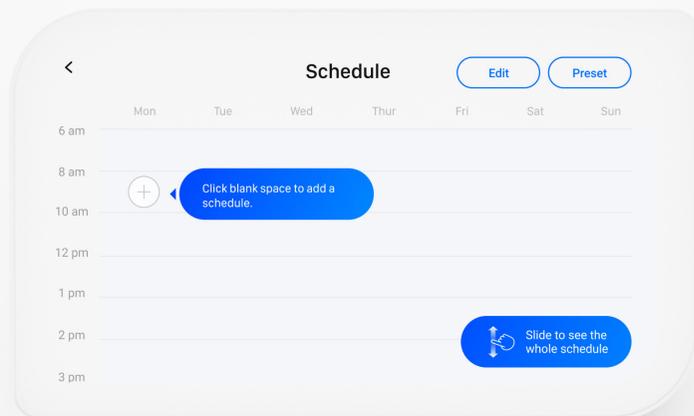
Privacy

The menu requires passcode to ensure limited access in a commercial environment.

Schedule

The user can easily set up the schedule for the entire week and designate ideal temperatures for each day.





Add New Schedule

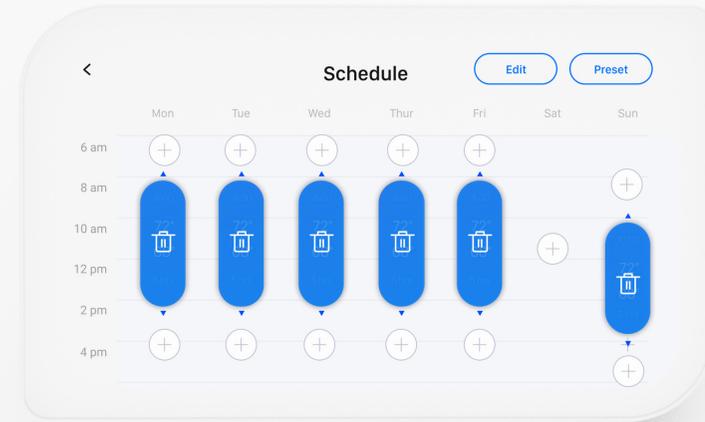
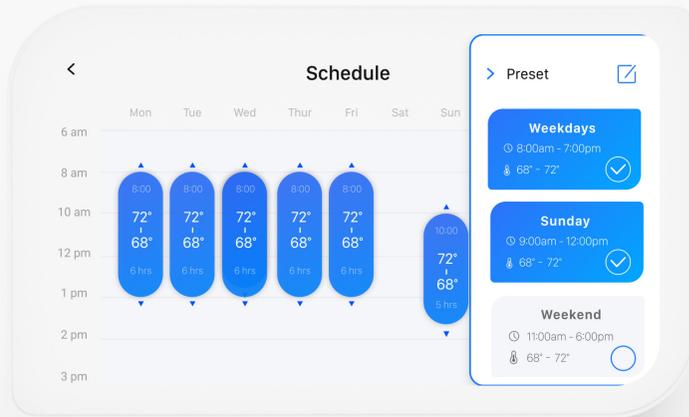
The user can easily set up new schedules by clicking the  button.

They can see the whole timeline by scrolling  up or down on the screen.

Edit Temperature

The user can drag  to change the operation hour.

They can also specify temperature for a set day aside from the override during unoccupied sessions.



Preset

The user can activate past presets schedules and presets provided by the system by clicking .

