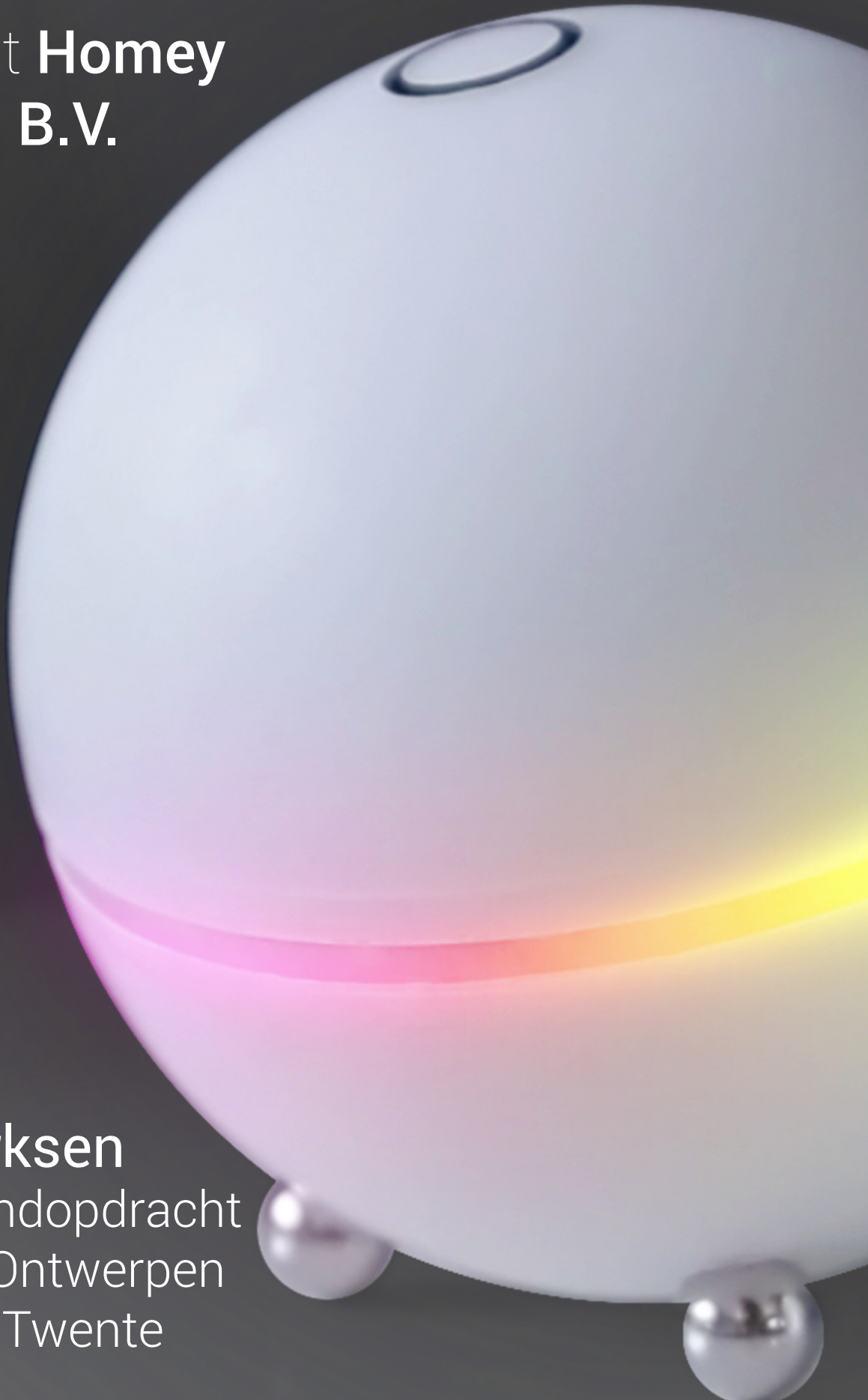


User Interface User Interaction **Design**

For project **Homey**
By **Athom B.V.**

Datum:
22-04-2015

By **Ivo Derksen**
Bachelor Eindopdracht
Industrieel Ontwerpen
Universiteit Twente



Interaction and user interface designer for:



Openbaar

Vanwege professionele redenen is een klein deel als confidentiële bijlage opgenomen. Op aanvraag bij het bedrijf is alles te bekijken. Zonder het gedeelte is het gehele traject ook voldoende zichtbaar.

