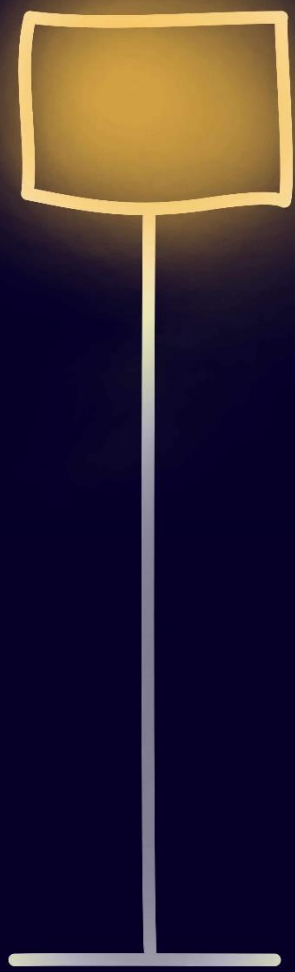
Slimmer dimmer Appendix



Contents

Appendix A: Smart home promises

There are many products that fit inside the smart home, but it can be hard to see how they relate to each other and what value they add. This chapter provides an overview and divides the market into the type of value the products promise. This report assumes three main promises: security, energy efficiency and comfort.

Security

The first promise is meant to provide home owners with an improved sense of security. Examples of products are smart locks, connected cameras and door/window sensors. Nuki is a smart lock system that allows you access to your home with your phone, as well as give friends access to your house with their phone. The nest cam records high quality video and can detect the difference between a pet and a possible intruder. The Fibaro window or door sensor provides peace of mind by knowing that all possible entrances to your home are closed.

Figure 1: Nuki, a smart lock with remote controls and a smart phone integration. (nuki.io)

Figure 2: Nest cam, a security camera that has a paid subscription service. (nest.com)

Figure 3: Fibaro door or window sensor, detects when they are opened. (fibaro.com)

Energy efficiency

The second promise is a reduction in energy usage and as a result a reduction of energy costs. These products are mostly attached to heating systems, some directly connected to a heater and some just as a wall thermostat. A well-known name for home thermostats is Nest, which learns from and adapts to your behavior. Toon is another wall thermostat, built by a Dutch energy company and provided with a 4-year energy contract. Toon's interface focusses more on the energy usage of climate control. Tado provides a system that can control individual rooms and therefore allows for more specific heating in houses.

Figure 5: The Nest E, released in Q3 2017. Nest was bought by Google in 2014. (cnet.com)

Figure 6: Toon Thermostaat, developed by Dutch energy provider Eneco. (eneco.nl)

Figure 4: Tado smart radiator thermostat for fine control of heating in a house. (tado.com)

Comfort

Lastly is a broader category that involves many products that fulfill completely different roles. The main promise is that these products will make your home more fun, flexible or generally more comfortable be in. It is important to note that the products in the security and energy efficiency categories partially fall within this category as well.

Examples that fit mostly within this category are smart lights, media devices, but also alternative interfaces and sensors.

Lighting

The big players in this area are Philips Hue and the recently released IKEA TRÅDFRI. They both make use of a hub to control the lightbulbs and provide programmable behavior such as wake up lights. Hue has a big focus on colored lighting, whereas TRÅDFRI is mostly white lighting.

Figure 7: Philips Hue bridge and bulbs, introduced in 2012. (amazon.co.uk)

Figure 8: IKEA TRÅDFRI bridge, switch, bulbs and app, introduced in 2016. (ikea.se)

Media devices

Devices to consume media have changed a lot in recent years, but they all seem to converge to streaming these days. Both Chromecast and Sonos stream directly from the internet, based on instructions from your smartphone or other device. Chromecast makes any TV capable of streaming, while Sonos is a fully integrated audio streaming solution.

Figure 9: A Chromecast plugged into a TV, first released in 2013. (google.com)

Figure 10: A selection of Sonos speakers, amps and receivers, all made for streaming audio. (sonos.com)

Interfaces and sensors

There are many ways to interface with connected appliances, but it seems like big companies are betting on voice control. Google home is part of an ecosystem through which many different devices can be voice controlled, including many of the devices previously mentioned. The Nanoleaf is the remote control of a lighting system. By placing a specific side up on the remote, a certain lighting pattern will be enabled.

Although there might be many physical interfaces, all eco-systems have a digital interface as well. Apple's HomeKit is an example of this, with an easily accessible panel on every iOS device. This interface shows all the devices in the eco-system and can control them.

Additional to interfacing with the system directly, automatic behavior is also a way to interface with a home. Automating requires information about the space the system is in. The Philips Hue motion sensor can detect a person in the room and be configured to enable Hue lights.

Figure 12: Google home, a smart speaker that can be voice controlled. (trusterreviews.com)

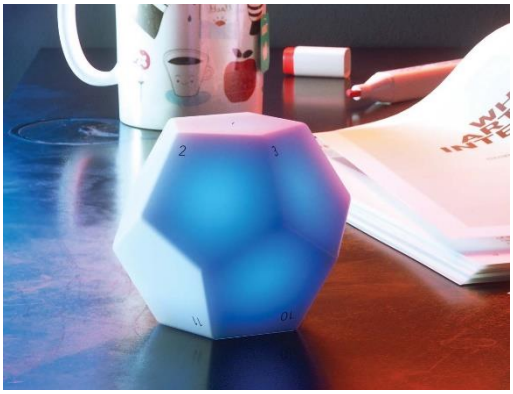


Figure 11: Nanoleaf remote, every side activates a function. (appleinsider.com)

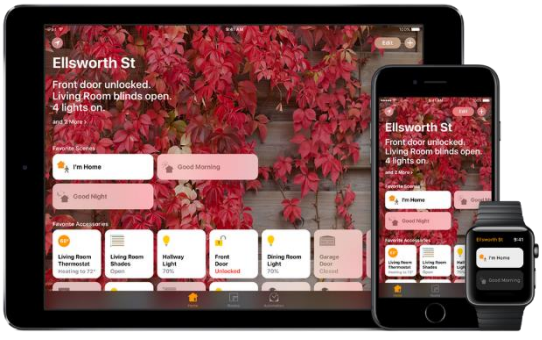


Figure 13: Apple HomeKit, a quickly accessible interface on iOS to control devices. (theverge.com)

Figure 14: Philips Hue motion sensor, which can automate Hue lights (meethue.com)

Appendix B: Lighting control

To gain an understanding of lighting control and what users might expect, an overview of the market was made. This overview includes digital control, traditional controls and smart controls.

Digital control

Common digital control for smart lights happens through apps and websites. An example of that is the Philips Hue app, see figure 16. This app allows a user to create groups, create lighting scenes, create lighting schedules and configure light behavior based on a motion or sunlight sensor. The app is place for daily control of lighting, as well as where all the features can be configured. An additional way of controlling lights is through voice control. This does require a user to know what the lights are named and how they are grouped.

Conventional control

The controls that are familiar to most people can be seen in figure 17 and 15. They differ in size, but when pressing the button, the lights will go on and off. The conventional controls create an issue with smart bulbs, they will disconnect the bulb and it can then only be enabled manually.

Figure 16: Philips Hue app with lights in a group, scenes and the color picker. (macstories.net)

Figure 15: Legrand, a regular light switch with dimming slider on the side. (legrand.us)

Figure 17: Gamma dimmer with a big knob and pushbutton. (gamma.nl)

Capacitive smart dimmers

These switches control lights with traditional dimming protocols and are a relatively cheap way to make regular lights smart. These switches do not show the state their lights are in, which is a way to avoid system synchronization issues between switch and lights. However, these dimmers are completely different from any traditional light control and might be hard to use the first time. Additionally the dimmer has no physical feedback, requiring the user to look at the switch when using it.

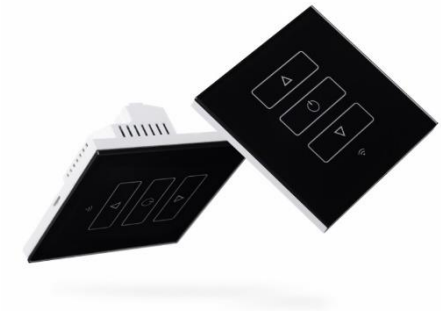


Figure 19: Wihouse dimmer that can turn lights on, off and dim. (bylight.pl)

Figure 19: MCO Home capacitive switch, made to switch between 4 lighting modes. (mcohome.com)

Low energy smart light controllers

The controllers in figure 20, 21 and 22 are not bound to a single light and can be connected to any smart lighting. This makes it possible to place these anywhere in the room and they are also not bound to a specific dimming technology. These devices are low energy, but don't provide any feedback.

Figure 20: Hue dimmer, which uses batteries and can be placed in a holder or used as a remote. (meethue.com)

Figure 22: Hue Tap, each button activates a scene configured in the app. (smarthome.com.au)

Figure 21: TKB HOME, can control two lights and dim by long pressing (aliexpress.com)

Smartest light controllers

These controllers are made to integrate with smart lights or dimming protocols for wired lights. This does mean they cannot be used as a remote, as they need a physical connection. They offer feedback to the current state of lighting and are always synchronized. The uLux is a great example of what's technically possible, but is very likely hard to comprehend for anyone but the most expert users. The Wemo dimmer strikes a balance between complex controlling features and a switch, familiar for the most novice of users. The Wemo can be dimmed by dragging on the touch interface. It also includes a programmable button that is hard to find the first time, but easy to use once familiar.

Figure 24: uLux, a complex programmable light controller that can also control climate (smarthomestore.at)

Figure 23: Wemo dimmer, can dim with an indicator and has a programmable long press function. (engadget.com)

Concluding

The dimmers in this chapter tackle common issues in different ways. Most dimmers seems to avoid an interface with visual feedback. The dimmers that do have visual feedback cannot be used remotely. The popular brands stick to buttons with physical feedback and none of the smart dimmers make use of rotating knobs. The following chapter discusses the choices for the dimmer that is being developed.

Appendix C: Contextmapping

This context mapping session aimed to gain insights on the different parties in a smart home. These insights were used to validate and further develop the differing views.

Session protocol (110 min)

Introduction (10 min)

1. To start, grab your keys. Explain why you have these keys. Are there any special keys? I'll start.
2. Discuss your booklet with your neighbor and then introduce your neighbor with one thing that strikes you.

Discussing the booklet (10 min)

3. Were there any things difficult to fill in?
4. Do the automations you created improve your living experience?
5. Do the automations impact just your experience or are there others who benefit as well?

Good technology collaboration (30 min)

6. Collage: What does good collaboration with technology feel like?
7. Show and tell
8. Discuss

Break (10 min)

9. Coffee, tea and cookies!

Abstract description of routine (30 min)

10. Abstract tool: Think of the last time you changed a routine. Where did it start and where did it end? What steps were there in between? What were your motivations? Did your motivations change over time? Were there points at which you wanted to stop, did you? Were there other people involved in your changes?
11. Show and tell
12. Discuss

Ideal automation discussion (15 min)

13. What does the ideal automation in your home look like?

Closing words (15 min)

14. Any other things to discuss?
15. Thank you and gifts

Preliminary mapping

These scenarios were created to offer a tangible entry point for research. Creating scenarios also offers a way to map any personal preconceptions. Mapping these preconceptions reduces the risk of projecting them on research subjects or findings (Sleeswijk Visser, Stappers, & van der Lugt, 2007). After additional research, these scenarios can be used for comparison to gain new, less obvious, insights.

Scenario 1

Context

- Household: Mom, Dad and Kit (14)
- Location: Kit's room
- Time: Wednesday evening, 15th of August 2018
- Device(s): Roomba
- Automation: Thursday morning
- Automation reasoning: When it's not vacation, nobody is home on Thursday morning.

Conflict (pre-existing, technology is involved)

- Practical: Roomba needs empty floors to function, Kit's floor is covered in clothes.
- Underlying: Parents value a certain level of cleanliness in their home, Kit does not respect this value.
- Kit's view: Its summer, days are long, and my friends are outside. Being inside and taking care of household tasks is the last thing I want to do. My parents have been nagging, so I'm purposely avoiding it.
- Mom and Dad's view: We bought a robot, so we would have to do less cleaning. We set up a Roomba on every floor and made sure the Roomba has access everywhere. Now the only room collecting dust is Kit's, which is unacceptable. Living in our house means living with our standards.

Scenario 2

Context

- Household: Mom, Dad, 3 kids. One called Kit (17).
- Location: Garage/workshop
- Time: Sunday morning, 13th of January 2019
- Device(s): Smart plugs (with energy monitoring), Toon (smart thermostat), Motion sensors
- Automation: When entering the garage, the lights go on. Extended movement in the garage will enable heating.
- Automation reasoning: The garage is mostly used to get in the car and leave, which does not require heating. In the winter the garage is also used as a workshop and then some electric heating is very welcome.

Conflict (Possible because of technology)

- Practical: Dad discovered the heating and lighting was on in the garage all night and the thermometer showed a 6-euro bump in energy costs. Kit was working on his latest painting and his paint had trouble drying in the cold. Kit turned on a fan in front of the motion sensor, which tricked the system into heating and lighting the room continuously. Previously, Kit's parents did not want him to take the paintings into the house, as they are very smelly.
- Underlying: Parents do not feel the impatience of kit is worth the cost and emissions of Kit's solution.
- Kit's view: What am I supposed to do with my paintings? My parents don't care about my hobbies and are not willing to invest anything in my talents.
- Parents' view: Kit is great at painting, but the way he solves problems like these is simply unacceptable. We put a lot of effort in minimizing our energy usage and Kit tripled our energy usage this night. It's not necessarily the money, it's mostly his arrogance and tricking the system.

Scenario 3

Context

- Household: Donald and Bernie
- Location: Livingroom
- Time: Thursday evening, 9th of March 2023
- Device(s): Apple TV, Smart lights
- Automation: When it's evening and someone plays a movie on the TV, the lights in the living room dim. When the movie is paused, the lights turn brighter again.
- Automation reasoning: A dark room often adds to the movie watching experience, especially for horror lovers such as Donald and Bernie.

Conflict (Caused by the technology)

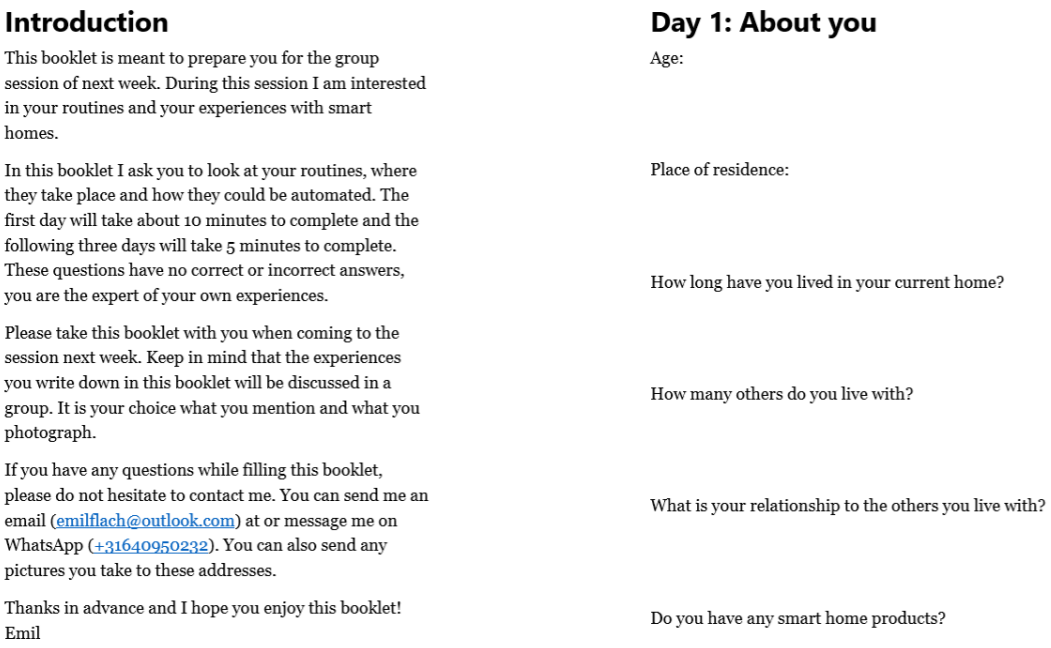
- Practical: Bernie was reading a book when Donald sat down and decided to start watching a movie. The room turned dark and Bernie could no longer read his book. It took two tries to get the lights turned on again with Alexa, taking about 30 seconds.
- Underlying: Donald heavily intruded on Bernie's current activity
- Donald's view: I didn't plan to turn off the lights. I had just forgotten that I set this up, as it had been a few weeks since the last movie. It only took 10 seconds to fix, no big deal.
- Bernie's view: How could he have forgotten? He set this up and proudly showed it a while ago. Then Alexa didn't understand him and we were sitting in the dark for a minute. This adds nothing to my home and is just annoying.

Participant selection and sensitizing

The scenarios offer a strong preference for participants in this contextmapping session. Most insights can be gained from a mixed participant group. Half has an interest for smart home products and the other half does not. Additionally, it seemed worthwhile to select participants who lived alone and participants who live with others.

Sensitizing booklet

The participants were sensitized for the subjects discussed during the session by filling in a booklet. This booklet had daily tasks, mostly about the surroundings and how they would automate things. The content was made to let the participants think about how technology might affect their surroundings.



Introduction

This booklet is meant to prepare you for the group session of next week. During this session I am interested in your routines and your experiences with smart homes.

In this booklet I ask you to look at your routines, where they take place and how they could be automated. The first day will take about 10 minutes to complete and the following three days will take 5 minutes to complete. These questions have no correct or incorrect answers, you are the expert of your own experiences.

Please take this booklet with you when coming to the session next week. Keep in mind that the experiences you write down in this booklet will be discussed in a group. It is your choice what you mention and what you photograph.

If you have any questions while filling this booklet, please do not hesitate to contact me. You can send me an email (emilflach@outlook.com) at or message me on WhatsApp (+31640950232). You can also send any pictures you take to these addresses.

Thanks in advance and I hope you enjoy this booklet!
Emil

Day 1: About you

Age:

Place of residence:

How long have you lived in your current home?

How many others do you live with?

What is your relationship to the others you live with?

Do you have any smart home products?

Figure 25: Page 2 & 3 of the sensitizing booklet

Day 1: Your routines

1. Walk around your home and think of the routines you do daily, weekly or once in a blue moon. Your routines can be big (e.g. going to bed) or small (e.g. tying shoes). Name 5 of your routines and list them below.

2. Identify your hotspots; which places are involved with a lot of routines? Name 5 of your places, list them below.

3. Choose the two busiest hotspots and take photos of these places. Send these pictures to emilflach@outlook.com

Figure 27: Page 4 & 5 of the sensitizing booklet

Day 2

You will create your first automation for one of your routines. Follow the steps below.

1. Choose one of your routines you want to automate.
   Name of the routine you have chosen:

2. Which places are involved with this routine?
   Write down the places:

3. What are the conditions this routine takes place in (e.g. rainy, dark, specific time, certain mood)?
   Write them down:

4. Which things should happen automatically when these conditions are met (e.g. close curtains, turn on lights, trigger alarm, warmer lights)?
   Write these things down:

Figure 26: Page 6 & 7 of the booklet

Session toolkit

Figure 28: The A3 template used for participants to draw how they changed a routine.