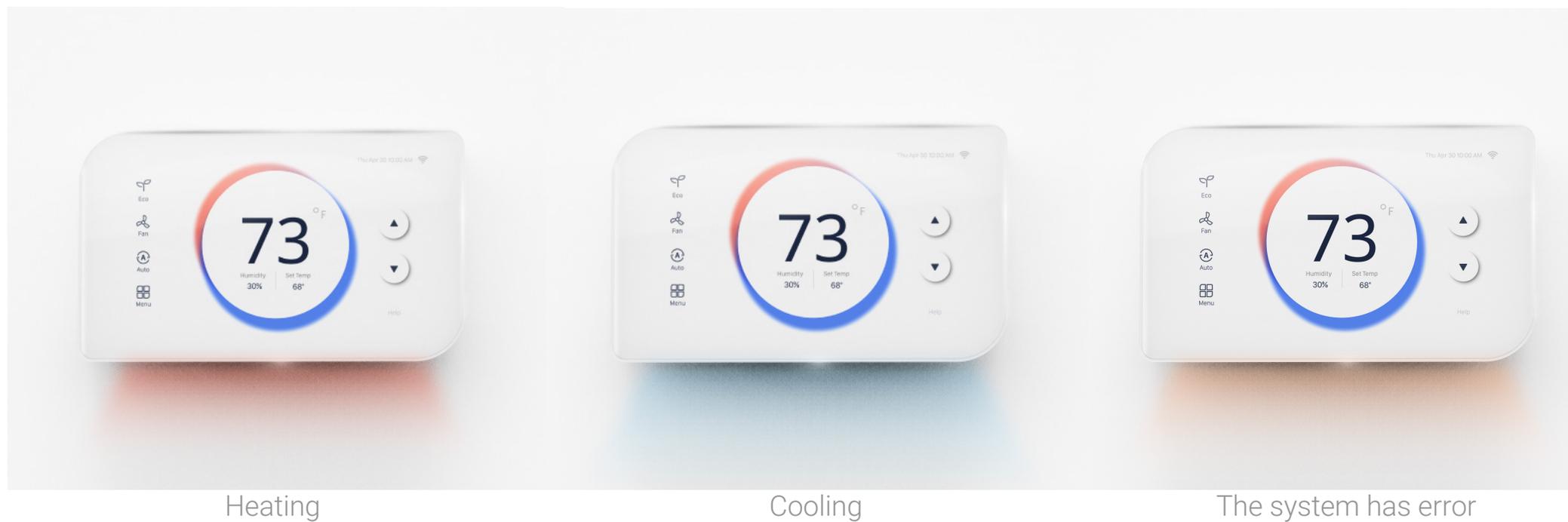
They can also drag   to change the operation hour.

Delete Schedule

The user can simply delete a schedule through .

Click  to delete the schedule and click  to add a new a one.

LED lights



Lighting

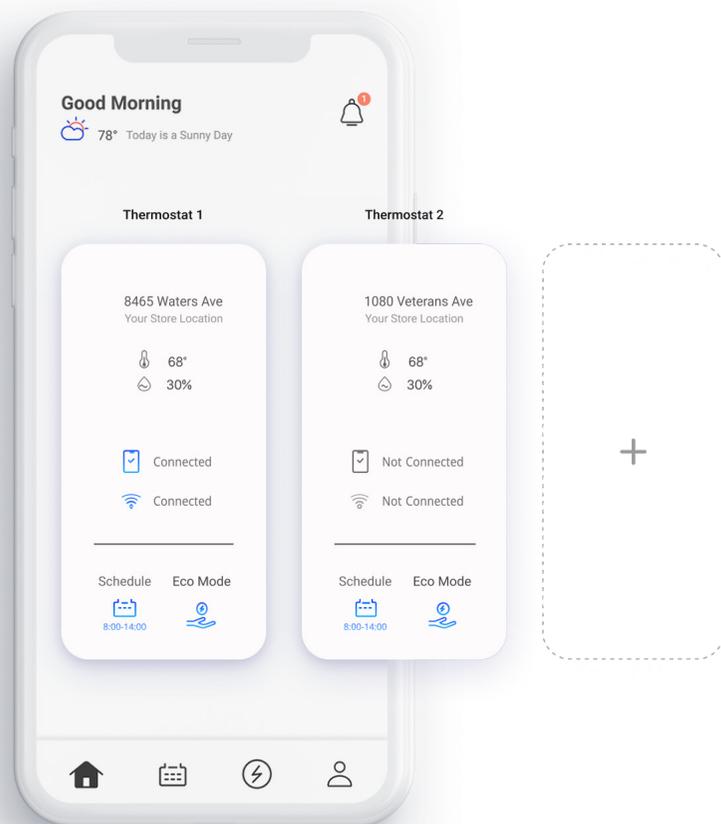
Users want to be able to observe the status of the thermostat from a long distance and know want system feedback.

Remote Control

The owner can remotely monitor the condition of the thermostat through the mobile application.

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 **Quickly Identify Status**

Users can quickly view the basic information of multiple thermostats and control the settings.



 **Same Adjustment Mode**

The thermostat and APP follow the same adjustment interaction found on the thermostat allowing users to quickly adjust modes.



Future Proof

Can withstand the market for the next 8-10 years, harmonizes with the environment, and is environmentally sustainable.