Dit verslag is geschreven in het kader van de bachelor eindopdracht voor de bachelor Industrieel Ontwerpen.

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Homey

Syllabification: **hom·ey**

Pronunciation:

Definition of homey in English:

adjective (homier, homiest)

- (Of a place or surroundings) comfortable and cosy: a **homey** atmosphere.
- Unsophisticated; unpretentious: 'an idealized vision of traditional peasant life as simple and **homey**'

noun (plural homeys)

- Variant spelling of **homie**.

Urban Dictionary

Homey

Syllabification: **hom·ey**

Pronunciation:

Definition of homey in the Urban Dictionary:

- Originating from the word home boy. People you grew up with. Trusting them and having faith in them.

Related words

4 WORDS RELATED TO HOMEY

- friend
- homie
- bro
- buddy

Hom-ey or home-y ?

My bachelor assignment is conducted for a company called Athom. Maybe you've heard of it? It's the first Dutch company who created a successful Kickstarter campaign.

Athom has created a product called Homey.

A small globe, who will be your companion around the house, packed with a lot of power and features. It will be your house companion, as you can see on the left page, it is your friend in your comfortable and cousy house!

The Homey was introduced in May 2014. Introducing a product which is capable of controlling your home, apparently was very appealing for the current market. Using Kickstarter, this project achieved its funding goal, but the goal was achieved in 3 days and after 30 days, the goal was more than doubled, which was a very pleasant surprise.

Homey is created to make your life easier.

With great honor I can say that I have also contributed a part to this great project!

A perfect opportunity to see a company realizing a dream they once had. For an Industrial Design student, this company attributed a lot to my existing knowledge. Partaking in milestone meetings and interacting with colleagues created great insight on multiple aspects of this great project.

I'd like to thank all colleagues of Athom and the neighbours at Printr, and I'd like to thank Fjodor van Slooten and Myrthe Lagrouw who helped me guide this project to the finishline.



Een opdracht uitgevoerd voor Athom, waarbij er gevraagd werd naar een user interface en user interaction designer. De taak was het creëren van elementen voor de mobiele applicatie die bij de lancering wordt gelanceerd. De opdracht is uitgevoerd door een analyse fase met daarin enkele goede stappen te doorlopen. De Homey en de stijl van Homey zijn onderzocht, waardoor er in een uniforme stijl wordt ontworpen.

Het ontwerpen voor het scherm is relatief nieuw. Door goed onderzoek te doen naar het touch, schermen en interacties ontstaat een goede basis. Hieruit blijkt dat een doorgaans vrij grote mobiel wordt gebruikt, van ongeveer 5", met een capacatief scherm. De ergonomie op een dergelijk groot scherm is onderzocht door middel van maten, en het simuleren van optimale gebieden van de duimen over het beeldscherm van de gebruiker. Het originele visuele prototype is onderheven aan een heuristische evaluatie. Hieruit blijkt dat er al een goed concept staat, maar er zijn punten ter verbetering. Onder andere feedback, gesloten actie aanduiden en het aanbieden van ongedaan maken en voorkomen van gevaarlijke situaties moet verbeterd worden.

Tijdens de idee generatie worden ideeën bedacht de fysieke en voor de interactie met het scherm. Het mom van de applicatie is zo veel en zo krachtig mogelijke functies te verwerken. De applicatie zal verder ontworpen worden op het idee van kaarten met informatie. Het oogt rustig, bevat veel en kan mogelijk als nog meer dienen. Zo zijn er 2 kaarten verscholen achter de kaart. De kaart kan uitklappen en vergroten, of naar rechts gaan en meer opties bieden naast de gewone kaartje.

Tijdens de conceptfase zijn de ideeën verder uitgewerkt en zijn ze visueel, trouw gemaakt aan het te bouwen ontwerp, met parameterisering.