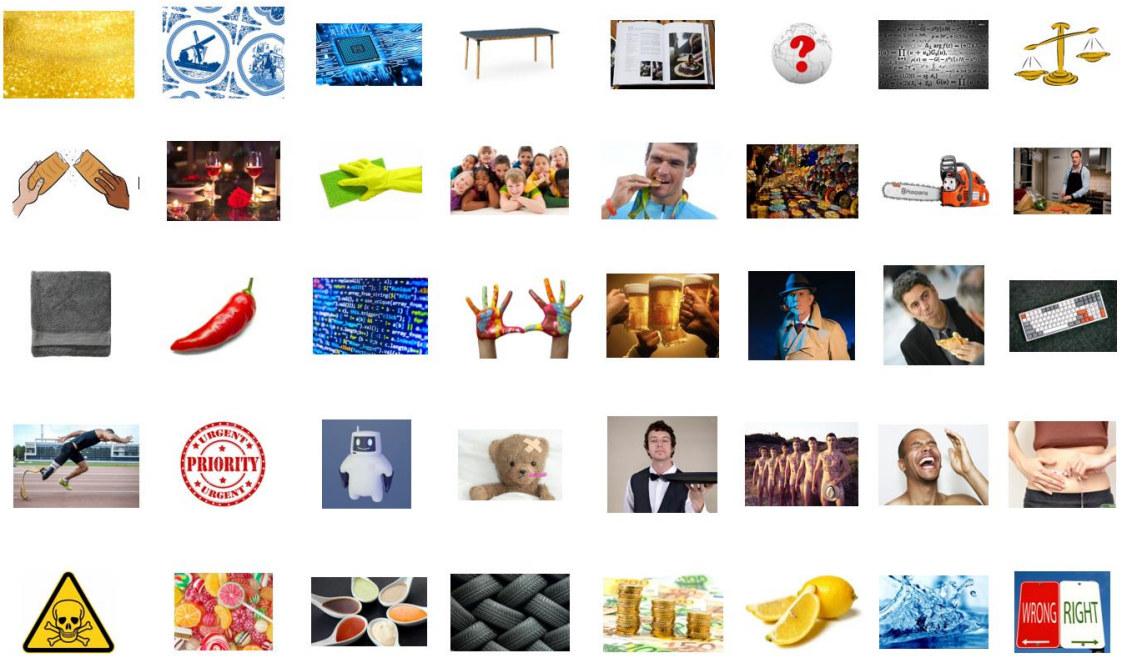


Figure 29: The A3 page of images participants received to use for their collages

Ridiculous	Unequal	Gentle
Personal	Glorious	Satisfying
Broad	Rough	Vulgar
Scientific	Fuzzy	Materialistic
Gezellig	Average	Awesome
Interesting	Undesirable	Shrill
Beautiful	Fresh	Innocent
Often	Good	Graceful
Popular	Mixed	Kindhearted
Tasty	Vigorous	Nondescript
Temporary	Future	Sincere
Complimentary	Icy	Stingy
Technical	Bizarre	Detailed
Cultural	Energetic	Relieved
Dry	Thoughtful	Comfortable
Scared	Tacky	Spiky
Immediately	Naïve	Divergent
Fixed	Overconfident	Muddled
Daily	Handsome	Hysterical
Smooth	Warm	Robust

Figure 30: The A4 page of words participants received to use for their collages

Session transcription

The enthusiasts are R and F, Non-enthusiasts are D and H.

Introduction

R: Daniela is a very nice cook, a bit chaotic sometimes. She would like to be more organized.

D: Ruben is very organized. More control over his routines, he keeps an overview. Like of the food that he has. That's organized to me.

H: Floris has a structured morning routine. Really, healthy with oatmeal. Time efficient. Has a lot of plants. Likes music.

F: Hester has a daughter! The daughter is part of most of the routines, like brining the daughter to bed. Changing diapers is a very intensive task.

Booklet

Difficult/stupid questions?

F: Didn't finish day 4 yet.

H: Automation is very difficult, a lot of tasks are done manually. Didn't know how to automate everything.

D: I filled in everything, but I was wondering if routines should be limited to inside the house. I filled it in inside the house.

R: I was thinking, if you want to automate further, you going to need to build a new house.

Did the automations offer an improvement?

F: Sometimes it is. My morning ritual I have partly automated already. Lamps go on before I wake up, sort of like a wake up light.

D: That's nice!

F: It is! It's really nice. When I say good morning, it will say what my day is about and play some music. But I still need to turn on my amp manually. Which is annoying. Half is automated in the first five minutes. So if that could be automated it would be great.

H: When we give Lieke a bath, we need to watch the temperature and if that could be automatically be the right temperature that would be nice. With a simple temperature sensor and warming element it could be okay beep.

F: Because you need the bath to be consistently warm enough over time right?

H: Yeah also

D: I was hesitant to add my son to the routine. So I filled the booklet in for me. But now you know why my life is such a chaos. I pretty much want his routine (Floris). Have the lights turn on smoothly. Smooth transition from bed to shower. Maybe music for my alarm instead of the horrible thing I have. Maybe open the curtains. Instead of being a horrible transition, I want it to be smoother.

R: Jaaaa. What is improvement? It is more taking work out of my hands. One way it is nice. But you are already not thinking about it. It's a routine. If it gives you more time, maybe a little bit. I don't know if the effort of automating is worth that time savings.

D: As a comment, now with a small knee injury, I would love automation. Your life is chaos when your knee is not functional.

Collage explanation

F: I thought about technology as automation, but also as your assistant. The assistant is the waiter over here. It should be gezellig, which is why the cute robot is there. It needs to always get it right. When eating you can't talk properly, even in those situations technology should work. It is nice if it's a satisfying experience, which is what happens when it goes right. I want it integrated. which the tires and tiles represent. Integrated in the home. If it's a detective and discovers what I want, that would be great as well. I'm fine with it being really technical and working on it, because then I feel like a champion when I finish something that actually works.

H: I have multiple viewpoints. The way you operate technology should be really smooth. I hate when I do something and it doesn't work. Life with technology should still be authentic. I don’t want it to do everything for me. It should also be stimulating. I don't think it should make your life too easy. Technology should also be a bit physical. It pushes you to do something. I think it should be a little bit unequal. That you know that it is technology. Sometimes people are like treating technology like a real person. It has to be clear that it is not a person. You can turn it off whenever you want. I also think that it should be awesome and cool. I push this button and the lights go on. I really like that.

D: Technology is most needed when... Right now! I am facing a challenge. I can't walk now. It would be great to have a help in some ways. My

boyfriend is in classes all days and my son is in school. I need help. For example, if I could automate turn stove on, that would be really good for me. Especially now. I also don't think technology should be the only thing you rely on. For my children I really hate the technology that makes you addicted to it. There should be a balance. It needs to be honest and innocent. The younger generations are getting addicted at such a young age. 10 years old with smartphones. That wasn't our childhood. That's more new generation problem. I don't want my kid always dependent on technology. My son doesn't know TV without Netflix, it's weird. Technology should be friendly. It can be scary and needs a friendly component. It needs to be beautiful in some way. It should be gezellig and personal. Adapted to your needs and your individual person that it's helping for.

R: Where shall I start. I think technology should be personal and complementary. It should help you, not sit in your way. It needs to make your life more robust. It should not be focused on money or materialistic stuff, it should be good, warm. It should help you. It should not make a difference between cultures or create inequality. Not focused on only technology, but also humans. A good thing about technology is that it can be broad, but also detailed. I think it should be not naive. It should know about the world. What is happening there.

Collage discussion

Common theme, there is supposed to be a human aspect. Something relatable?

H: Technology should always be clear that it is technology. It is not like your friend, because it is not human. It is not real.

R: What if it is equal to a human. What if as human you do not see the difference.

H: I don't like that.

R: Why not, what does it matter?

H: Because, maybe also the dependence thing. Also when it falls away, you really lose something. You are not daring anymore to turn it off when you don't want it. Because then maybe it goes against you. Like "I don't want to be turned off". You get scared of it. I don't want to lose the control. I want technology to be technology and when I don't want it anymore I want to push the button and then it's gone.

D: I agree with her. There is a robot called Sofia and they even gave it citizenship in Saudi Arabia. That's crazy. That's not something I want

technology to be. I agree it should something you can say "I don't want it now, I turn it off." Instead of fully relying on it. Fully depend on it.

H: Yeah, you hear these people dating robots and that kind of stuff.

R: Now you rely on humans.

F: Yeah that's the same thing.

R: Why does it matter what you rely on? You always rely on something or someone.

F: If technology becomes so advanced that you can't distinguish it anymore. It could be exactly the same. It could be the same when humans fall. Really dark, but you know.

I like this discussion, but I also feel that it is much more distant. Far away from right now.

R: I think, it's not that far away from the topic of automating stuff. It's much lower level, it's simpler, but still it's the start. Home automation, you give your house smartness. So, now if you would do it now. It would just react on some stuff. But in later on, your house might get personality.

H: Your house getting a personality?

R: Yeah, it's adapted to you, your house. It does things for you. I don't know where I want to go with this.

F: Let's say there are two people with their own houses and it's automated for them and it's adjusted for when they want it warm or cold. Then it kind of becomes a personality?

R: But it also works the other way around. So, you're taking care of your house and your house is taking care of you.

F: Ooooh yeah.

R: That's what I wanted to say.

I see a lot of use of technical, coding or some kind of chip like thing. Some of you were okay with it being technical. Is that something you can find yourself in?

H: That's I used stimulating (on my collage). I really liked the picture of the guy with the artificial leg. The technology is not running for him, the technology helps him to run. I like the view that it is not doing something for you, but that it is stimulating you and you get better yourself. I don't think technology should allow you to sit back and do nothing.

R: So complementary.

H: That's also what I have with smart homes, you also put in your booklet opening the curtains. And I really like to do that in the morning, looking outside. New day has started. If technology would do that for me, I would lose that experience. And I would not like that.

F: I feel like you wouldn't want to get really dirty in the technology to make it work, right?

H: Haha, no

F: But that is an interesting contrast. Looking back at the previous context, it needs to be clear that it technology and yet you don't want to have to really interact with the technology aspect of the technology.

H: That's why I put these lines of contradicting. I know I am contradicting myself. Sometimes, in the beginning, Tim had his amplifier and he put everything into that. If I wanted to turn on a CD, I had to change four different settings, with three different remotes. And only then I could turn on the CD. I don't want to learn that. I don't want to do this. I want to put in the CD and then.

F: So there it would be good if the technology took that away from you.

What about technology that steps in when it's needed, for example when you sick. Is technology allowed to do more, are you allowed to depend on technology more?
H: I think so, yeah! Also for you Daniela, if you really are not able to walk, but you are in the future. Then it would be really nice.

D: Thankfully it is temporary yes! Having the contrast between a regular leg having this tiny incident and suddenly not being able to do things by yourself, it makes you realize how much you depend on your legs. How much you depend on something helping you and that something could be technology, so that would be nice.

Routines explanation

F: It's about meditation, because I try to meditate. I want to do it every. A few years ago, this is the headspace logo. It allows to do meditation easily. To sustain the routine every day. I never managed it. 2 months ago I though, now I'm going to do it. It was at the same time I set up my whole morning routine with the light and everything was going great automation wise. My motivation rose and google calendar has this goal feature where you can set how often you want to do it. I said alright, in the weekend it's very difficult, so I'll do it every workday. And I thought, I could do it

during lunch. Then I have free time and I need to take a break. It worked for a while. The durations of the session differed. Sometimes I did 3 minutes and sometimes I did 10 minutes, I was fine with both. 10 minutes is hard to sit still. The biggest problem was finding a location. Attic is a quiet place, but this faculty doesn't have a quiet place, which makes it difficult. I also have to find the time, which is less problematic. Which I apparently don't. Which is why my motivation declined. At this moment I haven't done it in two weeks. I still want to do it...

H: My changed routine was preparing my breakfast and lunch. In the morning I had less time and very tired. I still prepared food in the morning, but Tim was complaining. So I decided to do it the evening before. The first day I was very happy, because it seemed to work. Sometimes I have more time and sometimes I have less time. It is good motivation to know I don't want to do it tomorrow. Yesterday I was home very late and still had to do a lot of stuff. So I just skipped the butter on my bread. Then I can still do it now. Except tomorrow, but Tim said come to bed, I'm tirred too. I'm still finetuning, maybe I can do it in the weekend and put it in the freezer. I always keep in mind my happy morning. I really don't want to do it in the morning anymore, that's my motivation. Still trying.

D: The thing is. It's kind of a long term change. Going from a car based life in Mexico, to adapting to my lifestyle in the Netherlands in means of transportation. It completely changed my routine. In Mexico I had a good estimation of time and take the car, go to the job. Coming here I needed to find a new means of transport and tried to bike and failed. In Mexico I biked when I was 10 years old around the block. We didn't use it for transport. My friends did, but one of them got run over. Not a friendly country for biking. I tried tram and train and iterate on it. I came to a combination of both. I live in the Hague and I need to drop off my son in the Hague and then go to delft. It wasn't one solution fits all. I needed to adapt. It has come to walking, tram, walk, school, walk, tram, bus, school. My morning is a hassle. I always try to make changes to make my morning easier. To make my lunch and Emilio's lunch so I can leave home on time, to take these means of transport. If any of these is delayed I am late. Which is not so fun. I rather depend on myself. That is sadly not possible. My morning is iterating and seeing how I can make it as easy as possible, so I can sleep a little bit longer. Also to do what I need to do to leave the house on time. Efficiency is my main motivator. How can I be more efficient with my time. I am used to carrying a lot of stuff and my car used

to be my extension of my house. My car always had the stuff I needed, even a change of clothes or shoes. My car was my life. Not having that, reducing the amount of stuff I carry to be functional, but still not be so heavy. That was. It was also less personal. My morning commute was also less personal. I used to put music on in the car. I needed to adapt to what I could. Basically, my biggest motivation is efficiency. And making it comfortable, which is why I am always listening to music or take a book.

R: My routine I want to change is waking up at a regular intervals / regular times. Some days I was waking up really late and some days really early. I wanted to even that out. So I could sleep better. It mainly started when it was getting darker. First I tried to wake up with my girlfriend, but she wakes up really early. I was mostly working till late in the night and so my schedule didn't fit with hers. So that didn't work. I asked other people how they did it. and they told me, go to bed early that's best. But I like to work in the evening. Some people used wake up lights and it seemed to work quite well for them. That also helped me a lot, until now. It's working less now. For a while I could wake up very regularly. Also very pleasantly, more natural than the annoying beep of your alarm. That kind of works. It is working less, because I am going to bed even later now. And even more irregular. I also need to change the day before.

Discuss routines

Everybody seems to struggle with changing their routines. Are you still confident in the way you are changing your routines?
R: I think it is all connected. When you want to change one routine you are also going to need to change all the other routines. Like waking up, I fixed it. Now I need to go to bed and change going to bed at regular times. To change that, I need to change other routines. It is all connected I think. That's what makes it difficult. Well, if you want to go to bed early, you also need to eat at a not too late time. Otherwise you cannot go to sleep. To do that, you need to do groceries at the right time. Get home at the right time. The time is the main influencer.

I have heard as time a very common routine motivator. Or motivator for change are there other motivations?
F: For me time is actually how I can change it, instead what motivates it. Because I need to find the time, it becomes more difficult to execute it.

Maybe you're trying to fight time to fit in a new routine?
H: I have to prepare my lunch at some time. But I would rather do it in the evening than in the morning. So it is time, but it is also being relaxed or not. Doing it in the evening, it doesn't matter how much time it takes, but in the morning it has a very fixed schedule. Maybe it's shifting time as well.

Something can be not fun to do, but when you are not stressed, it's fine to do.
H: Some time is more valuable than other time. yes.

Are there specific moments when time is more valuable?
D: Yeah! The morning for me as well. It's a limited resource and you need to make the most of it.

And Ruben is making his time an unlimited resource by going to bed late and I do the same thing!

What does an ideal automation look like?

R: If it would be the perfect routine. It should be holistic. So, said in the beginning. Whether there is an exception or technology doesn't understand you, that's annoying. To catch exceptions and understand everything, you need to be holistic. It needs to be in all parts of your life. Otherwise it will always just be annoying. I don't think, you can't make it perfect. You can't make one automation, they need to be connected to other automations.

F: I'm thinking it should be supporting, that should be the biggest part for me. Because, why I wanted the lamps in the end is because now it helps me wake up. Similar to a wake up light, which is normal. I also use mostly google calendar to support me in making sure I can actually use my routine and build it up. At the least at the moment I try to use technology to fix the problems I have, which make sure I don't get my routine. At the moment it should just support me. I am not sure if it should be more than that.

Similar to the prosthetic leg or more than that?
F: It doesn't have to help me run faster. The lag is kind of far away, because I guess it work. Without the leg you can't run and here, probably. Okay, maybe it is more running faster. Without the lights or app I can still wake up or motivate, but it becomes easier. Or I do it better when I have it.

R: Like an exoskeleton! Not needed, but it makes you stronger.

D: I was also thinking that maybe technology should be more of a long-term commitment. In the sense that. For example with a phone, there is a new release every year. Maybe you can ignore these releases, but at some point you can't update your phone anymore. I would like to postpone this as much as possible, because it would be more of a hassle to think about "In one year I need to change this". Getting used to something that isn't going to be with you for a long time is also a hassle. Having to constantly adapt. A reliability of sorts, you need to make a commitment and stay with you for a long time. Maybe you can buy add-ons, but not stop working.

Once you start depending on it, it should stay there.
D: Yeah exactly, you need to be able to depend on it if it's going to help you.

My last question then. Does this automation have a place in your home?
H: Hmmmyeah. I think so. Like you said, it should be more supportive. I don't think it should be a motivation in itself. It might maybe remind you of your motivations. I was thinking of the time shifting, that it maybe can help you reschedule gaps in your calendar. So it can support you by providing new angles.

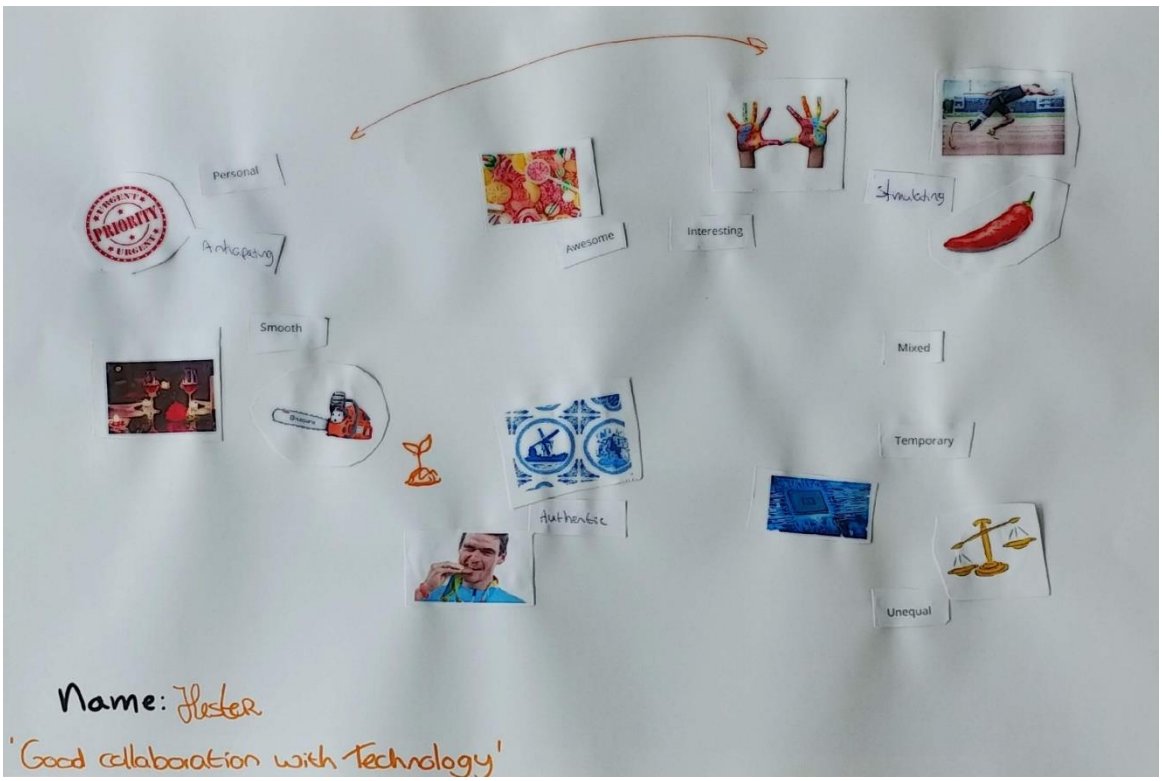
Providing new angles could be the value that the automation provides? Maybe not take tasks from you but provide more insight to what you're doing.
H: Yeah I think so, maybe.