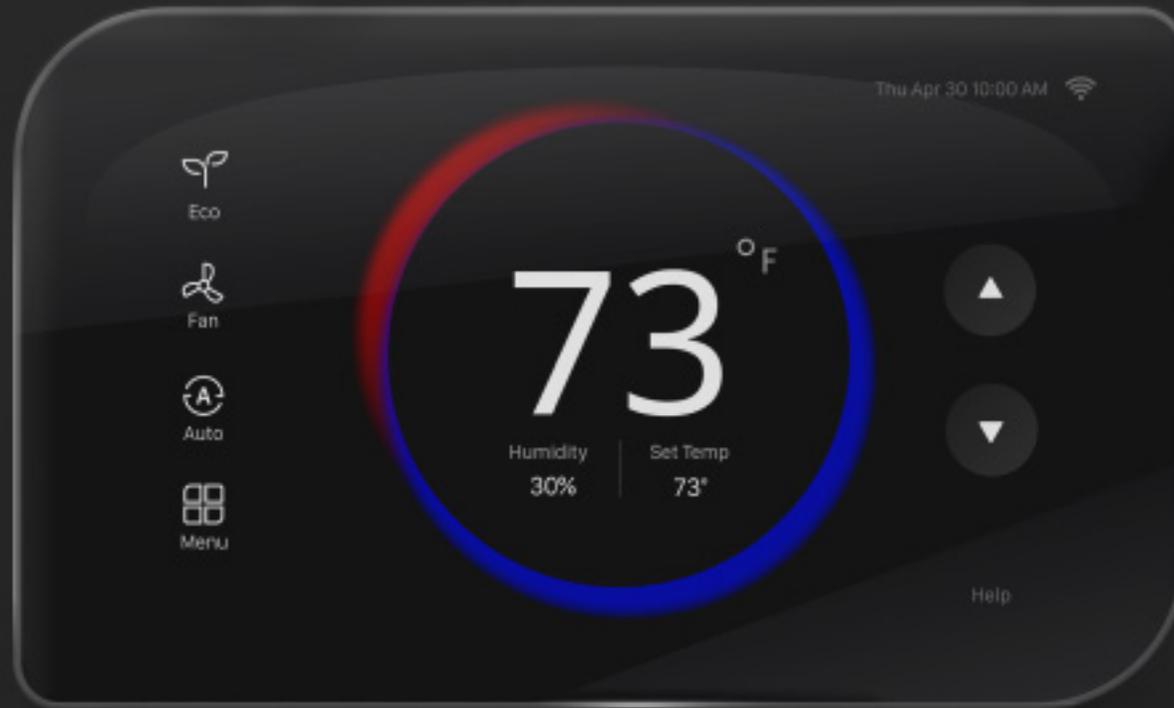
Longevity

Flexibility

Sustainability



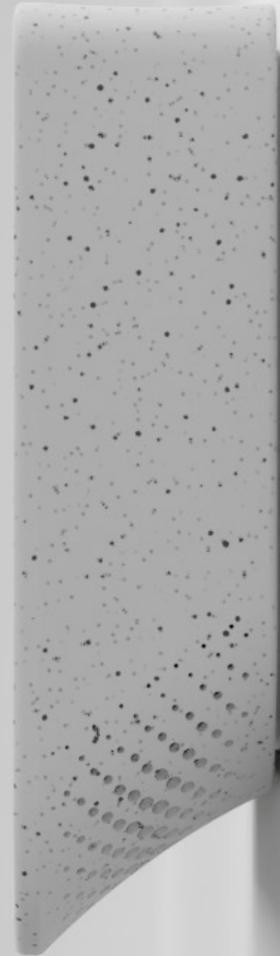
Dark Mode





The system can transition into dark mode when operating in a different environment.

Color & Material





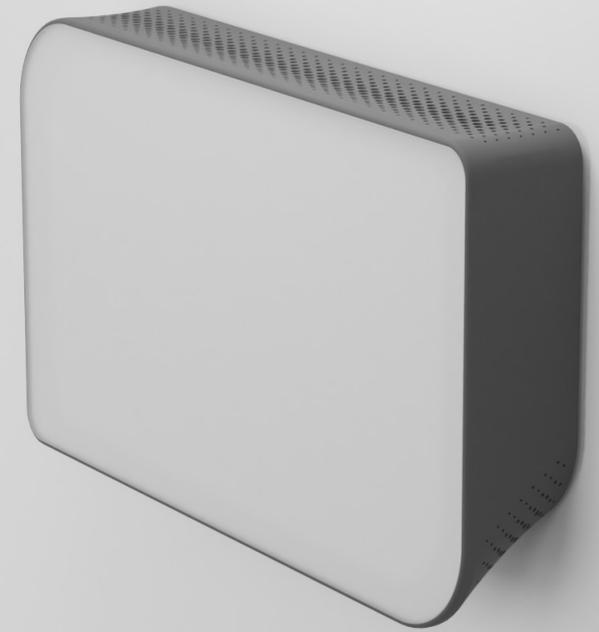
Antimicrobial White

This speckled look is one that our team loves, it has the benefit of not showing age or yellowing unlike a solid-color product. But beyond that, it makes potential imperfections in recycled plastics into a feature, broadening the range of material possibilities for Aura.