De concepten zijn vervolgens vertaald naar HTML, CSS en JavaScript code. Deze zijn werkend en zijn verwerkt tot een Hi-Fidelity prototype. Het Hi-Fidelity prototype is daarna getest doormiddel van een gebruikstest. De resultaten laten zien dat een ogenschijnlijk ergonomische menu niet geprefereerd wordt boven het oorspronkelijk menu.

De tijd widgets die zijn uitgewerkt tot functionele prototypen zijn uitgewerkt en getest vallen goed in de smaak. De circular widget is herkenbaar en goed bruikbaar, echter word de grote versie veel meer geprefereerd. Er is een duidelijk leer over effect merkbaar, de interface is vrij snel onder knie te krijgen. Behalve het verstoppn van functies achter een andere widget of 'card', dat roept soms vragen op en is dus meegenomen naar het herontwerp. De concepten zijn verder uitgewerkt en op basis van de resultaten verbeterd. Door de gegevens van de test en de heuristische evaluatie worden nog verbeterpunten meegenomen.

Er is een Design Guide for Developers gemaakt, op basis van deze widgets en elementen.

Als laatste stap zijn de elementen gerankt tegen de design brief en is er een heuristische evaluatie uitgevoerd. De resultaten die hieruit voortkomen zullen leidend zijn als aanbevelingen voor het gebruik in de interface van Homey.

The bachelor assignment was performed for the company Athom. An option for User Interface and User Interaction designer was available were it was possible to design elements for the interface of the mobile application of Homey which will be released at the near launch.

In the analysis phase the Homey, its working and the style of Athom are analyzed. By analyzing the style a style is created which would connect to the style of Homey.

Designing for the screen is new, therefore an analysis for devices, screentypes and screen sizes has been conducted. The elements will be designed for a 4.8", capacitive smartphone. The screen is relatively big, and the interaction will also be tested for ergonomic aspects. The user will control the Homey mostly via one hand, or a cradled hand. Both have other optimal areas of use.

The original visual prototype is subjected to a heuristic evaluation. It appears the concepts chosen, already scores really high for a visual prototype. Points to work on are informative feedback, provide yield closure and offer error prevention or reversal of the actions.

During idea generation the ideas of physical interfaces and application interfaces are being generated. The application must be as versatile and powerful as possible, with remaining simple and user friendly. The application will be built using the ideology of Athom, regarding the interface. Navigation through devices placed on cards. The application has a clean and easy to handle look. Beyond the card, a structure of cards is created. A card is used as window, behind which there are two other cards. A card on the right, providing extra space for shortcuts. The card can be extended by dragging the card down.

During the concept phase the ideas are detailed a lot more and parameterized. Detailing is firstly done visual. But after research the concepts will be translated to pure code.

Created via HTML, CSS and Javascript the concepts are visualized and built as a Hi-Fidelity concept. The Hi-Fidelity prototype is created with variations of a navigation menu - Multiple more ergonomic and thus faster

(hypotheses) menus were designed.

Widgets for setting time have also been varied through the test participants. A big circular time widget, a timeline and a small circular widget were used. The circular widgets were both received well, possibly because of the recognition. The timeline was a little harder, since it featured more options.

The results based on the user test were varied. A carry over effect can be seen and the interface is pretty fast in control. The menu which was preferred was the menu which causes the most strain on the thumb, which seemed illogical. But maybe it is habitual. The time widget that was preferred by the users was the bigger time widget. More easy and accurate input. The users had issues with functions being placed behind other widgets, without hints, after first experience, they understand better, but are still complicated with this issue.

The concepts have been, where needed, redesigned to meet with the results of the test and wishes of the users.

The concepts and redesigns have been collected in the Design Guide for Developers.

Finally the elements have been ranked to the design brief and have been tested via a heuristic test by Athom and myself. The results concluded from these tests are being presented as recommendations to the team of Athom.



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1.1 ATHOM

The assignment is for the company Athom BV. Athom is a startup company of two graduates, who are creating a smart product called Homey. The idea of Homey was introduced in May 2014. The vision is creating an easy to use product, which can communicate with almost any product at home. Apparently this was very appealing for the current market. Because, using Kickstarter, this project achieved its funding goal in three days. And it also doubled the initial goal after a month. Homey stands out to the market today, because it is a next level in smart products in creating a smarter home. Nowadays the two founders are working to make Homey a real product. Because this is a lot of work the team is rapidly expanding to help Homey get to the consumers.