D: Value of making me more efficient is also important. Helping me make better use of time and making processes more efficient definitely has a place in my house.

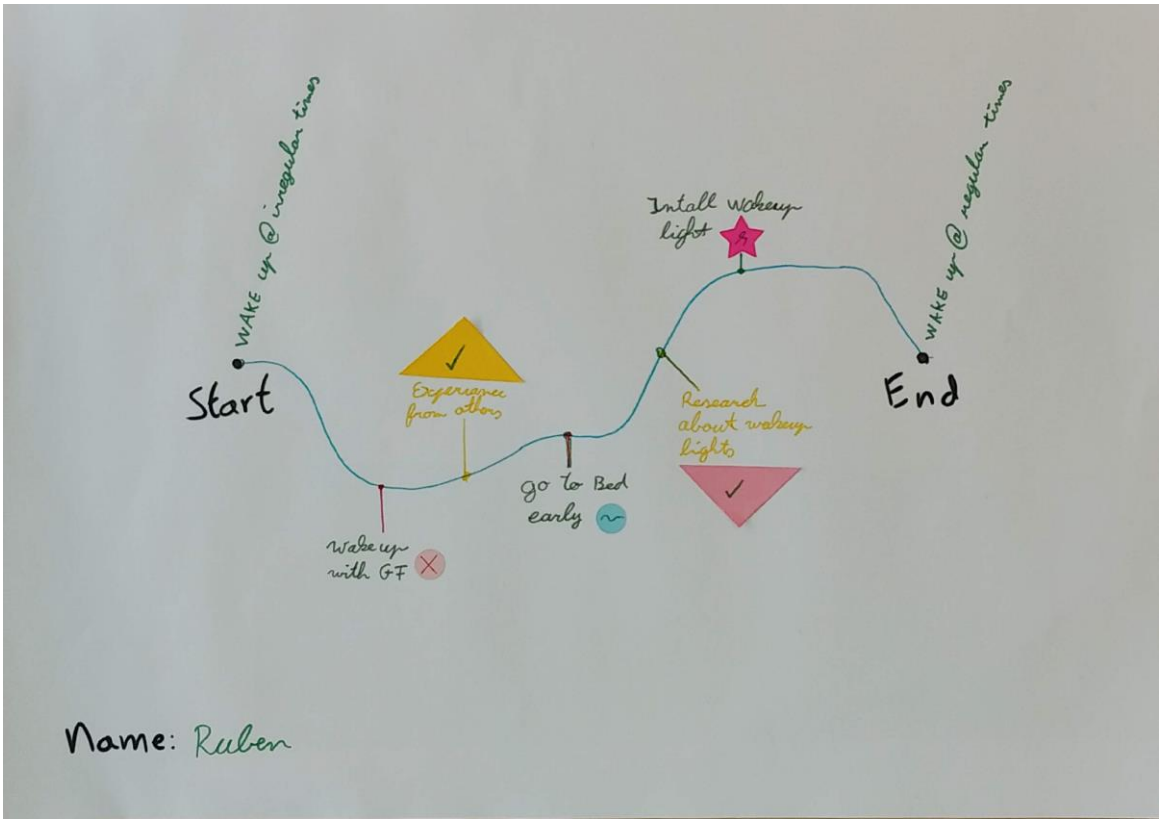
Do you guys have general technology excitement? Like the lights that turn on automatically in the morning? I know I get excited about that kind of stuff.
H: Yeah well, we can also turn on the thermostat when we are not at home. I really like that. "Oh we're going home, let's put on the heater". Then it's warm and cozy when we get home. I really like that.

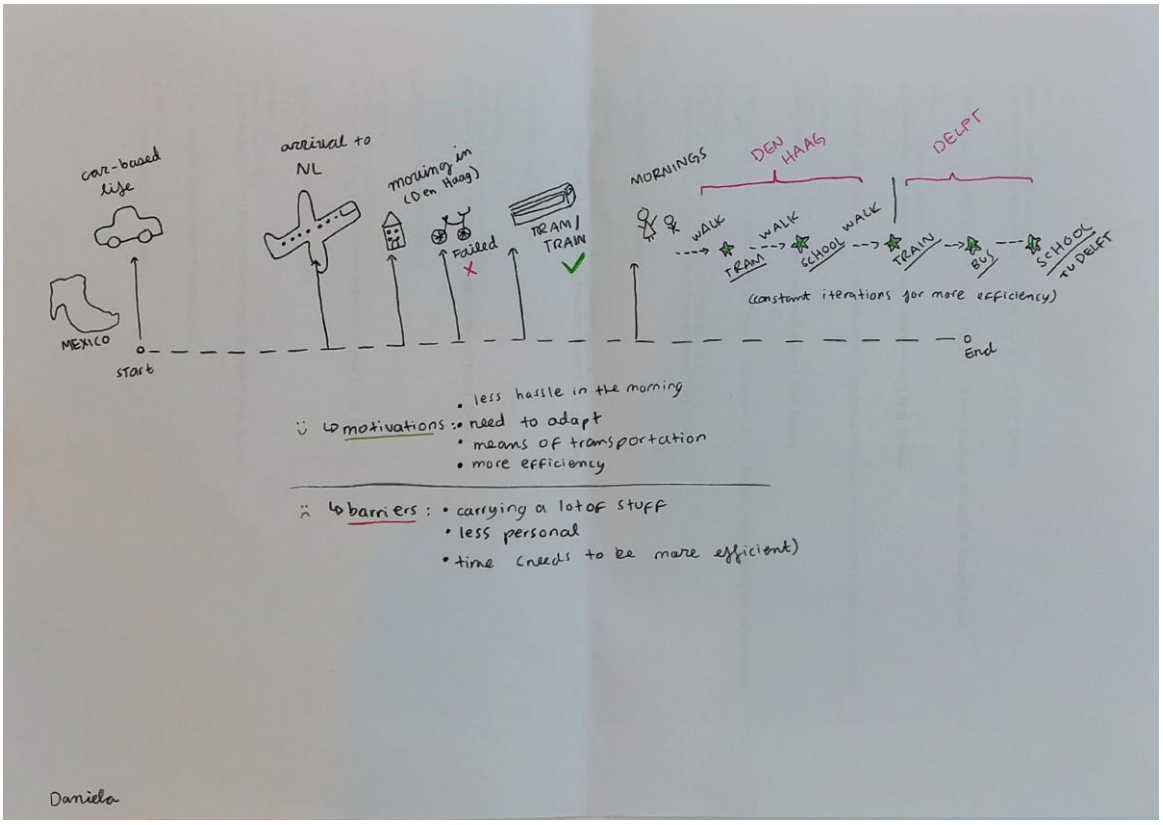
Technology collaboration collage

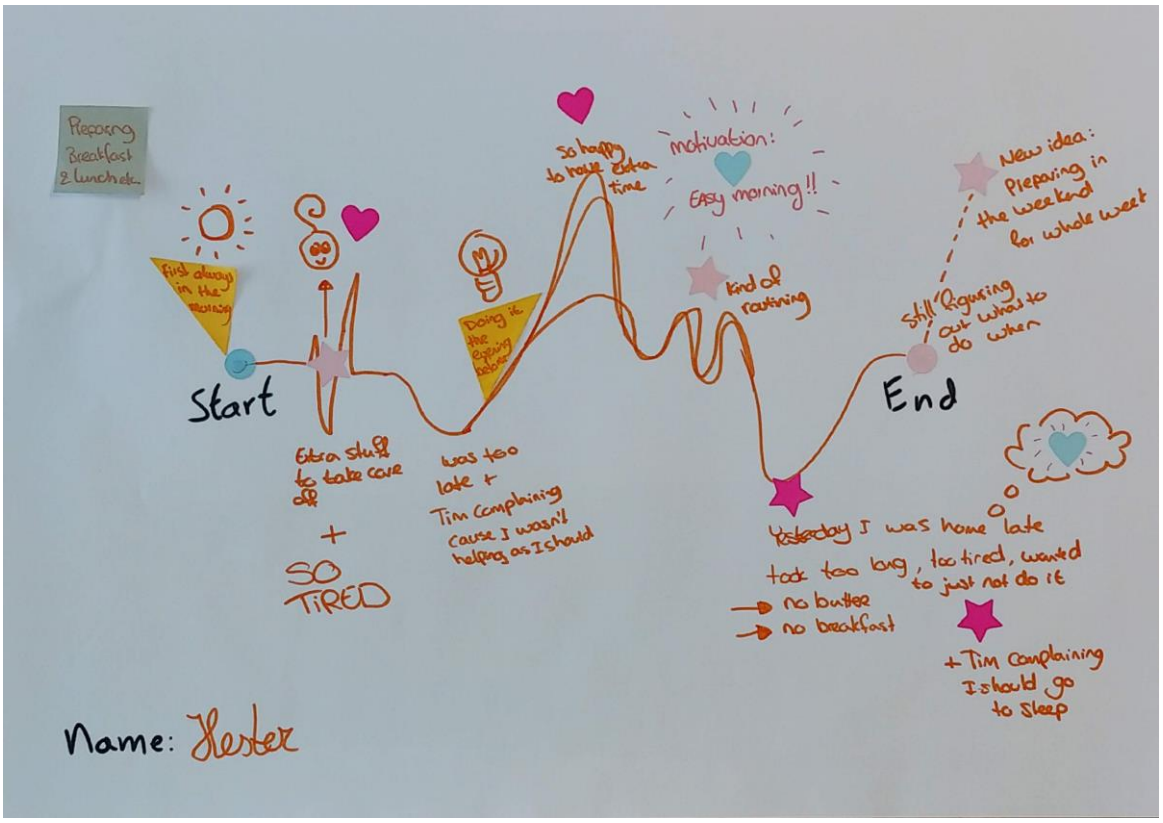

good collaboration with tech
ROUGH
URGENT
PRIORITY
URGENT
UNDESIRABLE
most needed when...
BALANCE
comfortable
HONEST
INNOCENT
children
attributes
TECH
GOOD
WATER
BEAUTIFUL
Daniela

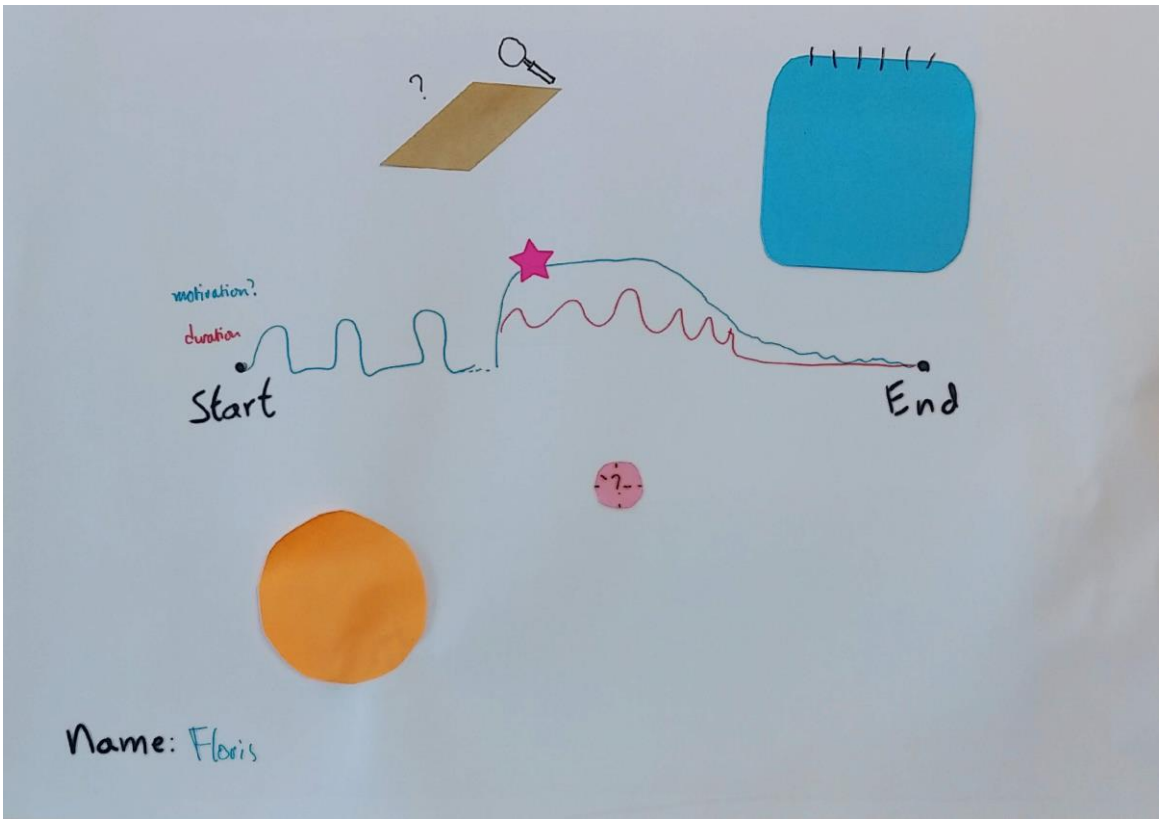

Personal
Awesome
Interesting
Stimulating
Smooth
Mixed
Temporary
Authentic
Unequal
Name: Hester
'Good collaboration with Technology'

Routine changes timelines






Preparing Breakfast & lunch etc.
Start
Extra stuff to take care of
+
SO TIRED
Doing it the evening before
so happy to have extra time
was too late + Tim complaining cause I wasn't helping as I should
motivation:
Easy morning!!
kind of routining
Still figuring out what to do when
New idea: Preparing in the weekend for whole week
End
Yesterday I was home late
took too long, too tired, wanted to just not do it
→ no butter
→ no breakfast
+ Tim complaining I should go to sleep
Name: Hester


?
motivation?
duration
Start
End
Name: Floris

Session insights

1. Non-enthusiasts are more afraid of losing control to technology than enthusiasts.
    a. *“You do not dare to turn it off anymore.”* ~ H
    b. *“I don't want it now, I turn it off.”* ~ D
    c. “*You always rely on something or someone.”* ~ R
2. When required to depend on technology, non-enthusiasts want that technology to make a long-term commitment.
    a. *“You need to be able to depend on it if it's going to help you*.” ~ D
3. Implementing a change or new routine is often trial and error
    a. *“I tried tram and train and iterate on it.”* ~ D
    b. *“First I tried to wake up with my girlfriend, but she wakes up really early.”* ~ R
    c. *“I'm still finetuning, maybe I can do it in the weekend and put it in the freezer.”* ~ H
4. Changing routines affects other routines and even the routine you are changing.
    a. *“It is working less, because I am going to bed even later now.”* ~ R
    b. *“I think it is all connected. When you want to change one routine you are also going to need to change all the other routines.”* ~ R
5. It is hard to measure whether you implemented or changed your routine successfully.
    a. *“I said alright, in the weekend it's very difficult, so I'll do it every workday. And I thought, I could do it during lunch. Then I have free time and I need to take a break. It worked for a while.”* ~ F
    b. *“The first day I was very happy, because it seemed to work*.” ~ H
6. Changing a routine is incredibly difficult.
    a. *“Attic is a quiet place, but this faculty doesn't have a quiet place, which makes it difficult.”* ~ F
    b. *“It wasn't one solution fits all. I needed to adapt.”* ~ D
    c. *“Yesterday I was home very late and still had to do a lot of stuff. So I just skipped the butter on my bread.”* ~ H
7. The view on technology in routines is heavily dependent on context.
    a. *“One way it is nice. But you are already not thinking about it. It's a routine.”* ~ R
    b. *“I don't know if the effort of automating is worth that time savings*.” ~ R

c. *"It needs to make your life more robust" ~ R*
d. *"If I wanted to turn on a CD, I had to change four different settings, with three different remotes. I don't want to learn that. I don't want to do this."* ~ H
e. *"How much you depend on something helping you and that something could be technology, so that would be nice."* ~ D
f. *"If technology would do that for me, I would lose that experience."* ~ H
g. *"The technology is not running for him, the technology helps him to run."* ~ H

Values towards technology from different perspectives

Shared values between enthusiasts and non-enthusiasts

- Get it right
- Personal / Adapted / Assistant / Discovers
- Complementary / Stimulating / Help
- Honest / Innocent / Friendly / Good / Warm / Gezellig / Beautiful / Authentic
- Satisfying / Awesome

Enthusiast values

- Robust / Always available
- Holistic/ Not naïve
- Integrated
- Champion when it works
- Equal (between people)

Non-enthusiast values

- Smooth
- Physical
- Control / Unequal (between technology and person)
- Balance
- Independent from it

Appendix D: Enthusiast interviews

Interview with Bart

Which platforms do you use?
I use HomeKit, to easily use it from my phone. I have home-assistant for integration, which runs on a NUC. Home made tools that work with home-assistant. Philips Hue, Belkin plugs I don't use. I don't measure my energy usage, I should though.

I had a Nest, but it couldn't interface with my floor heating. So, I returned it. Apparently, the American version can do this, so I might buy that. My TV I can control through HA, my amplifier I can control through HA. I have a music server.

What things are you proud of in your automations?
I have a movie time setup. When I start a movie, all my lights dim. When I press pause the lights in the kitchen and toilet go on, because I'll probably go there. When exiting movie time everything goes back to normal.

I do use it, when we watch a movie or a fun series, I'll enable it. Then the audio is also a bit louder.

Something I would like to make is automating my fume hood. What I notice is now, we have cooked and then we go for dinner and then we have forgotten to turn off the hood. I want to solve that by measuring power usage and triggering the fume hood.

I came home first and wanted to come home to a gezellig home and wanted some music and lights on. When I was close to home, the amp turned on. I have that on hold now, it is not in the current system. But it would be easy to make, probably one afternoon.

What is your main reason to automate?
I think it's cool! It's fun and with the cooking, it's just easy. Something I don't have to think about anymore.

Making the movie time was easy, so most enjoyment is when I use it. Every time it's enabled, I think to myself "dit is wel cool". Also, when you have visitors, everyone says "wooooow".

What is your most common way to interface with your house?
Actually, most of my lights work with sensors. When it gets dark outside, the lights in the living room go on. The only moments I do something manually is when I go to bed. To turn the entire house off and the light of my bedroom. I don't want to automate the light in my bedroom, because it's a bit too far. I can turn it on and off from my phone, that's enough.

Is there a place where you get inspiration from?
I get some from reddit, where I see some fun stuff. Normally just stuff that annoys me. and I'll try to fix it. That fume hood is just very annoying to have on the background when sitting in the living room.

Do you live with someone else in your home?
Yes! Sylke. We have been living together for three years now.

How does she experience your automations?
I don't think she is bothered by them. I don't think she would turn on movie night when she is by herself. It's also not fully automatic, I initially trigger it myself and then after that it's automated until I turn it off.

Can you recall any bad experiences she's had?
It was not an automation. I have Philips Hue lights which you can control with your phone. I once showed this to my family when Sylke was sleeping. My aunt turned the lights in bedroom on full brightness, that was not a very nice awakening experience for her. That scared her a bit.