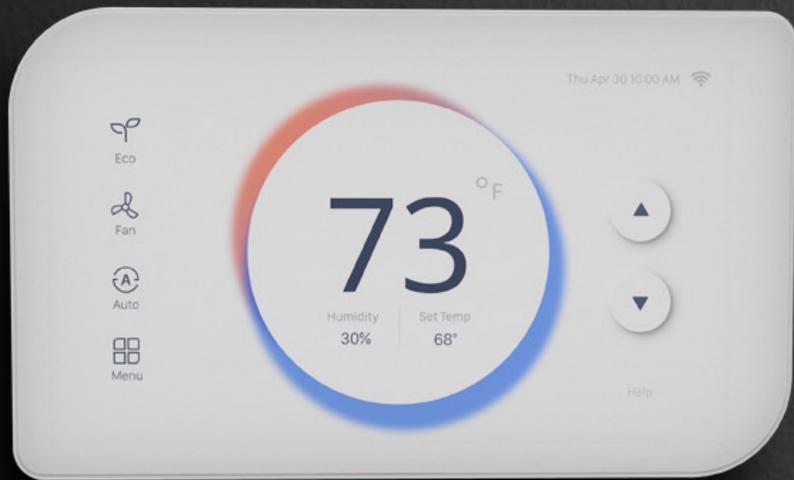
Speckled Gray

No talk of products after 2020 is complete without addressing the spread of disease. Brands like mPale make a material, known as an EIP Microbial Solution, which is applied as a spray coat that kills bacteria and viruses on the surface. This colorless chemical bonds directly into a solid and can be applied to the entire body of the thermostat.



Bioplastic Black

PLA, plant-derived or biodegradable has wonderful potential in sustainability. While it does suffer from lower UV resistance than some plastics, darker variants are more UV stable. Although on its own, PLA will not get you a UL rating, a PLA-aluminum hydroxide mixture, remains biodegradable and passes UL-94 tests for fire resistance.