The Homey is mainly focused on the users. So the interface has to be kept as simple as possible. Therefore, Homey is equipped with speech recognition. For more functionality, additional interfaces will be created, namely a mobile application and a web interface. The assignment is focused on creating part of the interface and to realize controllability of the interfaces via the mobile phone. The goal is that the interface will work fast and simple. But it also needs to be able to provide enough information and control all devices in an efficient way.

1.2 HOME AUTOMATION

Home automation, for some people a wish that is far away, for some available with the boundaries of their knowledge and some hardware components. A student once could not shut down the lights from his bed. He dreaded that feeling and felt like that had to change. Like in the Star Trek series, he'd love to talk to his room to shut down the lights.

As aspired, this hobby project saw the light of day soon. And more and more functionality was added. Since wireless switches of the action are not so expensive he bought a few, and found a way to connect those as well. Start Trek dream was getting more and more real..

The people around him were starting to noticing his project and were becoming interested. This was when the idea of a consumer product first saw light.

But with the trends on the current consumer market, the availability of high and low range home automation products, he saw an entry time. Together with Co-Founder Stefan Witkamp, Emile Nijssen started Athom, to Kickstart their idea.

The house automation products are entering the market in a rapid pace, the old companies have to innovate and the problem of limited connectivity is were Homey is exceeding on the market.

1.3 MOTIVATION OF THE PROJECT

My feelings towards the vision of home automation were very positive, the amount of attention and the technology pushed in a great looking product also grasps me.

Since I personally know Emile, I had a chance to come over and talk for an internship.

Help was always welcome, creating new insights in the user interface are good to have and can be used for development of the Homey mobile application.

I was on board with the task of user interaction designer. Design elements and interactions which are pleasant for use with a smartphone.

1.4 PROJECT FRAMEWORK

The frame of the assignment was aimed to fulfill user interaction and user interface design.

Creating elements, widgets and analyzing interactions for the future Homey mobile application.

The results of this assignment will be summarized in a Design Guide for Developers. A base for elements of the mobile application, and a guide for developers to create uniform looking applications for Homey.

1.5 PROJECT GOAL

Supporting the team of Athom as an Interaction Engineer and User Interface Designer.

Building an interactive prototype to create user tests

with. The result of the assignment will be a document with Design Guidelines for Developers containing widgets and interactions

Predefined widgets with tweakable parameters

1.6 READING GUIDE

This report consists of multiple phases which have been taken during the assignment.

A small reading guide, which describes what is being treated where.

Analysis, where the company, competition, market and important factors are being analyzed. Designing for the screen is new and researched and the current design is tested.

Idea generation, where ideas are created for improvement of the current design. Elements and placement are sketched and visualized.

Concepts and realisation, where the ideas are visualized with more parameters and are made ready for the screen. A user test is conducted and the interface is tested by Athom and myself.

Design Guidelines for Developers, where the elements are combined in guidelines which can be used for developers, building a uniform application and experience for the Homey application.

Conclusion, where the results are summarized and recommendations are being done for further development. Evaluation, where the assignment and progress is evaluated.

Appendix, with a list used during the assignment.

Online appendices, are available via the given links in the appendix list as well as the other appendices.

List of sources, used during the assignment.

CHAPTER 1

Analysis

INTRODUCTION

During the analysis of the project, the Homey will be introduced; what can a Homey do, how does Homey work. Then the interfaces Homey currently has are being discussed.

An investigation will be done to these interfaces, the physical interfaces (audio and LED ring) and application specific interfaces. The style will be analyzed and from then on a broad market analysis will be held, where the target group, competitors and the home automation market are being investigated. Because the assignment focuses on a mobile application, there will be an analysis for screen optimized designing. After the current situation is evaluated, a design brief will be formulated.

1.1 INTRODUCTION OF HOMEY

Homey broadens the vision of home automation. It is a device unlike other in its existing segment. It combines the use of home automation products, such as lights, blinds and thermostat with the future technology (oven, refrigerator). It is also combined with entertainment in this system and older wireless frequencies. Homey is actually expanding the smart home, by combining all popular protocols, and ensuring connectivity and usage via one product.