Any good experiences?
A think a good automation is one you would not really notice. But only notice when it doesn't work. I don't think she has had any bad experiences with just automation. My automations are not very frightening or big. Just very small. They are supportive, and you will miss them if you don't have them. Similar to that your blinker automatically turns off after turning a corner. Those small things I find very valuable.

Did you make any changes to automations for your SO?
Not specifically for her, but something we experiences together. I changed my automation for movie time. We ate on the couch and suddenly we were eating in the dark. So I added another button to actually trigger it. I would see this as an improvement, not necessarily a compromise. Gives a bit of control.

Has your SO ever made an automation with you?
Nope. I think she has once seen that I was playing with home assistant. but not what exactly I was doing.

Could she be made enthusiastic about this?
If it could help her out, I think she would be open to it.

Would you be able to make an automation for her?
Definitely possible, if she sees something that's annoying to her. And she thinks it could be solved with an automation. Then I would definitely look at that. I don't think she would ask me to solve it for her. I also don't think she has the knowledge to say "Bart can solve this for me with an automation".

Interview with Marco

Which platforms do you use?
Raspberry pi with HA which is in a Docker environment, so I can run some separate tools next to that. Combined with Node red. Those are the two main engines that drive everything in my home. Which is a deliberate choice. I have a RBPI running TV software (Kodi) and that crashes relatively often. And my HA raspberry pi needs to be always running, that's what my home is built on.

I have switches that work with MQTT. Sonoff switches with custom software (Tasmota). Last week one exploded in my house, because the wires touched each other. But in general, it works well. I am more a fan of those that go into the wall socket as they are a bit safer. I have a few of them at home, with that MQTT software.

All config is put on the NAS, so it can be backed up. I have download software that is attached to the system. I have Xiaomi lights in my house (Yeelights) that have great integration with home assistant. I have a Chromecast and Chromecast audio.

I have a camera that is connected to home assistant. My ubiquity router detects when I get home and then turns off the camera with a physical sonoff switch. When I leave it goes on again. The recordings are saved on my NAS, so I can see what happened. I don't trust those Chinese appliances that much. I might be going a bit far though. All my HA appliances run on a virtual network that is not connected to the internet. Nothing can go outside but can speak to my NAS. And my NAS can be accessed from the outside. Offering a security layer. I put a lot of time into it!

What things are you proud of in your automations?
Wife appreciation factor needs to be high. What I did, based on Telegram I built a bot that can control the entire house. So, when I ask telegram, give me a mood, it will ask which mood. Then when I select "romantic" the fireplace will go on, the lights will go to a certain setting and the music will go on. Then my girlfriend can control the entire house using a simple chat interface. That works well. And every time I show that to someone it works super great.

You no longer have to log in, just open a chat and done. When I go to bed, I tell it I will sleep soon. Then it asks now or in ten minutes. And ten minutes later the house goes "click click click". I love those clicks. You hear everything going off. Our fireplace is electric and can be turned off with that as well.

What is your most common way to interface with your house?
I only use the chat app these days. I do use a normal light switch for the lamp above the table. It's a light we turn on every morning and I don't want it to be attached. The lamp is connected with HA, but normally says not available, because you take the power off. Sometimes when we play games its fun to change color, which is nice. I would like to add a smart switch which can actually turn it on and off through MQTT. That's the only one I don't have automated. Oh, and in the hallway. Behind my TV is all automatic. And they go on when it is dark. It also makes you lazier, when you go to bed you know everything will be off in 15 minutes anyways. And you just lie down in bed.

What is your main reason to automate?
It's super cool to do! When people come in, I'll show them what's possible! Everything is automated and it's easy or something. I think it's very cool, in 90% of the times I love it when playing a movie, the lights go dim. And when the speakers have not been enabled yet, those will go on. Unless, when having dinner and it's getting dark out, you turn on the lights again with the app. Until next time that you press pause and play, when it dims again. That's annoying. It doesn't always work that well with you, sometimes it even works against you. My girlfriend and I really like it. I have to say my girlfriend doesn't have any issues with it.

Is there a place where you get inspiration from?
My inspiration I think of myself. I have looked at blogs. Generally, not that interesting. It would be easy if my house would do this or this. And then I think about how it could be done. After that I start googling and I have to say, I called the system Jarvis. But because of that, I start thinking: "Jarvis can do everything, I want that this thing can do everything as well." Everything I think of; this system should be able to do. That's why I have docker, so I can run many things next to each other.

Do you live with someone else in your home?
Yes, my girlfriend.

How does she experience your automations?
My girlfriend is very easy with this, especially with this chat thing. I do think it is annoying for her when I'm working on the system. Then I have to turn off the Wi-Fi to reset a router. Then all the lights go on again and then I'm puzzling for a while. Generally, she's very easy and says: "you do your thing, as long as I can control it." She also asks for access every time I change the system. That's relaxed with the chat app, the backend can be

changed, but her interface never changes. If I decide to move to another HA, she won't have to notice anything. That's nice.

Can you recall any bad experiences she's had?
Not really no. When I want to show something, it doesn't work... My parents came by, I wanted to show them and then suddenly all lamps appeared to be offline. Something went wrong, or the Wi-Fi was disconnected and none of lights work. Then the horror starts of trying to fix it. Because I have them connected on another network that's not connected to the internet, the supplied app doesn't work. For her it's just: "I want to have these lights on". But much worse than that I have not had.

Any good experiences?
Showing people what I made is fun. Also, fun to talk to other people who are working with HA. Nerding out and saying you got a step further already. I can do it like this. When something has to be downloaded, that's very easy. Within my chat application it's easy and in a few minutes the TV starts, after which you can watch it. The integration is seamless.

Did you make any changes to automations for your SO?
The chatbot was really for myself, not for her. Initially I wanted to use google assistant, but I didn't like the idea of a machine that's constantly listening. Next to that, you also need to talk to the machine. Chat application seemed nicer for that. Other than that, nothing specific.

Would you call your automations an improvement to you home?
Yes. This is also definitely stuff we want in our next home as well. This needs to come with us. I'm not planning upgrades now. Rather downgrades, we are getting a physical fireplace. I can't turn that on remotely anymore. Wooden fireplace, not going to happen. The kitchen does have Hue lights built in and a complete ceiling system, I think I'll do something with that. But actual improvements, not really. The camera in our room will move to the front door. Initially the camera was for keeping an eye on the cat, but we don't do that.

Has your SO ever made an automation with you?
No. I don't think she would be able to. She is smart, so if I explained it to her, I think she could do it. She is smart with that kind of stuff. But she also says: "that's your thing". But definitely in node red I can definitely let her build on something. There are appliances that HA can immediately detect, those she could do. But with my structure it's a lot more difficult. I also want to manually put everything in the system.

I made my own DNS server, so I can talk to every light with ://jarvis.1.light. Home assistant can do this automatically, but I set it up like this for easy moving between installations. If a bulb dies, I can replace it with one that has the same name and then everything works again. No messing around with IP addresses.

Would you be able to make an automation for her?
No. I think the simple automations are for us together. Such as lighting. Complex stuff is for me personally, such as integrating train delays with my sleep rhythm through a Fitbit. It was tell me the minutes of delay with a notification. That's very personal. She has access to simple stuff, like lights and the fireplace. She has used the film download system, but she barely used that either.

Interview insights

1. Enthusiasts are motivated by their competence with technology and the ability to show that.
    a. *“It's super cool to do! When people come over, I'll show them what's possible!”* ~ M
    b. *“Every time it's enabled, I think to myself that it’s pretty cool. Also, when you have visitors, everyone says wow.”* ~ B
2. Enthusiasts look for solutions specific to their situation, with a vision.
    a. *“Normally just stuff that annoys me and I'll try to fix it.”* ~ B
    b. *“Small things I find very valuable.”* ~ B
    c. *“My inspiration I think of myself. I have looked at blogs. Generally, not that interesting*~ M
    d. *“Jarvis can do everything, I want that this thing can do everything as well.”* ~ M
    e. *“It offers another security layer. I put a lot of time into it!”* ~ M
3. Enthusiasts have moments where they take manual control and see this as improvement.
    a. *“We ate on the couch and suddenly we were eating in the dark. So I added another button to actually trigger it.”* ~ B
    b. *“I do use a normal light switch for the lamp above the table. It's a light we turn on every morning and I don't want it to be attached.”* ~ M
    c. “*When I go to bed, I tell it I will sleep soon. Then it asks now or in ten minutes. And ten minutes later the house goes "click, click, click". I love those clicks.”* ~ M
4. The interfaces that are most used do not change a lot.
    a. *“That's relaxed with the chat app, the backend can be changed, but her interface never changes.”* ~ M
    b. *“I think the simple automations are for us together. Such as lighting.”* ~ M
    c. *“Most of my lights work with sensors.”* ~ B

Appendix E: Scenario tests

The previous chapter ended with opportunities to design experiences that work for all inhabitants. This chapter is the first of the three phases to design with these opportunities. The chapter describes the exploration of solutions that give any inhabitant full control when they want it. These solutions walk the line between new smart home features and the familiar light switches.

Scenario 1

The purpose of this first test is to place an intuitive solution into context as fast as possible. During the initial research of this project, many elements of importance were found and these automatically provoked ideas for solutions. These intuitive solutions can be interpreted as hypotheses of the researcher. This test setup offers a place to test one hypothesis and the results can be used to refine the solution or to discard it.

Goal

During research, the topic of control came up many times. Findings show that non-enthusiasts' feeling of control over their living space can be undermined by technology. The initial solution to this, is a button that allows users to easily go back to a previous state their living space was in. The goal of this intervention is to provide a physical way for non-enthusiasts to take control of their living area. This research is focused on testing to which degree the intervention achieves this goal. Therefore, the research question is as follows:

"Does the intervention improve control in a physical way for non-enthusiasts?"

Setup

The prototype

A lo-fi prototype that enables the user to undo the latest automatic change in their home. For the test this meant it switched between evening mode with a dim light and reading mode with a bright light.

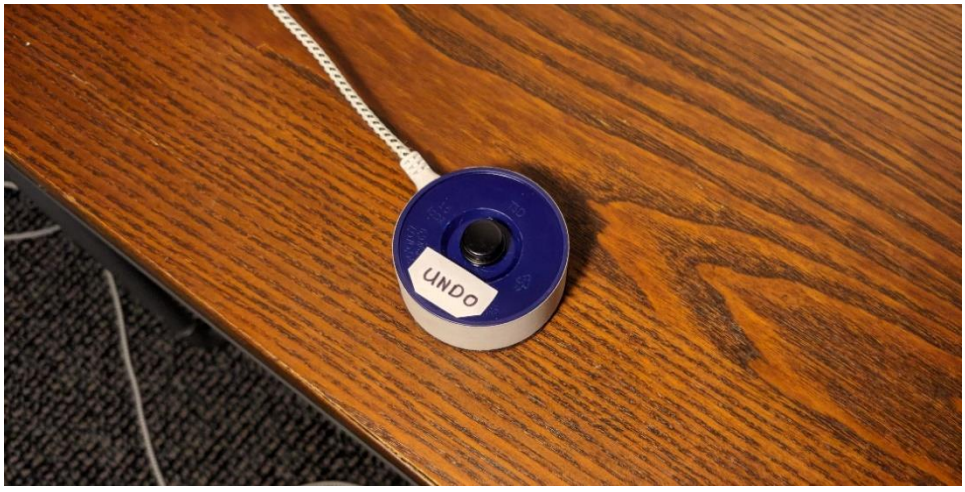


Figure 31: Scenario 1, the undo button prototype

Environment
This test makes use of the living lab at the Industrial Design faculty in Delft. The lab is a living room specifically built for testing in a living room situation. A camera is present in the room to record the behavior of participants, as well as regular furniture found in a living room and kitchen.

The choice for this environment was obvious, as it allowed for speeding up the prototyping considerately. It still provided a comfortable and recognizable living environment, while not intruding on the personal spaces of participants. The lab also allows for multiple tests in one afternoon without having to rebuild the test setup.

Materials
To recreate a living room situation with testable parameters.

1. Raspberry Pi (with power and SD card)
2. Router (for local network)
3. Tradfri Hub
4. Tradfri lights
5. ESP8266
6. Button
7. Light fittings
8. Ethernet cables

Participants
Non-enthusiast students at the IDE faculty.

Researcher roles
Quietly sit in the corner. Write shit down. Trigger stuff based on user behavior.

Methods
To make and differences and improvements visible, both a baseline test and a test with intervention must be executed. This should make evident how the experience of participants changes based on the intervention. To measure a difference, certain parameters need to be chosen that are measured.

This test will measure control, which can be measured from two perspectives. Control can be measured in speed and efficiency when dealing with the situation. The faster someone can deal with a situation, the more control they have over a situation. The other component is the perception of control they had while dealing with the situation. This is measured using a SUS scale. A SUS scale also allows other qualitative experiences to be tracked that might be affected by the intervention.

Tasks

Scenario

The participants are shown the living room, which is lit by one light, with the clock showing 21:56. The participants are asked to read a passage in a book (the design of everyday things). They are stressed I will have questions about the text afterwards. At 22:00 the room automatically goes into evening mode, which makes is excessively difficult to read their book.

Without intervention, they can only set the lights bright by using a phone interface. The intervention is a button saying “undo” and allows the users to revert to the previous settings with the push of one button.

Timeline

1. Welcome participant
2. Introduce living room, time and controls
3. Task: read a passage in the book
4. Questions about the test
5. Initial questions for demographics information
6. Reset set-up

Insights

Relating the prototype to the light

The prototype was on the table in front of the participants and not next to the light that changed. Because of this, the prototype was not relatable to the change that happened in the environment. The participants also thought a smart home was something you could talk to.

> “I’m looking for a way to get it brighter again, there is probably a sensor somewhere” *~ J*
>
> *“It is a smart living room, hmmm. Please, more light! Can it speak?” ~ H*

Figure 33: A participant using gestures to try and control the brightness

Figure 32: A participant turned on the light with the physical switch. The light was too dim to read from the couch.

Temporary control

The prototype offered a temporary control, some described this as no control, some described it as a little bit of control. The control was temporary because they were unsure if this would do anything for a future action. z

> *"Things going off when I turned them on was definitely not control." ~ M*
>
> *"The button gives a part of that control back" ~ J*
>
> *"I have short term control, as I can reset that exact moment. But how far can I go back?" ~ C*

The concept of undo is decently understood

Once participants found the relationship between the undo button and the light, they understood what the button would do. They did have question with how far back they could go with the undo button. They also questioned what caused the change in lighting in the first place.

> *"I believe it goes back to the previous thing you had" ~ M*
>
> *"Oh it's just a little undo button" ~ C*
>
> *"I don't fully understand it though, because I don't know what caused the light to change." ~ S*

Prototype data

The scenario created was annoying to the participants.

"Hahaha, that sucks." ~ S

"Ha, that's really annoying." ~ F

"The light got too dim to read" ~ J

"Nou!" ~ C

The prototype was not relatable to the change that happened in the environment. The participants also thought a smart home was something you could talk to.

"I'm looking for a way to get it brighter again, there is probably a sensor somewhere" ~ J

**Waved and moved around trying to find the sensor* ~ J*

"It is a smart living room, hmmm. Please, more light! Can it speak?" ~ H

"Or maybe say it? Light, more! More light." ~ J

"Am I supposed to talk to it?" ~ C

**Walked over to the light and turned it on with the switch* ~ M*

"Can I use the flashlight on the phone?" ~ M

The concept of undo was understood when playing with the prototype, but more was expected.

"I didn't get it at first, but when I look at it and started playing, it made sense." ~ S

"I don't fully understand it though, because I don't know what caused the light to change." ~ S

"Is it supposed to turn?" ~ H

"Hey there is an, undo" ~ J

"What happens when I turn it? … I thought maybe it was a dimmer because of the round button." ~ J

"Oh it's just a little undo button" ~ C

"I believe it goes back to the previous thing you had" ~ M

The prototype offered a temporary control, some described this as no control, some described it as a little bit of control.

"On the one hand, a lot, because I could simply click on a button. But first I had to pass the hurdle to use it." ~ F

"I hate this kind of stuff … no control at all … I want to decide how to spend my time, not something that has determined it for me." ~ S

“No, the prototype did not give me a sense of control.” ~ H

“The normal situation is that I turn things on and off, that’s full control.” ~ J

“The button gives a part of that control back” ~ J

“I do like that I can go back, but will my house do stuff like this automatically?” ~ C

“I have short term control, as I can reset that exact moment. But how far can I go back?” ~ C

“Will my house go mad if I do that? Or just a button to turn all the smartness off!” ~ C

“Things going off when I turned them on was definitely not control.“ ~ M

Methodology data

The participants did not see the prototypes as a part of the test.

“There is a phone here, can I use it?” ~ F

“There is a phone here, is that right?” ~ S

“The prototypes would be more visible when testing in someone’s home. The prototype would get more attention.” ~ C

The researcher mentioned the “prototypes on the table” twice.

The participants were too focused on their task of reading, they did not respond to the change of lighting.

“I didn’t know if I had to do something or if I had to adapt to the light” ~ H

Kept reading in the dark. ~ H

Noticed the light going off, but didn’t do anything about it. ~ M

“The assignment was to read the infographic” ~ M

The participants were afraid to change things in a room that wasn’t theirs.

“This is a very strange situation to be in.” ~ C

“Because it was part of an assignment, it did not feel like my living room.” ~ M

The participants asked the researcher questions during the test, likely because of the presence. This led to inconsistent testing between participants, making results hard to compare.

“Should I speak out loud?” ~ F

“Am I supposed to do something about this?” ~ C

“Can I use the flashlight on the phone?” ~ M

Questions afterwards

Can the prototypes be used without telling the participants they are in a “smart home”?

What is a smart home product?

Smart home switches could be nice for easier arrangement of the room. You don’t have to keep light switches free from furniture.

How would you give someone access to your house when you go on vacation? Do you have to give them instructions? A key is so simple.

Can people then go outside with a remote and control stuff in your house? Just like the tv remotes when you’re a kid?

Scenario 2

This second test iterates on the findings of the first test. This test is done with a prototype that builds on the findings of the previous test and an improved methodology.

Goal

The initial test focused on improving perceived control when automations are in play. The test concluded that the participants did not perceive to have control, despite the intervention. This needs to be addressed, however the intervention also lacked other properties. Participants had difficulty relating the intervention to the change of lighting in the room, which caused them to look for solutions elsewhere. This intervention and test address both problems with the following research questions:

"How well do the participants understand the relation between the intervention and the change of lighting in the room?"

"Does the perceived control of the participants improve by providing manual control and an override for all automations ?"

Setup

The prototype

A higher fidelity prototype that has lighting control with a dimmer. The prototype controls and indicates whether automations attached to the dimmer are allowed or not. This prototype is placed next to the light it is controlling.

Figure 34: Scenario 2, the first dimmer prototype with a user changing the brightness

Environment
Same as previous scenario test

Materials
Same as previous scenario test

Participants
Non-enthusiast students at the IDE faculty.

Researcher roles
Same as previous scenario test

Methods
In the previous test, there was no reference material and a baseline test was needed. The previous findings contained information about difficulties participants had relating the intervention to the change in lighting and thus a baseline is not needed during this test.

This test will measure how well participants can relate the change in the room to the intervention. This will be measured in two ways: the time it takes for participants to focus on the prototype and the understanding they have of the relationship. The first can be measured in time and the second will be measured using an interview after the test. The former is a quantitative measurement, whereas the interview afterwards should provide a qualitative insight.