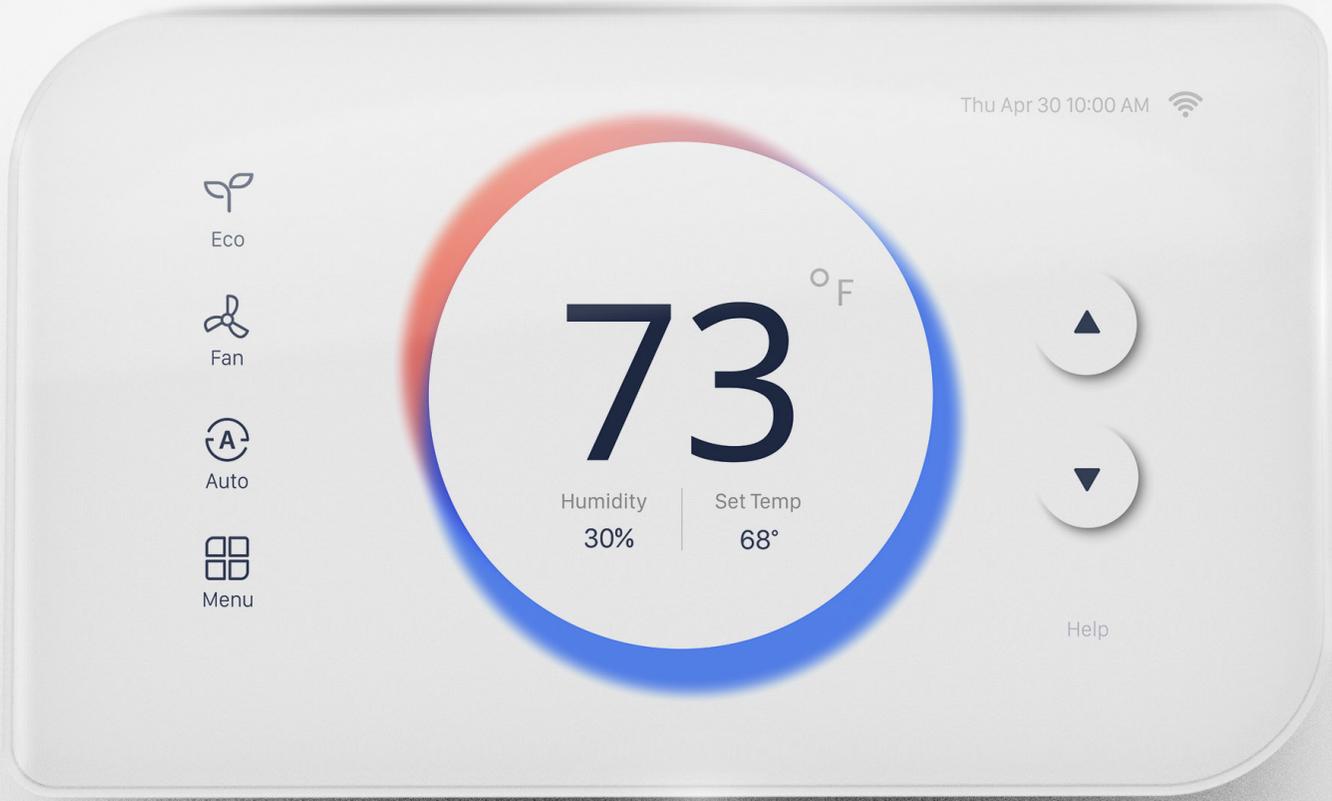




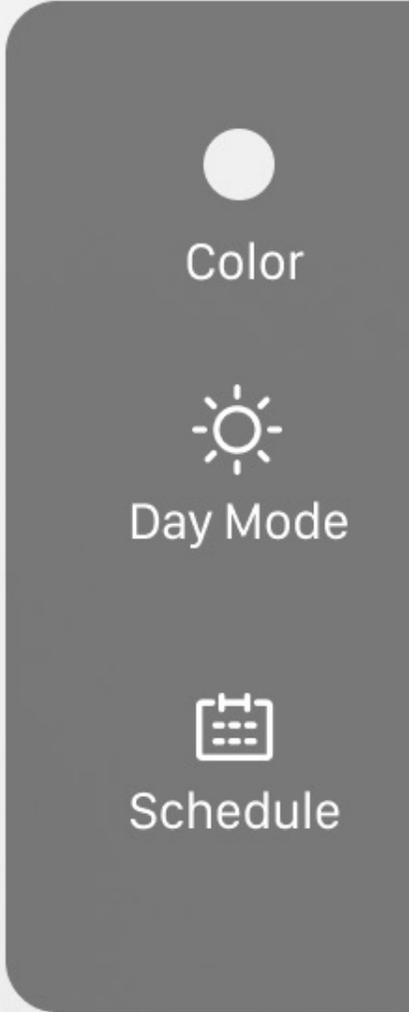
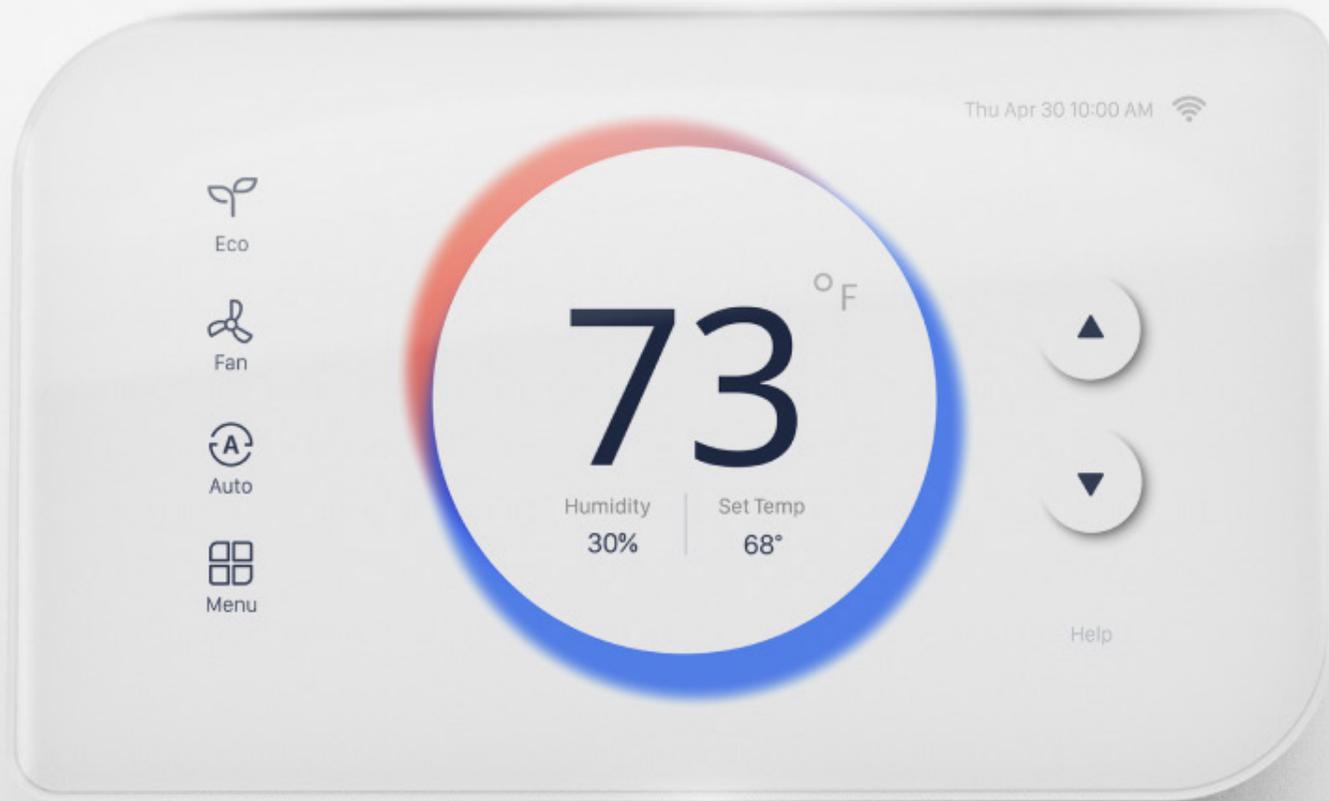
AR Implimentation