What Homey is bringing to market is a new interface between these devices. Using speech is the most natural way for an input. Which, with support for all (primary launch) languages, will be used to give Homey simple commands. This way of input is very intuitive, yet is still emerging. For more functionality additional interfaces will be created, namely a mobile application, a web interface and a more advanced web interface. Homey has hardware components that can give interactive feedback: a LED ring and audio output (if possible over a nearby speaker). This simple interaction and feedback must also take place in the applications of Homey.

Functions of Homey

Homey will be a companion of the house. The strong part of Homey is a community driven product. Where big brands usually make a product supporting their own products, e.g. Sonos created a Sonos Bridge. There is Homey a stand-alone product with the capability of controlling various devices. When the manufacturers have an open protocol or provide the protocol for Homey to work with. The Homey hardware is carefully selected and will support eight wireless modules as seen in figure 1.

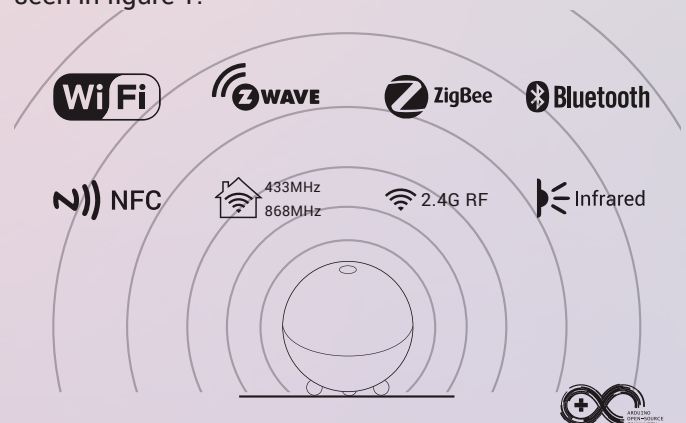
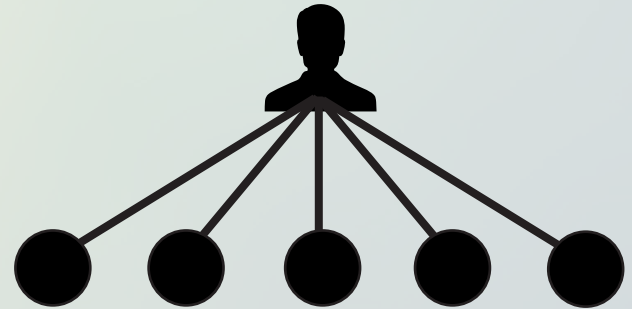


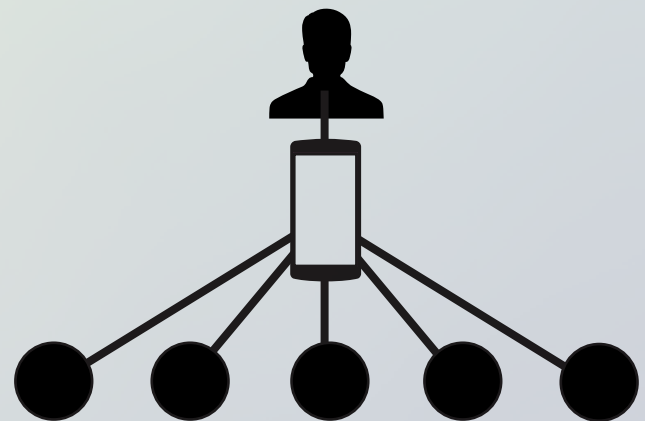
FIGURE 1: Eight supported wireless modules

Homey is able to communicate on all these frequencies. So if the user has an appliance which is smart and can be controlled via a remote or a smartphone, Homey can replace the remote and the smartphone application.