Timeline
1. The participants are shown the living room.
    a. The room is quite dim
    b. The room has one bright light next to the couch
2. The participants are asked to get comfortable on the couch and given the following information:
    a. This room is a “smart home”, this means the lights are connected to a central system and the room automatically does things. This room does not have a voice control system.
    b. This is your space and you are the boss. If you don’t like the way your house behaves, you can correct it.
    c. All the items in this room are part of this test and are for you to use as you see fit.
    d. I will be sitting in the room, but I won’t respond to any questions.
    e. Please think out loud during the test.
3. The test starts and the participant is given the following information:
    a. This house is programmed to go in evening mode at 22:00. It is currently a bit before 22:00.

    b. When the evening mode kicks in, I would like you to change the house back to what it looks like now.
    c. Here are some fun books to keep you occupied until the evening mode kicks in.
4. The participant starts reading on the couch.
5. The researcher triggers evening mode after about a minute.
6. The test ends when the light has been reset to the previous setting.
7. Interview using the questionnaire
8. Collect demographics information

Insights

It was clear to the participants that the prototype belonged to the lamp.

Compared to the previous test, the participants were able to find the dimmer fairly easily. When looking at the light, the controller was quite noticeable. This was both because of the placement and because of the lights on the dimmer.

> *"But I saw a button, so let's try that" ~ E*
>
> *"This is the only controller, right?" ~ H*
>
> *"This thing asks for attention because of the light on it." ~ M*

A discrepancy between the button state and the light state is confusing.

The prototype has issues that severely affect the usability of the device. When the light is dimmed by the system, the knob is not turned to the correct position. The dimmer also has a delay between turning and actually changing the light. These discrepancies between the state of the light and the state of the dimmer cause participants to believe something is wrong.

> *"Huh, but it is still on bright" ~ E*
>
> *"When I press the automation, I would expect it to change immediately." ~ E*
>
> *"Hey, now it's going all the way off" ~ H*
>
> *"I was turning it and it didn't respond immediately. I thought it wasn't working." ~ H*
>
> *"The button is on bright, but that's not true." ~ M*
>
> *"The only weird thing for me was that I need to turn it back and forth to set it back to bright" ~ W*

Participants expected automations to turn off when turning the dial

Participants mentioned that they had overruled the system and therefore it should have turned off the automations. They expected the dimmer to do this automatically as they manually changed the lighting.

> *"When turning the dial, it should know I don't want it to be automated?" ~ H*
>
> *"I didn't expect the light to turn off again, because I felt I had overruled it." ~ M*

It is unclear what the motivation is of the light to turn off every time again.

When the automations are not disabled, the light will go off again after a minute or so. This behavior was thoroughly confusing, as the participants expected they had overridden any automations. This made participants question and doubt why the system was showing the specific behavior. Fighting with an automation led to them creating their own theories of what the system is expecting from them.

> *"It almost seems like it's trying to push me to bed. Which could be good for me, I guess. You're standing already, might as well go to bed." ~ E*
>
> *"Wasn't it evening mode, why is it turning on when I turned the lights off?" ~ E*
>
> *"I don't fully understand the program of this device, but maybe it's because I didn't write that myself" ~ E*
>
> *"Why does it get dark again? Does it get dark to make you sleepier?" ~ H*
>
> *"I am not quite sure how it is configured, with the times and settings. " ~ M*
>
> *"Ha, why? Why is it doing this?" ~ A*
>
> *"Is it trying to make me stand up again?" ~ A*

When turning off the automation the participants have more control. However, some participants still lack control by not knowing the settings.

Participants appreciated the ability to disable automations as a way to gain control, but they had no way to alter the automations. This inhibited their feeling of control, because ultimately they could not actually influence the larger system.

> *"In the beginning, I had little control, as it turned back to another setting even though I changed it. But when turning off the automation, I had full control over the light." ~ E*
>
> *"Now that I know that I can turn the system on and off, I think it gives me quite some control." ~ H*
>
> *"If I only had this box, I would not have that much control. I don't have the transparency of the configuration." ~ M*
>
> *"I have no idea how I would have to set this automation to 23:00 for example" ~ W*
>
> *"Normally at 22:00 PM I would like it to be dimmer, but not this time. So for that it works well." ~ A*
>
> *"The other control would be having actual control over the settings of the lighting." ~ A*

Prototype data

It was clear to the participants that the prototype belonged to the lamp.
“But I saw a button, so let’s try that” ~ E

“This is the only controller, right?” ~ H

“This thing asks for attention because of the light on it.” ~ M

A discrepancy (a delay or non-matching setting) between the button state and the light state is confusing.
“Huh, but it is still on bright” ~ E

“When I press the automation, I would expect it to change immediately.” ~ E

“Hey, now it’s going all the way off” ~ H

“I was turning it and it didn’t respond immediately. I thought it wasn’t working.” ~ H

“The button is on bright, but that’s not true.” ~ M

“The only weird thing for me was that I need to turn it back and forth to set it back to bright” ~ W

Participants expected the automations to turn off when turning the dial
“When turning the dial, it should know I don’t want it to be automated?” ~ H

“I didn’t expect the light to turn off again, because I felt I had overruled it.” ~ M

It is unclear what the motivation is of the light to turn off every time again.
“It almost seems like it’s trying to push me to bed. Which could be good for me, I guess. You’re standing already, might as well go to bed.” ~ E

“Wasn’t it evening mode, why is it turning on when I turned the lights off?” ~ E

“I don’t fully understand the program of this device, but maybe it’s because I didn’t write that myself” ~ E

“Why does it get dark again?” ~ H

“Does it get dark to make you sleepier? ~ H

“I am not quite sure how it is configured, with the times and settings. “ ~ M

“Ha, why? Why is it doing this?” ~ A

“Is it trying to make me stand up again?” ~ A

When turning off the automation the participants have more control. However, some participants still lack control by not knowing the settings.
“In the beginning, I had little control, as it turned back to another setting even though I changed it. But when turning off the automation, I had full control over the light.” ~ E

“Now that I know that I can turn the system on and off, I think it gives me quite some control.” ~ H

“If I only had this box, I would not have that much control. I don’t have the transparency if the configuration.” ~ M

“I have now idea how I would have to set this automation to 23:00 for example” ~ W

“Normally at 22:00 PM I would like it to be dimmer, but not this time. So for that it works well.” ~ A

“The other control would be having actual control over the settings of the lighting.” ~ A

The prototype does not feel part of a smart home.
“It feels very analog to me, not very smart. I think it would feel smarter if it gives more feedback” ~ N

“Having to get up and go to the light doesn’t feel very cool, especially with all those apps around that can do it with way more control” ~ W

Methodology data

The instructions were more complete in this test, resulting in a clear idea for the participants of what was allowed in the room and what the smart home could do.
“So, I can’t control this room with my voice.” ~ E

Scenario 3

The previous tests focused on relating the intervention to the change of lighting in the environment and improvement of control over their environment. The participants were able to relate the prototype to the environment and gained a fair bit of control. This last prototype focuses on usability improvement and shifting control to the participant as soon as possible. Because of the recurring topic of control and the introduction of usability the research questions are as follows:

"Does the perceived control of the participants improve by providing manual control and the ability to enable automations?"

"How well do the participants understand the meaning of manual and automatic control in the setting of a smart home?"

Setup

The prototype

With instant feedback during usage and more information during usage, this prototype is mostly a usability improvement. The prototype is always aware of the latest states the light are in and reflects this with the LEDs. When a user turns the knob, the dimmer indicates it has switched to manual control and automations are no longer executed.

Figure 35: Scenario 3, dimmer #2 being manually controlled.

Environment
Same as previous scenario test.

Materials
Same as previous scenario test.

Participants
Same as previous scenario test.

Researcher roles
Same as previous scenario test.

Methods
In the previous test, there was no reference material and a baseline test was needed. The previous findings contained information about difficulties participants had relating the intervention to the change in lighting and thus a baseline is not needed during this test.

This test will measure how well participants can relate the change in the room to the intervention. This will be measured in two ways: the time it takes for participants to focus on the prototype and the understanding they have of the relationship. The first can be measured in time and the second will be measured using an interview after the test. The former is a quantitative measurement, whereas the interview afterwards should provide a qualitative insight.

Timeline
9. The participants are shown the living room.
    a. The room is quite dim
    b. The room has one bright light next to the couch
10. The participants are asked to get comfortable on the couch and given the following information:
    a. This room is a “smart home”, this means the lights are connected to a central system and the room automatically does things. This room does not have a voice control system.
    b. This is your space and you are the boss. If you don’t like the way your house behaves, you can correct it.
    c. All the items in this room are part of this test and are for you to use as you see fit.
    d. I will be sitting in the room, but I won’t respond to any questions.
    e. Please think out loud during the test.
11. The test starts and the participant is given the following information:
    a. This house is programmed to go in evening mode at 22:00. It is currently a bit before 22:00.

    b. When the evening mode kicks in, I would like you to change the house back to what it looks like now.
    c. Here are some fun books to keep you occupied until the evening mode kicks in.
12. The participant starts reading on the couch.
13. The researcher triggers evening mode after about a minute.
14. The test ends when the light has been reset to the previous setting.
15. Interview using the questionnaire
16. Collect demographics information

Insights

The concept of manual and automatic is well understood

All participants understood what manual and automatic meant in the context of a smart home. Switching to manual control when using the dimmer enforced their understanding of the concept.

> *"If I pushed the automatic button, it would go to the comfortable lighting setting. The manual part was obviously when I set the brightness with the knob." ~ D*
>
> *"It was configured to automatically change the lighting, but with the box I could switch it to manual" ~ J*
>
> *"On a timer the light dims, and by manually changing the light it goes on again" ~ M*
>
> *"It has manual and automatic, which means automatic is connected to a bigger system" ~ C*
>
> *"I did override the automatic control, because the light went to manual." ~ F*
>
> *"If the dimmer is on manual, why did it dim? Maybe it was on automatic when I walked in." ~ Z*

Participants are still ambivalent about the control they have

The participants feel the control of the current situation, but have difficulty with their limited information on the complete system. Understanding why the light changes and how they can change this behavior is an important factor for control to many participants.

> *"Definitely, the manual aspect. It gives me a lot of control" ~ D*
>
> *"Maybe if it's smart I would want to control how much energy it's using. Suggesting ways to reduce energy in combination with other lights? When turning the knob further it turns red, showing high energy usage." ~ D*
>
> *"If I have the knowledge to change it, then I have control" ~ C*
>
> *"Now, I can control this light, what if I want to change another one?" ~ F*
>
> *"Because the feedback is not instant, I feel like I have less control. What about changing the color of the light?" ~ Z*

Participants were confident in the understanding of the prototype

The participants used the prototype faster than previous prototypes. When asked to explain how the prototype works, they had less doubt and explained it correctly.

> *"Troubleshooting is not that difficult" ~ D*
>
> *"For what I needed, it did exactly what I wanted" ~ J*
>
> *"Is this for the light? Ah yes it is for the light. Now it's bright again" ~ Z*

Participants expected more of a "smart" dimmer

The previous test setups have been improved a lot by specifying what the limitations and possibilities are of the testing environment. This does show that participants have a strong expectation of what a smart home behaves like. This is generally not consistent between participants, except for the preconception that the system is more elaborate than is possible.

> *"Having to physically change my light settings, does not feel very smart." ~ D*
>
> *"Smart would be getting more information from the system, it would give me more control and understanding." ~ D*
>
> *"Because this is about smart homes, I could imagine there to be more settings. I have not found those." ~ J*
>
> *"Now I got up to change it, that's not the idea of a smart home!" ~ M*
>
> *"I just scratched the surface of what it can do. I think this could also open my blinds, with the same movement. " ~ F*
>
> *"Why do I need this device if I can do it with my voice or in an app." ~ F*

Remote controlling is desired and expected

One thing participants mentioned often is the desire for control without getting up. This is a logical feature in a smart home and is within reach.

> *"A portable remote that you can take when you enter the room could be nice?" ~ D*
>
> *"I expect, that when I'm sitting here, I should able to do it from here. Is there a remote controller or something?" ~ M*
>
> *"I would prefer to stay on the couch if something like this happens" ~ J*
>
> *"Can I clap?" ~ Z*

Usability data

Participants use the power cable to get insight to what it's controlling.

"I'm not sure what that's plugged in to." ~ D

"The cable also goes to the same place, so that makes sense" ~ C

"I didn't associate it with the light" ~ F

"The wire however does look like it goes to the TV and not the light. The design of the dimmer also doesn't fit with the light." ~ Z

The concept of manual and automatic is well understood

"If I pushed the automatic button, it would go to the comfortable lighting setting. The manual part was obviously when I set the brightness with the knob." ~ D

"It was configured to automatically change the lighting, but with the box I could switch it to manual" ~ J

"On a timer the light dims, and by manually changing the light it goes on again" ~ M

"It has manual and automatic, which means automatic is connected to a bigger system" ~ C

"I did override the automatic control, because the light went to manual." ~ F

"If the dimmer is on manual, why did it dim? Maybe it was on automatic when I walked in." ~ Z

Participants were confident in the understanding of the prototype

"Troubleshooting is not that difficult" ~ D

"For what I needed, it did exactly what I wanted" ~ J

"Is this for the light? Ah yes it is for the light. Now it's bright again" ~ Z

Direct response between the dimmer and the light is required

"It's annoying that there is a delay between the dimmer and the light itself" ~ Z

"When I started playing with the box it wasn't completely clear to me, as I was looking at the light and not at the box. There is a slight delay" ~ J

Perception of smartness data

Participants expected more of a "smart" dimmer

"Having to physically change my light settings, does not feel very smart." ~ D

"Smart would be getting more information from the system, it would give me more control and understanding." ~ D

"Because this is about smart homes, I could imagine there to be more settings. I have not found those." ~ J

"Now I got up to change it, that's not the idea of a smart home!" ~ M

"I just scratched the surface of what it can do. I think this could also open my blinds, with the same movement. " ~ F

"Why do I need this device if I can do it with my voice or in an app." ~ F

Remote controlling is desired and expected

"A portable remote that you can take when you enter the room could be nice?" ~ D

"I expect, that when I'm sitting here, I should able to do it from here. Is there a remote controller or something?" ~ M

"I would prefer to stay on the couch if something like this happens" ~ J

"Can I clap?" ~ Z

Perceived control data

Participants are still ambivalent about the control they have

"Definitely, the manual aspect. It gives me a lot of control" ~ D

"Maybe if it's smart I would want to control how much energy it's using. Suggesting ways to reduce energy in combination with other lights? When turning the knob further it turns red, showing high energy usage." ~ D

"If I have the knowledge to change it, then I have control" ~ C

"Now, I can control this light, what if I want to change another one?" ~ F

"Because the feedback is not instant, I feel like I have less control. What about changing the color of the light?" ~ Z

“I could imagine sitting on the couch and it turning off, being annoyed by that.” ~ J

“I feel really stupid” ~ M

“I did not go back to reading, so I think the smart home decided it was time for me to sleep. I probably configured this myself or something” ~ M

“There has to be another way, as I don’t want to get up to fix it” ~ M

“Are you asking me about the control over the whole house or just this prototype?” ~ F

Methodology data

Using words like smart home has a lot of preconceptions

“Because this is about smart homes, I could imagine there to be more settings. I have not found those.” ~ J

“Now I got up to change it, that’s not the idea of a smart home!” ~ M

“I thought it was weird that light had a device and the others did not” ~ M

“I was disappointed that I Solved it that quickly with a little device, I figured there would be more with this luxury smart home” ~ M

“Yes, am I allowed? It’s 22:00 now, right?” ~ Z

“What about the other lights?” ~ Z

“This is also another light and a device I don’t know” ~ Z

“I guess if there is no voice recognition, there is no point in clapping.” ~ D

Leftover data

“Is there a remote control?” ~ D

“There are buttons here” ~ J

“When I press the button, it goes to automatic” ~ J

“I just noticed that I can see how bright the light is when looking at the device” ~ J

“I don’t think it will go back to the other light setting, because it’s on manual now” ~ J

“Automatic, that’s why it just went off” ~ M

“I thought the device looked interesting, so that it needed to do something with the lights.” ~ M

“I did have to experience how it works” ~ M

“I can see the relationship with the lights, it changes the intensity” ~ C

“My knowledge is limited to the experience I just had, there might be more to it” ~ C

“When I turned, the light went on. That was a nice reinforcement” ~ F

“I’m not sure when it returns to automatic mode, I assume by itself after a little while” ~ F

“The first thing I noticed, was the switch on the light itself. Which of course makes sense.” ~ Z

“A rotating knob is obvious for dimming, so that made sense” ~ Z

Appendix F: Usability tests

The previous chapter ended with a lighting control prototype that was successful in giving back control to users. This chapter turns the prototype into a consumer product by redesigning and focusing on usability. The usability also leads to a discussion of which inhabitant should discover which features. Finally, the findings are represented in a higher fidelity prototype with long term testing purposes in mind.

Usability 1

To achieve the features presented, another series of design iterations was completed. This series focused on fitting the interface in a new form factor, finding the right balance in discoverability of features and assuring usability of the dimmer. Each exploration tackled all of these themes, while focusing on a specific usability aspect.

The initial explorations made a very explicit distinction between the manual and automatic states of the dimmer. This was useful to see if the participants understood the concept of manual and automatic control on a dimmer. Now the dimmer will be developed into a consumer product, the requirements of the previous chapters need to be achieved. To find a happy medium between the requirements and the understanding of the dimmer, this chapter tests ways to simplify the interface.

Research question
"*Do the new interfaces provide participants enough information to understand the concept of manual and automatic control?*"

Setup

Method
To make a proper comparison between the interfaces, all participants will use both interfaces. Half the participants start with the minimal interface and the other half will start with the more elaborate interface. This should eliminate differences between participants and might highlight information that is missing in either interface.

The participants are informed similarly as a user would be when using the device in its context. The participants are told the device controls light and none of the text in the device is allowed to be mentioned as instruction.

The test measures the speed at which the participants complete the tasks. Their comprehension is tested using qualitative questions and an open interview if needed.

Participants
This test makes use of 10 participants, which are all non-enthusiasts. They are students from the IDE faculty.

Materials

Because this understanding does not need a fully functioning device, the interfaces are tested with prototypes on a touchscreen. The materials can be seen in figure 36. Left shows an interface similar to the previous explorations, but in the new form factor. Right shows the minimal interface, which has less buttons and a less explicit indicator between manual and automatic.