Working Pvrototype

1. Install TestFlight on your iPhone (only works on an iPhone).
2. Email your Apple ID to Amir (aahmad21@student.scad.edu) .
3. After you receive an invitation in your email, click accept on the invitation.
4. Wait for a few seconds for the email to install the Trane app on TestFlight.
5. Open the Trane app in TestFlight.
6. Scan the picture (this is the trigger) on the right to activate the mode.
7. Have fun!



Scan It







TRANE
SCADpro
Alex



Alex Whitman

SMART
SCADpro
Esther



Esther Holliday

TRANE
SCADpro
Nathan



Nathan Duderstadt

TRANE
SCADpro
Amy



Xiaojing Li

TRANE
SCADpro
Bella



Yimeng Sun

TRANE
SCADpro
Star



XINYU WU

TRANE
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Sparkle



Sparkle Lyu

TRANE
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Vivian



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Viki



Miao Viki

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Juan



Juan De La Garza Evia Castillo

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Christine



Suwenjing Li

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Grace



Guanzhi Kou

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Tena



Shuning Fan

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Goutham



Goutham Thirumalesh

TRANE
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Nick Dine

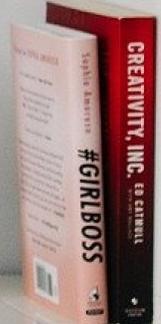
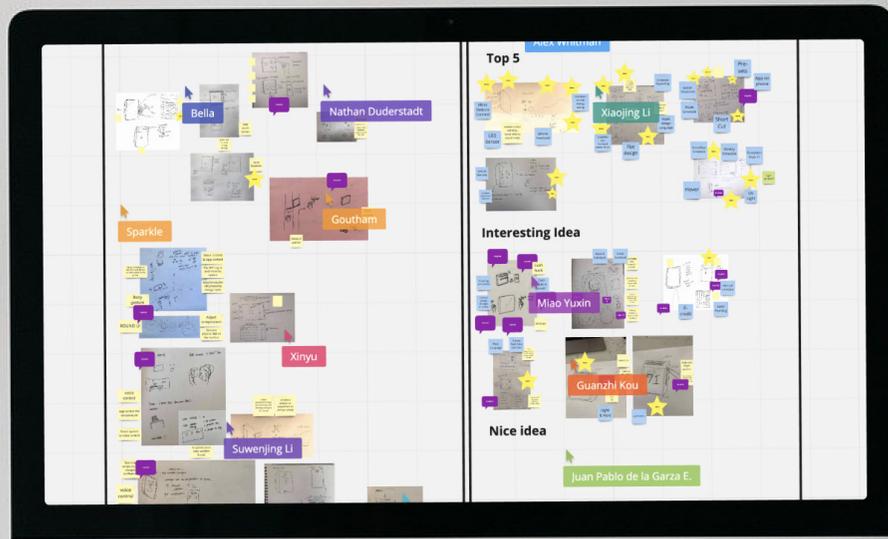
TRANE
SCADpro
David