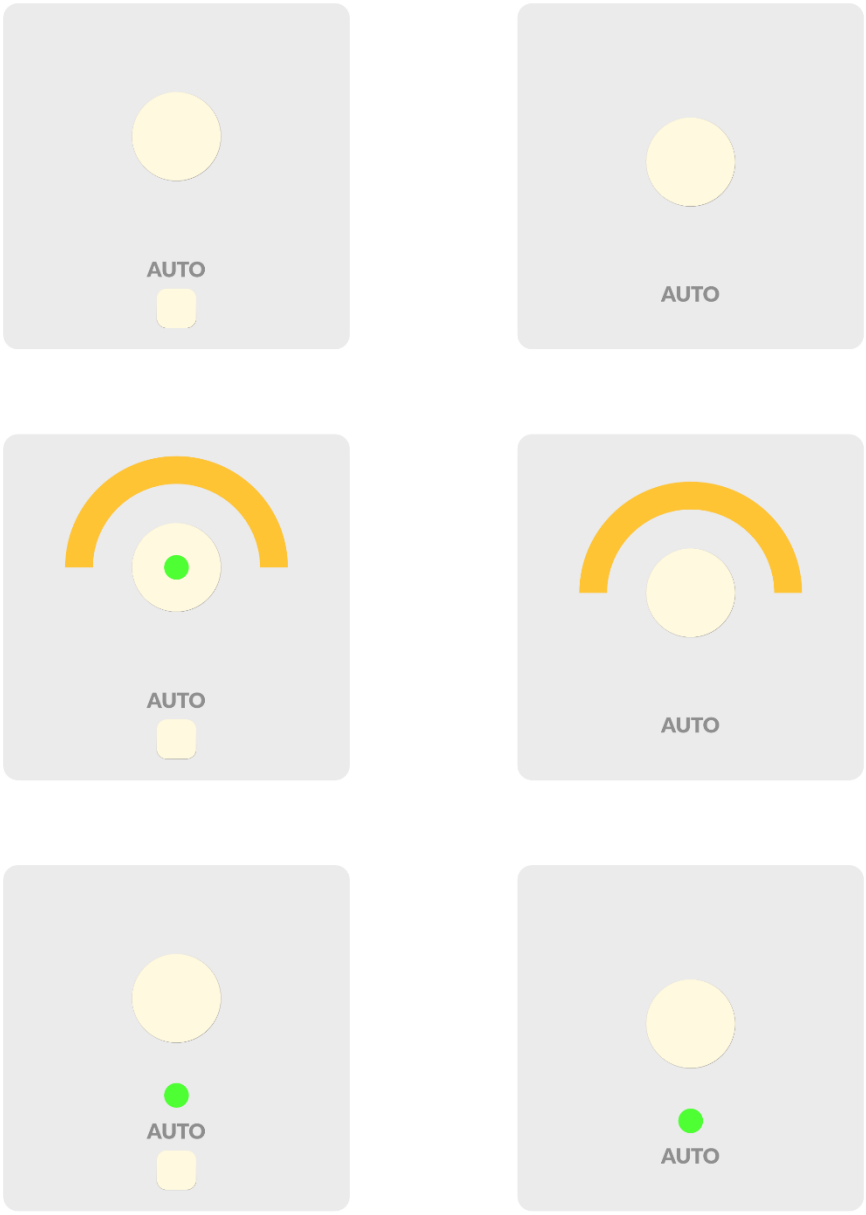


Figure 36: The dimmer designs used. Left is the elaborate design and right is the minimal design. The top shows them in manual mode, the bottom in automatic mode.

Timeline

1. Thank you for participating:
    a. I would like to record the audio for transcription purposes.
    b. This is a test for a dimmer that controls smart lights. These smart lights are a combination of automatic control and easier user control.
        i. Show the prototype as an example dimmer
        ii. In this test, the knob on screen does not turn.
    c. Please follow the instructions on the screen.
    d. Afterwards we'll have a brief interview.
2. Demographics:
    a. Age / Nationality / Profession
    b. Any smart home products?
3. Instructions on the screen:
    a. Elaborate design
        i. Enable the dimmer
        ii. Set the dimmer to automatic control
        iii. Take the dimmer out of automatic control
    b. Minimal design
        i. Enable the dimmer
        ii. Set the dimmer to automatic control
        iii. Take the dimmer out of automatic control
4. Questions:
    a. What does it mean when the dimmer is in auto?
    b. What does it mean when the dimmer is not in auto?
    c. Could you explain what features the dimmer is capable of?

Insights

This test resulted in many findings that help answer the research question. There are also other findings that answer the tangential and broader design topics.

A label that says auto with an indicator light is well understood.
First of all, the new interfaces did not impact the way participants interpreted the meaning of "auto" on a dimmer. Both interfaces did well in getting users to understand when auto was enabled and when it was not.

> *"It's about a dimmer, so when I turn this the lights do something? And then auto does something to adapt to the outside lighting" ~ P1*
>
> *"When there is no light at auto either it's turned off or it is on a manual mode." ~ P8*

Double clicks are difficult to find without any indication.
Participants had difficulty finding "auto mode", which was hidden behind double clicking the button. This is in line with the design, which makes an advanced feature more difficult to find for a non-enthusiast user. This does mean that this feature needs to be known for at least one user, maybe through a manual or through packaging.

> *"Oh I did it, I think I needed to double press." ~ P2*
>
> *"It was hard to figure out the double pressing, but it could be solved with a manual." ~ P4*

With a separate auto button, participants thought the button acts as a toggle.
Using a separate button for selecting "auto mode" caused some participants to see it as a toggle, causing a few misclicks. The auto button also caused participants to try and click the auto button before they were tasked to do so. Removing this button would be sufficient in fixing this issue.

> *"I would press on the auto button again to go out of auto" ~ P2*
>
> *"Pressing auto again, doesn't work as a switch." ~ P5*
>
> *"There are two buttons, so I'll press the other one." ~ P2*

Methodology insights

It's hard to relate the screen to actual use on a physical device.
Choosing to prototype the new device interface on a digital platform caused quite a few issues during the test. Digitizing the interface caused participants to question which elements were buttons and whether their

visibility indicated a certain state. For future testing digital interfaces are insufficient.

> *"Because it is a flat interface, I'm not sure I can press on the word auto." ~ P2*
>
> *"I think it's already in auto mode, because it's written there and I can't do anything else" ~ P8*

Design suggestions

After performing the tests with the participants, the open interview gathered a lot of design opportunities. Some of these opportunities seemed very worthwhile and were implemented. The following suggestions were implemented or seriously considered.

> *"It looks nicer without the button, but you can't find how to turn it to auto. But with a lot of products you understand this after a while." ~P5*
>
> *"This dial does not really look like a button, not like you can press it. Maybe silicone on the top?" ~ P5*
>
> *"Normally a dimmer is bigger and wider" ~ P6*
>
> *"In a car, it only shows up when you have auto selected, otherwise it goes away." ~P9*
>
> *"It's just coincidence that I tried long press before double press. Both are hidden. To me there is no difference between long press and double press." ~ P3*

Concluding

Even though the test had flaws, the research question was answered. Participants had no difficulty understanding the difference between automatic and manual through both interfaces. The test also uncovered that an additional button for auto is not needed and might even be detrimental to the experience of non-enthusiasts. These and the other findings are used to develop a new prototype and test.

Design data

The word auto with an indicator light is well understood to be automatic control.
"When the light is there, it is on auto. When it is not there it is not on auto."~ P1

"It's about a dimmer, so when I turn this the lights do something? And then the auto does something to adapt to the outside lighting" ~ P1

"Auto is probably for automatic" ~ P2

"Auto makes sure it gets brighter when it gets dark, or something like that." ~ P2

"On/off, dim and auto." ~ P5

"With the button you can turn it on, dim it of course and on auto, it dims automatically?" ~ P6

"You can put it brighter and it can do something automatically" ~ P7

"When there is no light at auto either it's turned off or it is on a manual mode." ~ P8

"I guess when it is not on automatic, it's on some kind of manual mode." ~ P9

Enabling the dimmer with the bigger button if obvious.
"There are two buttons, so I'll press the other one." ~ P2

"I can recognize the bigger button, that should be to enable." ~ P4

Double clicks are difficult to find without any indication.
"Oh double clicks… I feel stupid now." ~ P1

"Oh I did it, I think I needed to double press." ~ P2

"It was hard to figure out the double pressing, but it could be solved with a manual." ~ P4

"The button is easier than pressing twice." ~ P7

"I feel really stupid right now. I have no clue how to get it to auto" ~ P9

With a separate auto button, participants thought the button acts as a toggle.
"I would press on the auto button again to go out of auto" ~ P2

"Pressing auto again, doesn't work as a switch." ~ P5

"You can put it to automatic and not automatic. When it is not on automatic, you can control it with the slider thing." ~ P10

Methodology data

It's hard to relate the screen to actual use on a physical device.
"It is hard to relate the screen to the physical device." ~ P1

"Because it is a flat interface, I'm not sure I can press on the word auto." ~ P2

"Without the light there, I would need to be able to see that it is a label and not a button. Without a light the whole thing could be a button for auto! " ~ P5

"Is auto written on the device?" ~ P7

"I think it's already in auto mode, because it's written there and I can't do anything else" ~ P8

"If it's automatic control, I can just press on auto."~ P10

After participants learned to double click, they often double clicked in other parts of the test. This caused them to skip through parts.
"I went a step too far in the test, I think." ~ P6

"Once I see it, it will be very obvious." ~ P10

Instructions given to the participant might have been too limiting or direct
"You told me it works with click, so I am going to click something" ~ P10

Possible control improvements

Current control improvements or preferences
"I prefer a button like this (the elaborate interface)" ~ P1

"Long pressing is easier, you just wait until you get a response. I like that from turning a phone off as well." ~ P2

"It's just coincidence that I tried long press before double press. Both are hidden. To me there is no difference between long press and double press." ~ P3

"It looks nicer without the button, but you can't find how to turn it to auto. But with a lot of products you understand this after a while." ~P5

"When I dim it and turn it off, then turn it on again, at what brightness is it?" ~ P5

"This dial does not really look like a button, not like you can press it. Maybe silicone on the top?" ~ P5

“Normally a dimmer is bigger and wider” ~ P6

“When someone turns it off and then turns it on, does it remember at which point the light was stored? And when auto kicks in, does it go back to the last auto value when you turn it on?” ~ P6

“In a car, it only shows up when you have auto selected, otherwise it goes away.” ~P9

“It’s either automatic, automatic with a slight adjustment or completely manual. Generally I want you to be brighter, but when it gets dark, it needs to get darker anyways.” ~ P9

“When I look at this interface with the button, it looks very crowded, there is a lot going on here.” ~ P10

New or different control considerations

“Or something similar to the old iPod” ~ P1

“It’s nice to be locked in a setting.” ~ P2

“The blue light, might give me the possibility to set a neutral mode.” ~ P2

“Are you in auto when you select a scene?” ~ P2

“It would not be confusing if the auto label only showed up when it is on auto. But then you wouldn’t know there is an auto feature. “ ~ P3

“I can imagine it to be difficult to double or long press when you are physically disabled.” ~ P3

“It would be nice if the light was in the button. With non-automatic, the light was also in the button” ~ P4

“I like that automatic is not in the center, it’s not something you have to select. It’s something you can select it as an alternative.” ~ P4

“You could use the blue light as a clock and say until what time the light is allowed to be on.” ~ P4

“Pressing auto probably also enables the devices, but that’s not what you asked for.” ~ P5

“Are you playing with the haptics? I wonder what happens when it is easier to turn” ~ P5

“Would be cool if the button could be pressed and go flush with the front.” ~ P5

“What about side clicks or silicon clickable membrane.” ~ P5

Leftovers

“With my parents dimmer you don’t get feedback, you just turn. Now you know what the maximum is.” ~ P1

“It’s like smothering a person with pillow, just hold it for a second and they’re out.” ~ P2

“Pressing the button then? That doesn’t do it either.” ~ P7

Usability 2

The previous usability exploration had flaws in execution, yet still managed to answer the research question successfully. One of the flaws in the previous test was the use of a digital interface, instead of a physical prototype. In this test the digital prototype makes space for a physical one with all required behavior programmed. This includes animations to show when the light is turned on and off. These animations will be verified in this test.

The previous test also generated many design suggestions. A recurring theme was the suggestion to only show the “auto” label when auto is selected. This should make the selection of auto more obvious. It will also be harder to discover auto mode, something that is beneficial to non-enthusiast users.

Research questions
How do the participants interpret the animations shown on the dimmer?

Do participants understand when the dimmer is set to automatic?

Setup

Method
The participants will be introduced to the prototype without it being attached to lights. This will focus the test on comprehension of the interface and not the supporting feedback. The participants will be asked to complete tasks with the device which span all the features of this prototype.

The participants are informed similarly as a user would be when using the device in its context. The participants are told the device controls light and none of the text in the device is allowed to be mentioned as instruction.

This test measures the speed at which the participants completes the tasks. Their comprehension is tested using qualitative questions and an open interview if needed.

Participants
This test makes use of 10 participants, which are all non-enthusiasts. They are students from the IDE faculty.

Materials

The previous test assumed no functioning device was needed for testing, but this was incorrect. This test makes use of a physical prototype, as can be seen in figure 37. Left shows the device when it is in auto mode after timeout. Right top shows the dimmer turned on and right bottom shows the dimmer when auto is selected. The participants will encounter all of these states.

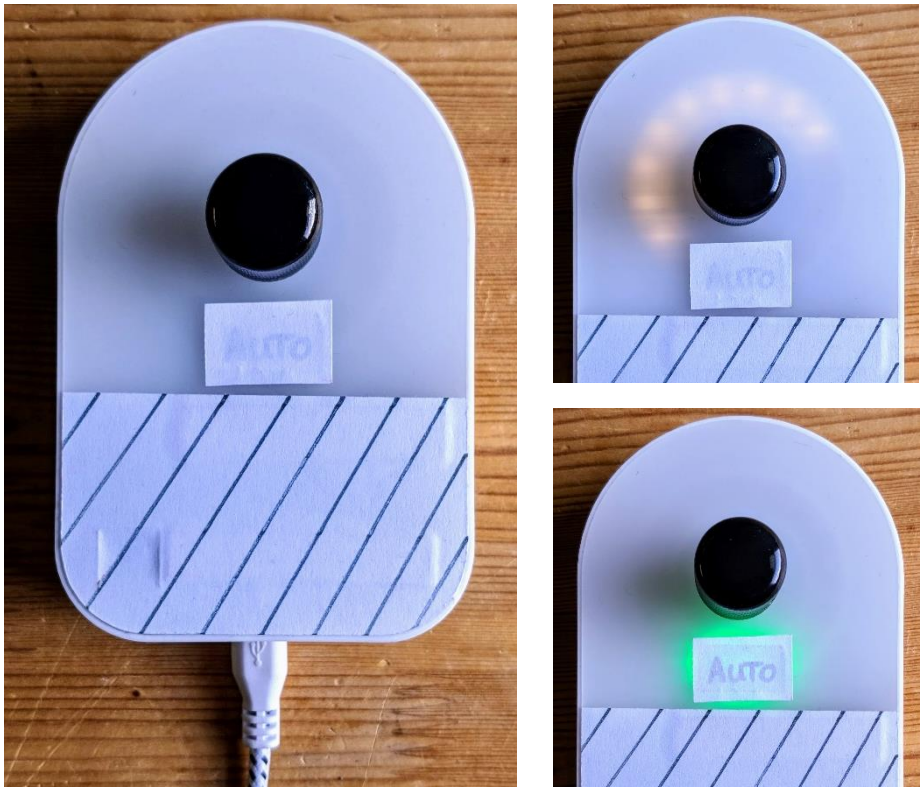


Figure 37: The test device showing different states

Test setup

The test setup changed from the previous test, to allow for more data collected in the form of a video recording of the participants' hands. This supported what they were saying and allowed the possibility to analyze what was not being said.

Figure 39: The participants sat straight in front of the researcher, which allowed the hands to be recorded as well as the audio.

Figure 39: This is what the recording looked like, which gave a better understanding of what the participant was saying

Timeline

5. Thank you for participating:
    a. I would like to record the audio and the video of your hands for transcription purposes.
    b. First we're starting with demographics
    c. Then we're doing a little test
    d. Afterwards we'll have a brief interview
6. Demographics
    a. Age / Nationality / Profession
    b. Any smart home products?
7. Test explanation
    a. This is a test for a device that controls smart lights.
    b. It will be in the same place as a light switch in your home
    c. It's smart, but there is no voice control.
    d. However, in this test there are no lights connected. You will be requested to complete tasks without a light to see if you're successful.
    e. Everything above the marked area is part of the test.
8. Test instructions
    a. Turn on the lights
    b. Set the lights brighter/dimmer
    c. Turn off the lights without rotating the knob
    d. Are there any settings you have not enabled yet?
        i. Could you try to enable this?
9. Questions:
    a. What does it mean when the interface shows this:
        i. On, timed out
        ii. Off, timed out
        iii. Auto, timed out
    b. Could you explain what features the dimmer is capable of?

Insights

Participants consistently interpreted the animations correctly
The animations of this prototype were rather basic, but made very clear to all participants that it was being turned on or off. When greeted with this animation, their responsive was positive and certain.

> *"Ah yup, it's on!" ~ P1*
> *"Yes, I turned it on." ~P3*

Participants found it harder to find auto and never enabled it by accident
During the test, participants never encountered the auto mode when not looking for it. Even when instructed to find the mode they often had difficulty enabling it. Some participants took more than a minute to find the feature, after which the researcher instructed them. Once familiar with the way to enable the mode, participants had no difficulty replicating it.

> *"I thought I could have enabled auto by turning it all the way down." ~ P2*
> *"Hmm this, is not a button. Oh, it's the long press. But I don't see indication for that option." ~ P3*
> *After 45 seconds: "Oh, just a long press." ~ P5*

Participants understood when auto mode was selected and not
The prototype had some visibility to the label, even when auto mode was not enabled. This was enough for participants to understand that when the label was lit up, it was enabled. Some participants even put this specific understanding into words.

> *"Ah, I think I found it!" ~ P1*
> *"Oh long press! This looks like it is on." ~ P2*
> *"My guess is, that in the final design you can't see the "auto" and only when it is turned on." ~ P3*

Participants dim slower than the prototype registered
When using the dimmer for the very first time, the participants turned the knob a lot slower than they expected. This prevents accidental turns, but also confused the participants when using it for the first time.

> *"Then I turn, turn turn turn" ~ P2*
> *"I would say turn. Ooooh I have to go way further!"~ P7*

Participants guessed correctly what auto could be doing in regards to lights.

Similar to the understanding in the previous test, when asked what auto could do in regards to lighting, participants answered that something else would decide what the lighting would do. The responses below show the breadth of correct answers they gave. It also indicates that conveying what automatic control is based on, can be very difficult.

> *"When I press the auto button, it will check with the sensors and give me a proper light." ~ P3*
>
> *"I can imagine that it's a mode where it's on a time schedule. And then you configure that with your smartphone." ~ P4*
>
> *"Not sure, but I think it sets the light based on the light intensity outside." ~ P6*

Participants did not uniformly understand the timed out states of the dimmer

The interface turned off most of its' lights after 10 seconds and the way participants interpreted this was very diverse. This is likely caused by a missing context, as the participants could not see if the lights in the room were enabled. This should probably tested again in context.

Lights on at 2/3 of brightness:

> *"It means that only one light is on?" ~ P1*
>
> *"Standby, but when you enable it, it goes on to that brightness." ~ P4*
>
> *"It's on at a certain brightness, about 2/3" ~ P8*

Lights off:

> *"I don't know, maybe the same as the previous one?" ~ P1*
>
> *"It's on lowest mode, maybe standby" ~ P4*
>
> *"Also on, but much less bright." ~ P8*

Automatic mode:

> *"All the lights are off" ~ P1*
>
> *"That's off." ~ P4*
>
> *"It's off"~ P8*

Design suggestions

This test also concluded with an open interview where the participants could give suggestions and could discuss the current design. The following design suggestions were considered or implemented in a later design.

> *"When it is on auto, the lights should be somewhere on the circle. Why doesn't it show me that? I might want to know that." ~ P2*
>
> *"You could have two colors, one where you set it manually and the auto color." ~ P2*
>
> *"I like being able to see the individual LEDs" ~ P2*

Concluding

Both the methodology and the prototype have improved a lot. The participants understood most interface changes, both from the previous iterations and additions such as the animations. The next test requires a change in methodology to see whether the timed out states are properly understood in context. The test could also be used to test the complete experience of a non-enthusiast.

Design data

Participants consistently interpreted the animations correctly
"Ah yup, it's on!" ~ P1

"Yes, I turned it on." ~P3

"I think this is it." ~ P6

"Video 02:58" ~ P7

Participants found it harder to find auto and never enabled it by accident
"I thought I could have enabled auto by turning it all the way down." ~ P2

"Hmm this, is not a button. Oh, it's the long press. But I don't see indication for that option." ~ P3

"Video 04:55 – 05:45" ~ P5

"Video 02:25 – 03:10" ~ P6

"Video 04:10 – 05:10" ~ P7

Participants understood when auto mode was selected and not
"Ah, I think I found it!" ~ P1

"For auto I would expect a special light somewhere and not on the rest of the ring. So right now it is not on yet." ~ P2

"Oh long press! This looks like it is on." ~ P2

"My guess is, that in the final design you can't see the "auto" and only when it is turned on." ~ P3

"Aaaaaaaah" ~ P7

Participants dim slower than the prototype registered
"Then I turn, turn turn turn" ~ P2

"Aaaah, there it goes. (02:05)" ~ P4

"Video 02:40" ~ P5

"I would say turn. Ooooh I have to go way further! Video 02:20 – 02:50" ~ P7

Participants guessed correctly what auto could be doing in regards to lights.
"Maybe automatically the lights can dim or be lighter depending on the weather?" ~ P1

"When I press the auto button, it will check with the sensors and give me a proper light." ~ P3

“I can imagine that it’s a mode where it’s on a time schedule. And then you configure that with your smartphone.” ~ P4

“Not sure, but I think it sets the light based on the light intensity outside.” ~ P6

“You can make it guess what you want with the auto button, based on sensors? Maybe it can learn from your behavior?” ~ P7

“You can turn it on/off, by pressing. You can make it brighter or less bright. You can turn it on to the brightness it was at previously. I think you can set with time when things go on and off.” ~ P8

Participants did not uniformly understand the timed out states of the dimmer

On at standard brightness:

“It means that only one light is on?” ~ P1

“This means the strength of the light is in this part, maybe 45%. But then I was a bit confused, because this part is not on. I am not sure if I am correct.” ~ P3

“Standby, but when you enable it, it goes on to that brightness.” ~ P4

“The device is on” ~ P5

“The strength of the light if it would be turned on, but it is off now” ~ P6

“Until there the light is on” ~ P7

“It’s on at a certain brightness, about 2/3” ~ P8

On manual mode, lights off:

“I don’t know, maybe the same as the previous one?” ~ P1

“The same meaning, but the strength of the light is lower.” ~ P3

“It’s on lowest mode, maybe standby” ~ P4

“The device is on?” ~ P5

“Still off, but less brightness when you turn it on.” ~ P6

“Light is a little bit on” ~ P7

“Also on, but much less bright.” ~ P8

On automatic mode:

“All the lights are off” ~ P1

“It’s completely off.” ~ P3

“That’s off.” ~ P4

“It’s off” ~ P5

“It’s off and when you turn it on, it would start at the lowest.”~ P6

“Off” ~ P7

“It’s off”~ P8

“Is it supposed to turn off? Because I’m not sure what that means” ~ P2

Design suggestions

“When it is on auto, the lights should be somewhere on the circle. Why doesn’t it show me that? I might want to know that.” ~ P2

“When turning to get out of auto, it should start from the point that it was in auto. Otherwise I can’t see what auto means and I can’t learn how that differs from my settings.” ~ P2

“Long press does feel like it is changing a setting. Not really normal use. Generally, I would get the manual to do long press kind of stuff.” ~ P2

“Is auto the word you would like to use? It doesn’t show what the goal is of auto, with just that label. It’s about me as a user, not the system. This thing shouldn’t think for itself, it should just know what I want. A smart product would have its own opinion and would tell you to go to bed and turn off the lights.” ~ P2

“You could have two colors, one where you set it manually and the auto color. When I’m not on auto, it still could show you what auto thinks would be best. That could teach you more. For you this could be good, but for other people auto could be better.” ~ P2

“I like being able to see the individual LEDs” ~ P2

“I am also thinking about an interaction where you push and then turn. Like synthesizers. They make your movement a lot bigger when you press the knob and turn.” ~ P4

“You only need to learn one controller, so I think that’s very easy to learn” ~ P7

Scenario 4

Thus far, the usability explorations happened outside of any context that the participants could relate to. As the designs have improved and the previous tests have been successful in basic use, the device should be tested in context. This allows to test parts of the interface that require information from the environment, such as whether the lights are on or not.

In the previous test, the participants had difficulty with understanding what the dimmer displayed when it was in a “timed out” state. This means the dimmer has not been used for a while and disables some indicators to save energy. This test has built on the results of the previous test and also provides feedback with the lights.

“How do the participants interpret the indicators on the dimmer when they have feedback from the environment.”

Setup

Prototype

This test makes use of a new physical prototype, as can be seen in figures 41 and 42. Participants encountered both of these states during the test and interview.

Figure 41: The device when used for dimming.

Figure 41: The dimmer when auto is selected.

Environment

This test setup was back in the comfort lab at the IDE faculty. This room provided context, as the room had two lights that were attached to the dimmer. The dimmer was placed next to the regular light switch, which was taped off during this test.

Figure 43: The room with the dimmer on the wall.

Figure 43: The dimmer next to the light switch while in automatic mode.

Materials
To recreate a living room situation with testable parameters.

9. Raspberry Pi (with power and SD card)
10. Router (for local network)
11. Tradfri Hub
12. Tradfri lights
13. ESP8266
14. Dimmer V6
15. Light fittings
16. Ethernet cables

Participants
Non-enthusiast students at the IDE faculty.

Researcher roles
Quietly sit in the corner. Write shit down. Trigger stuff based on user behavior.

Methods
This test will measure how well participants can relate the change in the room to the interface of the dimmer. This will be measured in two ways: the time it takes for participants to complete the task and their interpretation of the dimmer interface. The first can be measured in time and the second will be measured using an interview after the test. The former is a quantitative measurement, whereas the interview afterwards will provide a qualitative insight.

Timeline

17. The participants are shown the living room.
    a. The room is quite dim
    b. The room has one bright light next to the couch
18. The participants are asked to get comfortable on the couch and given the following information:
    a. This room is a “smart home”, this means the lights are connected to a central system and the room automatically does things. This room does not have a voice control system.
    b. This is your space and you are the boss. If you don’t like the way your house behaves, you can correct it.
    c. All the items in this room are part of this test and are for you to use as you see fit.
    d. I will be sitting in the room, but I won’t respond to any questions.
    e. Please think out loud during the test.
19. The test starts and the participant is given the following information:
    a. This house is programmed to go in evening mode at 22:00. It is currently a bit before 22:00.
    b. When the evening mode kicks in, I would like you to change the house back to what it looks like now.
    c. Here are some fun books to keep you occupied until the evening mode kicks in.
20. The participant starts reading on the couch.
    a. Device is on auto at full brightness
21. The researcher triggers evening mode after a minute.
    a. Device is on auto, transitions to low brightness
22. The test ends when the light has been reset to the previous setting.
    a. Participant is supposed to turn the dimmer brighter
23. Interview of time out states
    a. Off, timed out
    b. On, timed out
    c. Auto, timed out

Insights

Using the dimmer in context gives enough information to understand the indicators on the dimmer

The indicators that non-enthusiasts would encounter when using the dimmer are well understood. This means that the hypothesis after previous test, that context would solve issues in understanding, was correct. Some very specific brightness did cause one participant to add additional meaning to the indicators.

> *"This means it's all the way on and it shows what brightness it is on." ~ P1*
>
> *"Is this light a preset? It shows the level of light. And I know the light is on." ~ P3*
>
> *"I think it's on, but it looks like daylight. There is a sun in the upper corner. Now I think it's off. This means it's the brightest. Now that I have seen the movement, I know it is not a sun. It's the brightness and it goes off to have less lights on." ~P2*

There is not enough information in context to understand the auto indicator.

Participants often though that the blue lighting would indicate some sleep mode. It is clear to participants that this state differs from the one they had been using before, but they cannot unanimously attribute the correct meaning. This might not be an issue, as the participants never reached this state by themselves.

> *"This is some automatic setting you made, like a previous setting you configured." ~ P4*
>
> *"I think it's in another state, but what that means… I have no idea." ~ P5*
>
> *"Maybe this is for configuring it. This is when you long press. Is this your standard brightness? One you use very often? Yeah I think that's it." ~ P6*

The dimmer is fun to play with

Participants mentioned enjoying using the dimmer. This was not something that was tested for, but this makes the researcher particularly happy.

> *"I want to keep turning it, it's very attractive!" ~ P1*
>
> *"I like the interaction! It's so nice! It's very friendly." ~ P3*

It was clear that the device was a dimmer to control lights

In some of the first explorations, it was found that participants had difficulty finding the device when it was not in an expected location. This

was the first test where the dimmer was controlling multiple lights and was placed as a light switch on the wall. Participants had no difficulty finding the dimmer and once they found it they were quite certain it was to control the lights.

> *"I see a knob here." ~ P2*
>
> *"Button with a light here!" ~ P5*
>
> *"As it's a smart home, I'm expecting a controller somewhere, I see something here." ~ P6*

When a light is not controlled with the dimmer, it is confusing
It is unclear which lights the dimmer controls and which it does not. When a light in the room does not change, it is unclear if something is broken or if that it was not made to change. This caused confusion for a few participants, but might hint at a potential future issue with the dimmer.

> *"Oh, was that one already on? Or did it stay on?" ~ P3*
>
> *"I would expect all lights to change brightness! Maybe you don't want your room to be entirely dark, so you can still walk around." ~ P4*

Concluding

This test ends a series of usability tests. Most aspects of non-enthusiast usage are confirmed to be universally understood. After this test decisions need to be made on what might be important to know for a more frequent non-enthusiast user. They will encounter auto mode more often, as well as certain lights that are not attached to the dimmer. This interaction might need to be further specified and made such that non-enthusiasts have knowledge and control over this.

Design data

Using the dimmer in context gives enough information to understand the indicators on the dimmer

"This means it's all the way on and it shows what brightness it is on." ~ P1

"I think it's on, but it looks like daylight. As in there is a sun in the upper corner. Now I think it's off. This means it's the brightest. Now that I have seen the movement, I know it is not a sun. It's the brightness and it goes off to have less lights on." ~P2

"Is this light a preset? It shows the level of light. And I know the light is on." ~ P3

"That means that everything is on. I think it's because otherwise you have the whole light ring on. That's a bit counterintuitive with smart and energy savings. If I turn it and wait a few seconds, I think the light will be there." ~ P4

"This means it is on, Oh and now it's all off. Before I had a little light on it, so it was easy to find. When it's dark, I would like to be able to find it." ~ P5

"I think it's in standby. I noticed that when I turned it showed more lights. This means everything is off." ~ P6

There is not enough information in context to understand the auto indicator.

"You think it would go automatically, but I am not sure. Maybe it stays on this brightness. No I don't know." ~ P1

"Some kind of sleep mode? Does this change with the amount you have? Automatically at 3. Maybe some kind of automatic setting you can set. Like a maximum brightness?" ~ P2

"I guess you can leave it on auto, you can simulate that someone is in the room like a timer. Maybe a sleeping mode or something." ~ P3

"This is some automatic setting you made, like a previous setting you configured." ~ P4

"I think it's in another state, but what that means… I have no idea." ~ P5

"Maybe this is for configuring it. This is when you long press. Is this your standard brightness? One you use very often? Yeah I think that's it." ~ P6

The dimmer is fun to play with

"I want to keep turning it, it's very attractive!" ~ P1

"Nicely prototyped!" ~ P2

“I like the interaction! It’s so nice! It’s very friendly.” ~ P3

“Very well executed!” ~ P4

It was clear that the device was a dimmer to control lights
“I knew it was a dimmer, but I did try the normal light switch first.” ~ P1

“I see a knob here.” ~ P2

“Aaaaah, I like it!” ~ P3

“I see something of a button there, but maybe I could do it from the table?” ~ P4

“Button with a light here!” ~ P5

“As it’s a smart home, I’m expecting a controller somewhere, I see something here.” ~ P6

When a light is not controlled with the dimmer, it is confusing.
“Oh, was that one already on? Or did it stay on?” ~ P3

“I would expect all lights to change brightness! Maybe you don’t want your room to be entirely dark, so you can still walk around.” ~ P4

Other data

“On my light I have something similar with filtering out the blue light. And it’s nice because it tells me to go to sleep. It’s a nice trigger in the dilemma of staying awake or going to bed.” ~ P3

“I like that I can see where I’m walking. The light is very cozy.” ~ P3

“Imagine doing this with kids: ‘Mom I want to go to bed!’, ‘The house is telling you, not me!’” ~ P3

“Maybe it would be better if the light transitions slower. A bit more gentle. So you avoid accidents at home when the lights go off immediately.” ~ P3

“It would be nice if you press it, it shows you are entering in a mode. With some lights? So you know you are changing modes.” ~ P3

“Knobs like this could also be useful for people who are disabled. Like blind people who can still see contrast.” ~ P3

“The faster I turn, the brighter it gets!” ~ P5

“Smart home you said, so then when I walk around the light would go on, right? But we end up at this button, that doesn’t seem very smart.” ~ P5

“Ah it seems a little bit slow.” ~ P5

“If I would buy this, it sounds expensive!” ~ P5

“With the last question, I was wondering how you configure your preferred lighting. Or is that not a relevant question?” ~ P6

“When you clicked it, is the first time I realized I could click the button. I just turned it. “ ~ P6

“For me everything is still by hand, I go around to turn on the lights.” ~ P6

“With two people who live in a home, you might have two automatic programs.” ~ P6

“It’s interesting that you configure your light in another place that you would normally turn it on.” ~ P6

Appendix G: Communication tests

The previous chapter turned the dimmer into a consumer product with a focus on usability at first use. This chapter continues the steps towards a consumer product, but now with a focus on understanding of the enthusiast user. This chapter explores how to explain the device, it's features and the responsibilities of the enthusiast user. The result of this chapter is a prototype that has addressed all novel or complex aspects of the dimmer.

Communication 1

Thus far testing was focused on the experience of the non-enthusiast. This test explores a design that helps an enthusiast configure the device. During this configuration, the enthusiast will need to learn all the features the device provides. This includes an understanding that their automations will be paused when it is used as a dimmer. Because this is the first design attempt, the research is rather open. This should allow for a wider range of input for a following design iteration.

Research questions
What do participants understand of the device's behavior after the configuration?

Setup

Method
The participants will be shown the prototype and explained that is a device to control smart lights in a smart home. The participants will be asked to complete the configuration, which has no supplementary feedback from lights or the device.

Participants
Participants were made into enthusiasts by providing them with more information. The participants were students from the IDE faculty.

Environment
This test was executed in the main hall of the IDE faculty. The participants sat straight in front of the researcher with the physical and digital prototype. This allowed all actions to be recorded, see figure 44

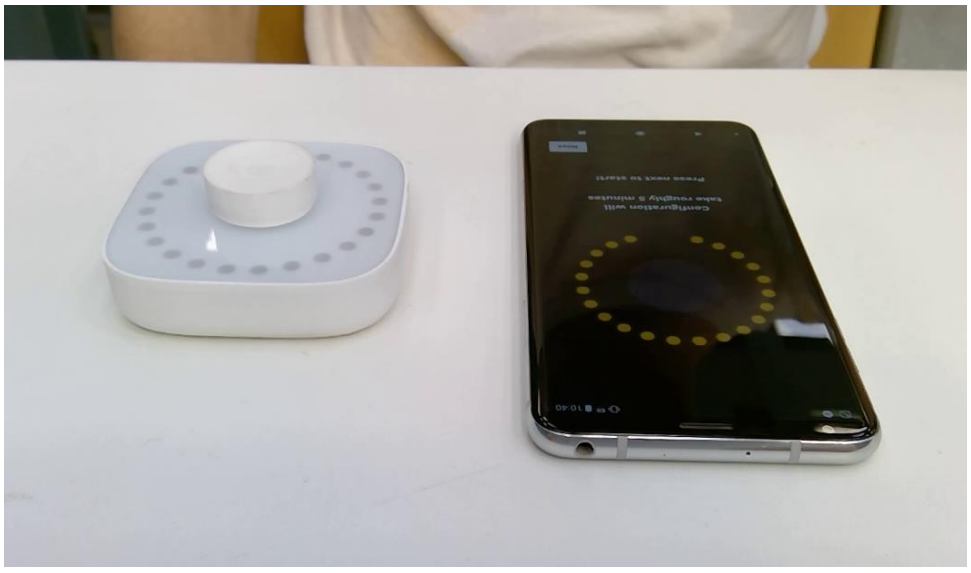


Figure 44: Left the physical prototype and right the digital prototype.

Materials

The digital interface was made to instruct the enthusiasts. Figure 45 shows two pieces from the configuration, left configuration of the defaults and right the teaching of controls.

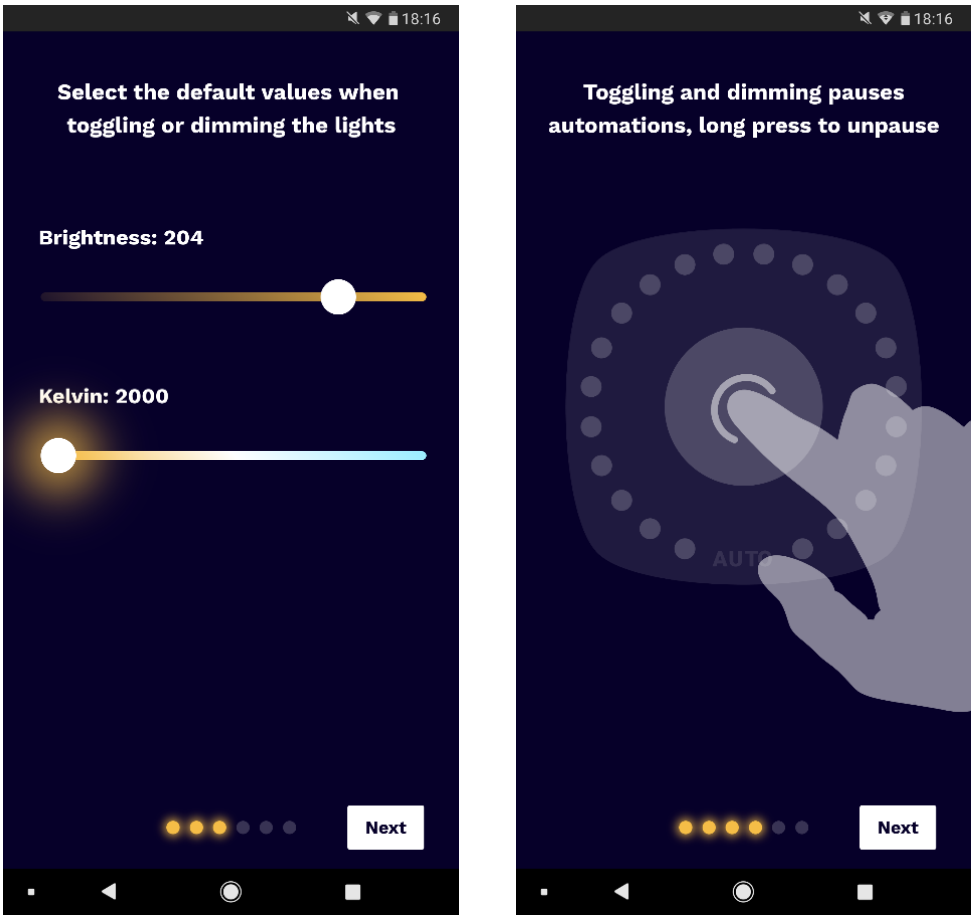


Figure 45: The digital prototype used for communicating principles to an enthusiast

Timeline

1. Thank you for participating:
    a. I would like to record the audio and the video of your hands for transcription purposes.
    b. First we're starting with demographics
    c. Then we're doing a test
    d. Afterwards we'll have a brief interview
2. Demographics
    a. Age / Nationality / Profession
    b. Any smart home products?
3. Test explanation
    a. This is a test for a device that controls smart lights in a smart home.
    b. This is your smart home and you are configuring the device during this test.
    c. Your house has all kinds of lights, sensors and automations which you configured in the past. These will come back in the configuration.
        i. Examples of automations
    d. The configuration has dummy data, so you can fill it in as you please.
    e. When the configuration asks you to use the physical device, you are allowed to press next when I confirm you have done it correctly.
4. Test instructions
    a. Select any network
    b. Select two lights in the living room
    c. Select maximum brightness and lowest kelvin
    d. Select all in the living room
    e. Control the reading light
    f. Configure no custom trigger
5. Questions:
    a. Could you explain what happens when you click the button?
    b. Could you explain what happens when you long press and turn?
    c. Could you give a summary of the features the device has?