David Meyers

APPENDIX





Sources



https://drive.google.com/drive/folders/1GAlZrC8Cc24vWioxN9_mtlMp900bTEw?usp=sharing

<https://jyinspiration.tumblr.com/post/190270502870/via>

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<https://www.pinterest.com/pin/619596861223600228/>

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<https://www.amazon.com/WIshioT-Display-ILI9341-Controller-Arduino/dp/B07916R3KY>

<https://pixabay.com/photos/home-office-workspace-desk-design-820389/>

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<https://www.pentatonic.com/work/#recycled-pet-fabrics>

<https://www.pexels.com/photo/photo-of-imac-near-macbook-1029757>

Google Drive

For more information on primary and secondary research as well as other information go to this link:

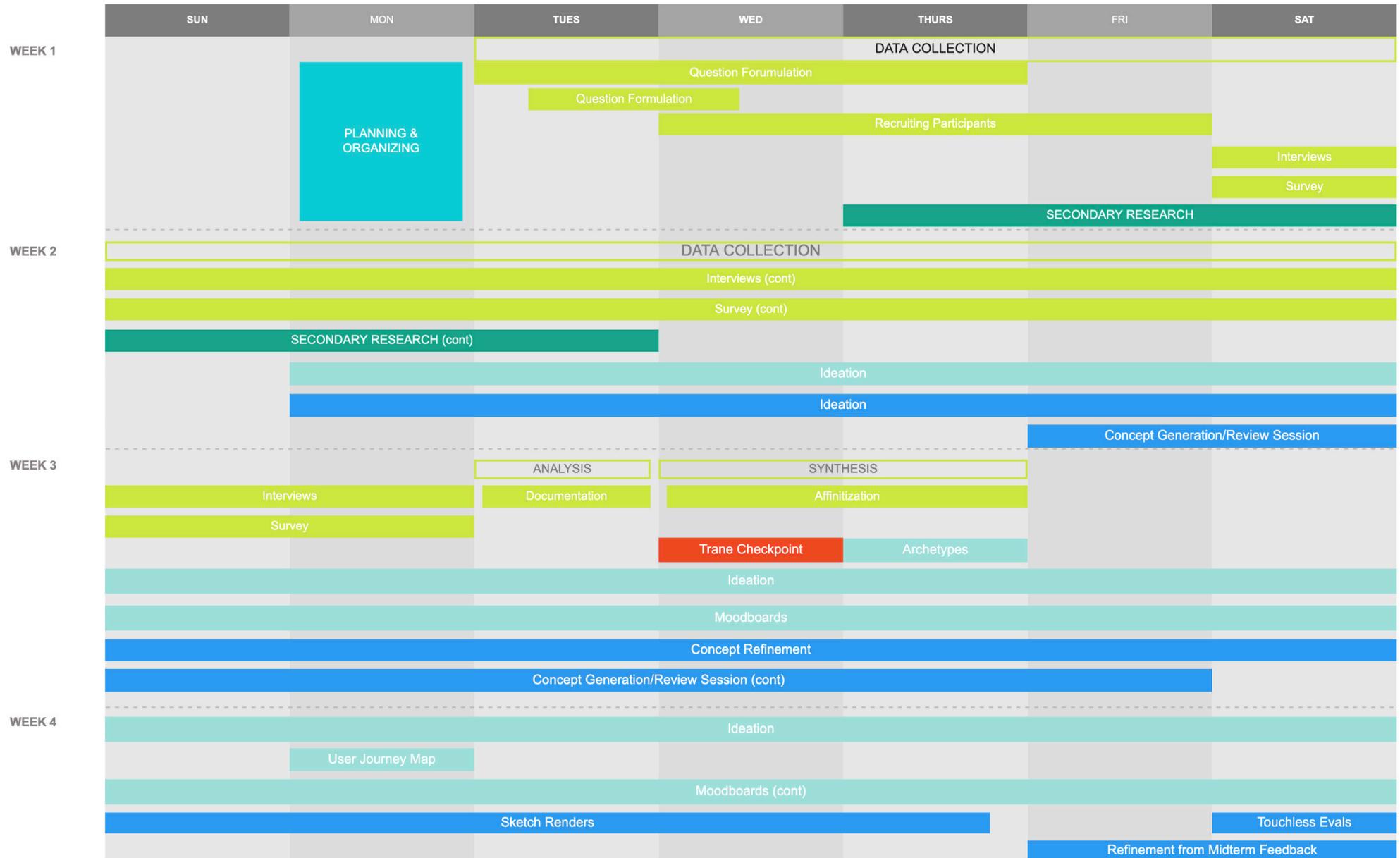
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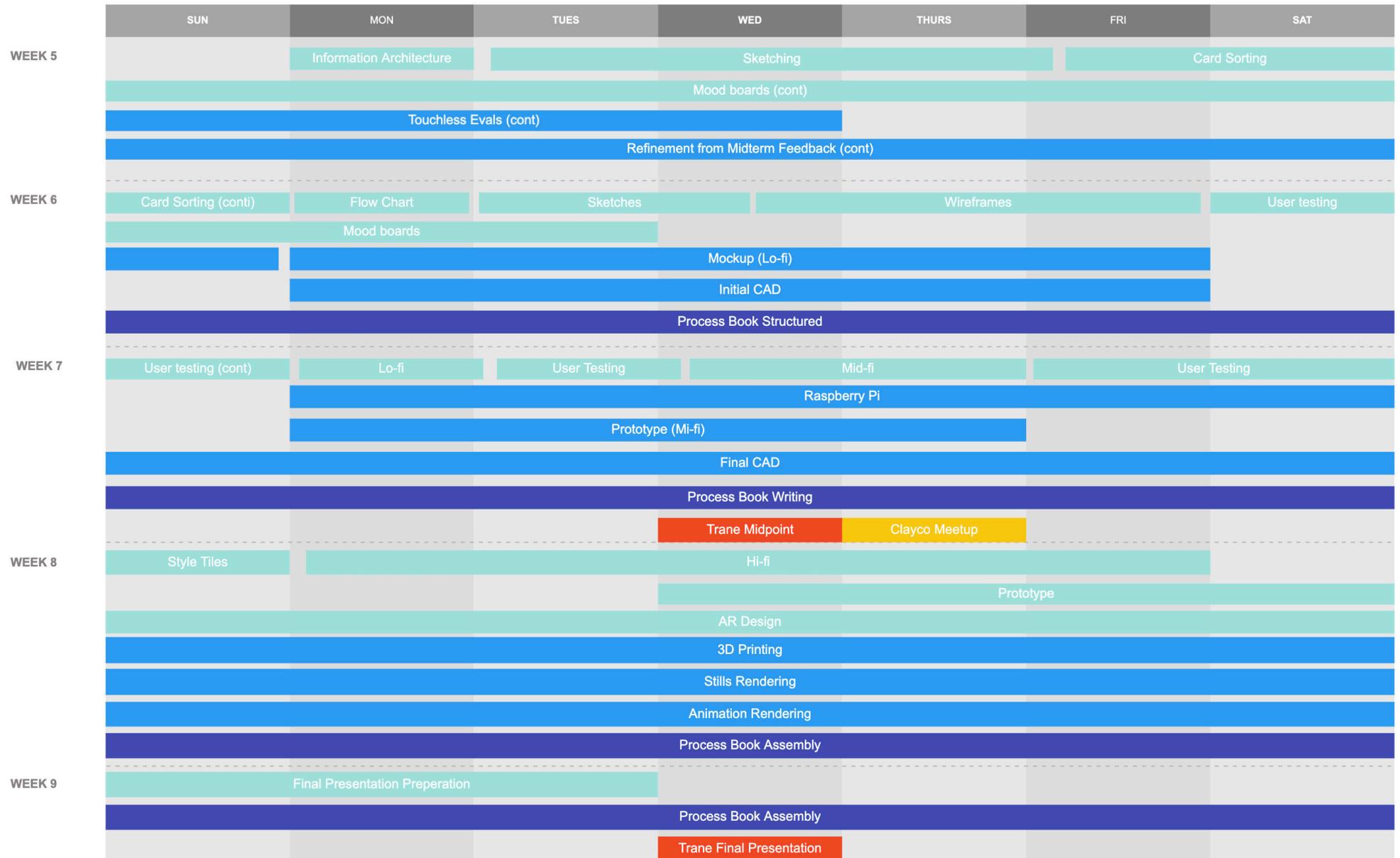


Credits

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CopyWriting: Nathan Duderstadt
CopyWriting: Esther Holliday
Photography: Nathan Duderstadt, Esther Holliday, Alex Whitman
Illustrations: Yimeng Sun







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Thank You