Insights

Explaining the device behavior was insufficient
Participants had difficulty understanding more than the dimming and toggling behavior. The concept of automations being paused was understood by just one participant, which is not sufficient. This is likely the result of a lack of feedback, the many steps during configuration and unclear copy.

> *"I'm not sure what I just did." ~ P2*
> *"When I press the button it goes on, I think. Didn't stick." ~ P5*
> *"I don't know why automations are paused. I don't understand." ~ P6*

Participants had no difficulty choosing configurations
When participants were asked to select brightness or the color temperature of the lights, they had no troubles doing so. These names and sliders required no explanation or introduction of use. Pressing and turning was also easy to do for participants, though understanding what control options there were was a more difficult.

> *"I live in a slightly darker home than normally, with quite warm light" ~ P3*
> *"I guess these are the values it jumps to when you turn it on. Not too bright and a bit warmer." ~ P6*
> *"Then it controls the light I just configured, I forgot the name it had though" ~ P2*

The animations helped participants learn to control the device
Even though participants had difficulty understanding why they were completing certain tasks, they had no trouble executing them. The animations provided a clear example of the movements they were supposed to make.

> *"I do know which controls the device has, that was helpful." ~ P1*
> *"I am now long pressing it, but I am not quite sure why." ~P3*

Participants had difficulty understanding some copy
There were participants who read very little and they missed important steps during the test. This is probably caused by text that all had the same importance and they did not read all of it. Using words in the interface that already have meaning in the context of smart lights also caused misdirection. Additionally, the participants had good questions that the copy did not answer.

“What is the name of the device? I think I need it. I’m not sure what device I have to select” ~ P1

“Hmm Hue control I think has to do with those Philips lights” ~ P2

“It’s a bit weird you can’t select this default for every light separately. It seems like this is the same for all lights now” ~ P4

Participants needed more context during the test

Lack of context was planned, but the participants still needed more to understand things that were not being tested. The participants needed an explanation of the automations to confidently continue the test.

“I don’t know what these automations do” ~ P1

“Reading light? How would it know I am holding a book?” ~ P3

Design suggestions

Because this test was conducted with design students, they provided many valuable insights during the interview afterwards.

“I would like to see live reactions of the light when configuring” ~ P1

“Tell me it is a light switch first! And then tell me about the extra features, then I don’t have to learn the light switch part.” ~ P2

“Maybe you could explain it with a gif, like in some other apps.” ~ P5

“Why don’t you call it overriding or overruling the automations? Now I am above the settings.” ~ P6

Concluding

This test provided the clear insight that the device’s features are complex and explaining them needs tweaking. Because the participants have no trouble configuring the device, this can be removed from the introduction. This will make the introduction shorter and leaves more space to explain how the device behaves.

For the next iteration the exact information required needs to be distilled and should turned into more succinct copy. Questions asked during this test should not come back in the next iteration. Additionally the test needs more context, to make sure the participants don’t struggle with the lack of information.

Design data

Participants generally did not understand what it meant to long press the device, nor did they understand that automations go off when using the dimmer normally

"I want it to do sunlight automations. Huh, I can do multiple, how does it know which automation I want? ~ P1

"When I press the button, it goes on." ~ P1

"I'm not sure what I just did." ~ P2

"I want them to go on when I'm here" ~ P2

"When pressing the button, I'd think something would go on. Probably the light goes on." ~ P2

"When I do something myself, the presence automation should go off. I don't want lights to go off when I turned it on manually, when it thinks I'm not there" ~ P3

"When I press the button, it pauses the automations, I think. And then I need to long press to turn on the automations again." ~ P3

"I am not quite sure what this is supposed to mean at the moment. Purely based on the text." ~ P5

"When I press the button it goes on, I think. Didn't stick." ~ P5

"I think the long press was a shortcut to trigger something." ~ P5

"Apparently it's on pause right now" ~ P6

"I don't know why automations are paused. This I don't understand." ~ P6

Participants were able to understand and remember press and turn fairly well

"Then it controls the light I just configured, I forgot the name it had though" ~ P2

"I'd want to control the ceiling light, that seems useful to me." ~ P3

"I configured it for color temperature, so I am guessing it will get warmer or cooler when I am turning it." ~ P4

"Not sure what it means. I didn't understand it before either." ~ P6

Participants asked many meaningful questions that could not be answered from the interface

"Is this for controlling ALL my lights?" ~ P1

"I'm not sure what toggling is and if that is the same as dimming" ~ P2

“It’s a bit weird you can’t select this default for every light separately. It seems like this is the same for all lights now” ~ P4

“I think I can control separate lights with this, but without the app I would have never found out.” ~ P6

The animations during the configuration were sufficient for the participants to learn all the interactions
“I know do know which controls the device has, that was helpful.” ~ P1

“I am now long pressing it, but I am not quite sure why I am doing that” ~P3

Participants understood configuring brightness and warmth of the lights
“I don’t like very bright light and I want it a little bit warmer” ~ P1

“I want it a bit warmer” ~ P2

“I live in a slightly darker home than normally, with quite warm light” ~ P3

“This is the brightness, which I want a bit more. And this is the warmth, which is fine.” ~ P4

“I guess these are the values it jumps to when you turn it on. Not too bright and a bit warmer.” ~ P6

Participants liked the feeling of the knob
“Oh, that feels, quite okay” ~ P1

“beep bop beep, fun!” ~ P2

Using the word hue in combination with lights is strongly linked to the Hue products and should not be used.
“Hmm Hue control I think has to do with those Philips lights” ~ P2

Some participants read really carefully, some read nothing at all.
“What is the name of the device? I think I need it. I’m not sure what device I have to select” ~ P1

“This sentence I don’t understand” ~ P4

Methodology results

Participants needed more context to fully understand the configuration. Lack of context was planned, but they still needed more.
“I have no idea what a floor lamp is. I know reading light. Philips Hue has reading mode in the app.” ~ P1

“I don’t know what these automations do” ~ P1

“Reading light? How would it know I am holding a book?” ~ P3

“Probably if I had the lights I could see what happens, but I’m not sure I did it correctly” ~ P3

“Is the button connected or should I just continue?” ~ P6

Design suggestions

“I’m not sure I would want to do this entire configuration at the start. I would just want to start using it. And then configure more later. You don’t know exactly how you’ll use the lights.” ~ P1

“I would like to see live reactions of the light when configuring them” ~ P1

“Maybe the specific automations could have animations with what they do?” ~ P1

“Tell me it is a light switch first! And then tell me about the extra features, then I don’t have to learn the light switch part.” ~ P2

“I had this game controller with extra buttons that you could program. I never really used them, until one of the normal buttons broke. Then I programmed it to be that button. But it was much easier to just not use the extra buttons.” ~ P3

“Hmm, no feedback if I did that correctly” ~ P4

“I thought it would be one device that controls lights in all the rooms, like one of those smart thermometers” ~ P4

“Do you always have to long press it to **reset** the automations, or does it enable them at midnight again?” ~ P4

“Maybe you could explain it with a gif, like they do in some other apps.” ~ P5

“Why don’t you call it overriding or overruling the automations? Now I am above the settings.” ~ P6

“I like the idea that you can just say. Stop. No.” ~ P6

Communication 2

The previous prototype aimed to guide enthusiasts through the configuration of the device and teach them how to use the device. During testing it became clear that participants have no trouble selecting configuration, but they did lack understanding. The new design ditches most of the configuration and focusses on understanding of the device. This test will also provide more context to the participants, which should improve their confidence in understanding.

Additionally the new design will not just educate the participant on the behavior of the device, but also their responsibilities when installing the device. This regards how they should use the information the device gathers while it is in use. This provides the test with three very specific research questions.

Research questions
To what degree do participants understand that automations are paused when they use the device as a switch or dimmer?

To what degree do participants understand their responsibility to make use of usage insights for the improvement of their automations?

How confident are the participants in their understanding of the device?

Setup

Method
The participants will be shown the prototype and explained that is a device to control smart lights in a smart home. The participants will be asked to complete the configuration, which has supplementary feedback from the environment and the application itself.

This test measures the comprehension of their responsibilities, their understanding and the confidence in their understanding. Their comprehension will be measured using interview questions, their confidence will be measured by analyzing how they answer those questions. Any interesting remarks might result in an open interview.

Participants
This test makes use of 10 participants, which are not necessarily enthusiasts, but are tech-savvy.

Materials

This test also makes use of a digital and physical prototype, see figure 46 and 47. A live version of this prototype can be found at: http://graduation.emilflach.com/config

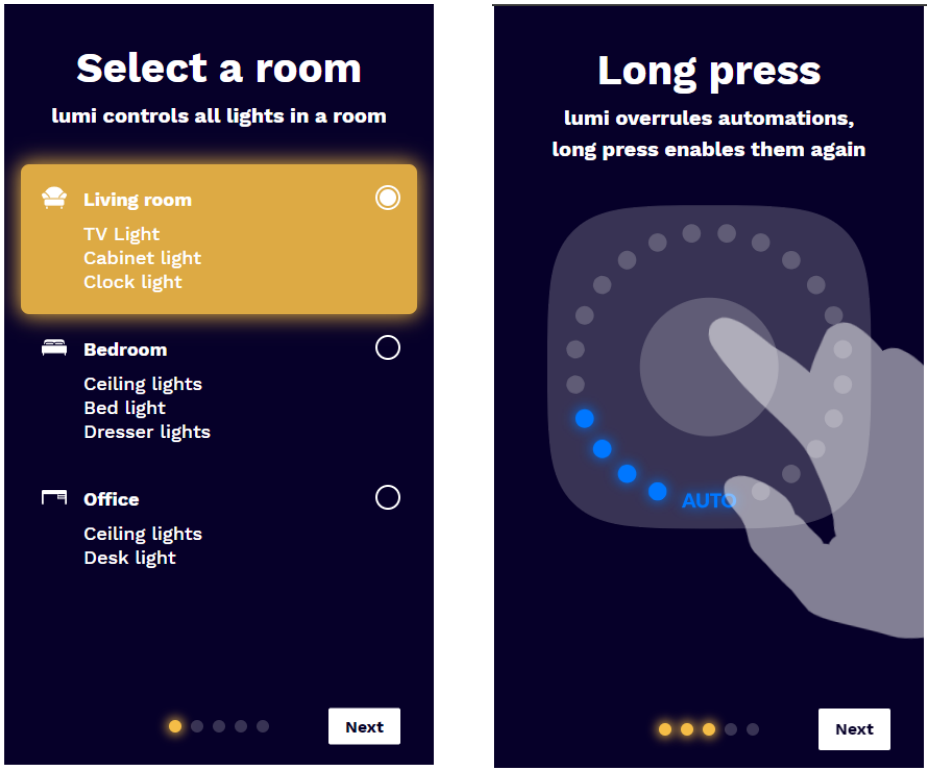


Figure 46: Left shows a more clear way of selecting which lights the device controls. Right shows a refined instruction to control the device. Copy has been improved to have a better call to action.

Figure 47: The physical prototype used for this test.

Environment

This test was conducted in the comfort lab. Figure 48 and 49 show the setup, similar to the other usability and communication setups.

Figure 48: The test setup with a participant learning to use the device for the first time.

Figure 49: The view from the camera and the researcher.

Timeline

1. Thank you for participating:
    a. I would like to record the audio and the video of the room.
    b. First we're starting with demographics
    c. Then we're doing a test
    d. Afterwards we'll have a brief interview
2. Demographics
    a. Age / Nationality / Profession
    b. Any smart home products?
    c. Do you easily get excited about technology?
3. Test explanation
    a. This is a test for a device that controls smart lights in a smart home.
    b. This is your smart living room and you are configuring the device during this test.
    c. Your house has all kinds of lights, sensors and automations which you configured in the past, these will come back in the test. This room has:
        i. When you enter the room, lights go on
        ii. Light transitions with brightness outside
        iii. When you watch TV, the lights dim a bit
4. Questions:
    a. Could you explain what happens when you click the button?
    b. Could you explain what happens when you long press?
    c. Could you explain what the device aims to help you with?
    d. Could you give me a summary of the features this device has?

Insights

Participants understood the behavior of pausing automations

With the new design, participants were able to fairly consistently explain what happens when they controlled the lights manually and how they could make the system automatic again. One non-enthusiast, got the behavior correct, another non-enthusiast thought the system worked in the opposite way.

> *"You can turn it on/off, dim it, that is in manual mode, to get back to automatic mode, you long pres." ~ P1*
>
> *"The main thing is control lights. You can do it manually. You can also hold the button and set it to self-adjustable mode." ~ P2*
>
> *"I guess you turn on the automations when you long press. And turn them off when you do a short press. That's what I think." ~ P4*

Some participants understood the insights, however the page was overwhelming.

It was clear to most participants how the insights related to the usage of the device. However, most participants figured that the system would adapt itself to solve the issues find through insights. Overall this is not universally understood and only two participants see their responsibility in using these insights to improve the system themselves. Additionally, participants found the amount of information on the insights page overwhelming.

> *"It makes it easier as long as the automations work. And then you can use the insights to improve them. The better you configure the automations, the less you use the device. You just don't need it at some point." ~ P5*
>
> *"This was very confusing to me, it was a lot of information! I didn't know this was an example." ~ P1*

Participants were generally confident in their understanding

All participants were confident in their explanations. Most participants went through the test in similar times and gave all their answers with little doubt. Enthusiasts P1, P2, P3 and P5 all completed the task within 50 -77 seconds. Whereas non-enthusiast P4 and P6 took 214 and 83 seconds respectively. Participant 4 had more doubt, as they did not know what overruling meant. This caused them to slow down a lot and to doubt their answers.

> *"Hm. This I don't really understand. Lumi overrules automations. I can ask this right? What does overrule mean? ~ P4*

There was less confusion about specific device behavior
The improved copy answered all questions that participants had in previous tests. For example, none of the participants asked which lights the dimmer controlled. This was also more obvious because the lights changing in the environment reflected this. Two participants did have a new questions, which was whether the device went back to automatic mode by itself.

> *"Does it turn back to automatic mode after some time?" ~ P1*

Participants enjoyed using the device a lot
During testing many participants mentioned enjoying using the device. They specifically mentioned liking the animations and praised the ability to play with it.

> *"I like these animations, like here. Double press? Oooooeh!" ~ P2*
>
> *"It's really clear in usage, and it has one button. With a bit of playing, you can get here without the instructions," ~ P3*

During the test there might not have been enough focus on answering the research questions.
Some participants didn't mention parts that were required to answer the research questions. This could have been more deliberately asked for during the open interview part. This was a missed opportunity.

Concluding

The design iteration and test focused a lot more on teaching the device mechanics. This focused paid off and many aspects have improved drastically. The role of the enthusiast and how to use the insights still needs improvement, as participants were expecting automatic improvements.

Confidence of the participants was also greatly improved, which strengthens their positions as enthusiast. Alongside this confidence, the participants also enjoyed using the device, which is an important sign of their acceptance. The participants did have specific questions about the behavior of the device. These questions should be answered, but maybe not during the introduction. Another iteration should deal with these unknowns and where they could be answered.

Design data

Participants understood the behavior of pausing automations quite well. One participant did describe the opposite of how it works.

"I am able to change this manually, but when I long press, the computer will take over." ~ P1 (4:05)

"You can turn it on/off, dim it, that is in manual mode, to get back to automatic mode, you long pres." ~ P1 (4:55)

"Switch to, automatic, automation mode. The lights are self-adjustable." ~ P2 (3:44)

"The main thing is control lights. You can do it manually. You can also hold the button and set it to self-adjustable mode." ~ P2 (4:58)

"With long press it goes to your pre-selections, your programmed system." ~ P3 (3:50)

"I guess you turn on the automations when you long press. And turn them off when you do a short press. That's what I think." ~ P4 (5:00)

"Long press can overrule automatic values. Which is when you're watching TV and you don't want it like that, you can go overrule it." ~ P5 (4:25)

"Short press, it turns on and off. Long press it activates the automations. Right now it's daytime/nighttime, whether I'm inside or not and I guess the Chromecast is connected because it automatically dims when the TV is on." ~ P6 (3:30)

The insights page had an overwhelming amount of information, this made it difficult for all enthusiasts to understand what it was for.

"Basically, these devices. They are smart, but not that smart. They don't allow for improvisation. This allows me to overrule that and hopefully train the system behind it to be more adaptive to me." ~ P1 (4:22)

"It gives you insights in the app, to help you train the system." ~ P1 (5:15)

"This was very confusing to me, it was a lot of information! I didn't know this was an example." ~ P1 (11:10)

P2 did not mention the insights at all.

"You can configure programs that are automatic and at the same time it's trying to learn from your behavior. I'm not sure if it automatically adjusts itself. But I would expect that." ~ P3 (4:05)

“Automatic depends on sunlight, and something about movie mode. Not sure what I read there” ~ P4 (07:31)

“The device tries to help be a middleman between full on automations and regular switches. Maybe a friend is over and you quickly want to adjust it and just to have a physical button. Could be in a party and you can’t use google voice, so then you can still use the button.” ~ P6 (3:50)

There was a difference in speed and confidence between enthusiasts and non-enthusiasts.
P1 is an enthusiast and took from 2:20 until 3:35 to complete the test, 75 seconds

P2 is an enthusiast and took from 1:55 until 3:12 to complete the test, 77 seconds

P3 is an enthusiast and took from 2:15 until 3:19 to complete the test, 64 seconds

P4 is a non-enthusiast and took from 2:45 until 6:28 to complete, 214 seconds

“Hm. This I don’t really understand. Lumi overrules automations. I can ask this right? What does overrule mean? ~ P4 (3:40)

P5 is a non-enthusiast and took from 2:35 until 3:58 to complete, 83 seconds

P6 is an enthusiast and took from 2:20 until 3:10 to complete, 50 seconds

It was clear to the participants which lights were controlled with the device. There were no questions about this, unlike the previous test.

Participants wondered if the device went back to automatic mode by itself.
“Does it turn back to automatic mode after some time?“ ~ P1 (8:22)

“It doesn’t jump back to automations, right?” ~ P3 (7:07)

Participants enjoyed using the device a lot
“Nice feel by the way!” ~ P1 (4:15)

“I like these animations, like here. Double press? Oooooeh!” ~ P2 (5:28)

“It’s really clear in usage, and it has one button. With a bit of playing, you can get here without the instructions” ~ P3 (6:35)

“Looks good, nicely made.” ~ P3 (8:15)

“It’s cool, I like it!” ~ P6 (6:55)

Design suggestions

“She has priority, because she is in the moment right now.” ~ P1 (7:28)

“One thing, when it times out, the first time this was a bit confusing. Is it on or on the lowest setting?” ~ P1 (9:19)

“So you need to have the cable?” ~ P2 (7:40)

“Maybe it’s a bit much for one screen, you normally see one image per screen.” ~ P5 (7:50)

Methodology results

Some participants didn’t mention the insights at all, this was a missed opportunity to not question them about it.

During the test there might not have been enough focus on answering the research question about responsibilities