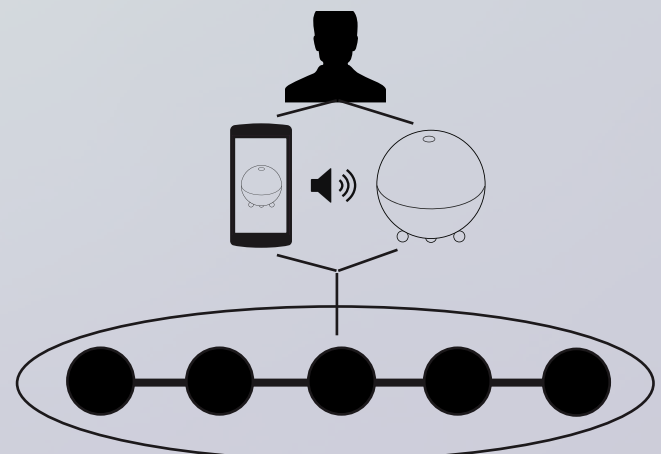
To clarify what Homey can do, an illustration is made to visualize the idea, Homey as home controller seen in figure 2. Imagine a house with entertainment set, Hue lights and smart oven. In situation 1, the user has to walk to every device and set each device. In situation 2, where the devices are upgraded to smart devices, the devices can be controlled using the smartphone. This variety of devices by different brands are controllable using their own application on the smartphone. In situation 3, the user also has smart devices. Using voice or the Homey application, all devices can be set. No switching applications. An overview of all devices is shown in just one application.



Situation 1: The user needs direct physical interaction with the devices.



Situation 2: The user needs to physically use a phone with device specific applications



Situation 3: The user can interact physically via the Homey application or by speaking to the application or the Homey itself

FIGURE 2: Three situation of controlling devices.

Working of Homey

The ideal solution would be Homey controlling everything according to wishes of the user, and not having to setup anything and just get all the information a user would want. This would require an AI, Artificial Intelligence, which is a feature the team of Athom would like to implement and is currently working on.

So the ideal solution is not possible yet, but that does not mean Homey does not work. When the user would like to change any 'setting' of its house, the user can interact with Homey. Interaction with Homey means talking to Homey or controlling Homey via a smart-phone or other devices such as a tablet or a PC.

The diversity in supported hardware and the diversity in control means Homey is a very scalable product. If a product is controlled by one of the seven wireless techniques seen in figure 1 and 3, the product is theoretically supportable. But because of the large products that are available working on these wireless techniques, the team cannot build all device support, currently seen in figure 4. That would simply be too many work. Therefore Athom let the people be involved with the project. It is possible for users to create support for their own devices. This way Homey can support virtually every device. Integrating people in the project is done by creating a community driven platform. A place where people can share their preference files, automation (flow editor) files, but can also share their own made applications, and do it yourself accessories designs for Homey.

The power of Homey is its high connectivity, realized by the high number of wireless modules. It is controlled by a Linux operated Hummingboard module and a microprocessor which control the input and outputs. Homey runs on Homey OS, a Linux based operating system which is extended by Node.js, a platform build on Chrome's Javascript runtime. Homey OS is built from the ground up for better support of the devices and users. It is partially open so the community can write applications for unsupported devices. Homey OS is also partially based on Chrome's Javascript Runtime, basically the platform can be seen as an intelligent 'website'. Because of this open source attitude and platform style, Homey can develop an interface for almost every device which has JavaScript enabled browser capabilities.

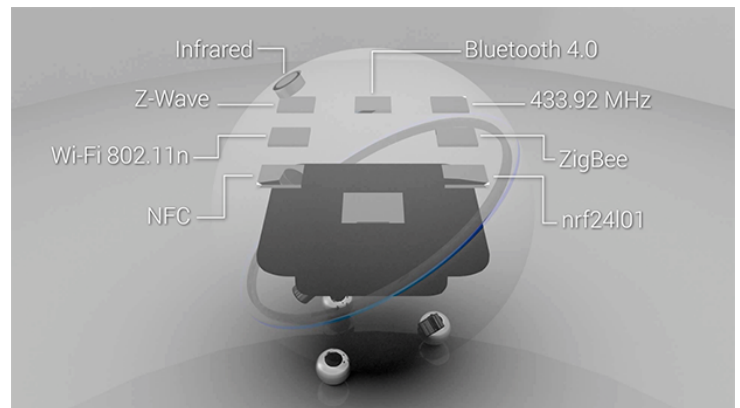


FIGURE 3: Inner workings of Homey according to their kickstart campaign⁽¹⁾



FIGURE 4: Works with... a lot of devices and services according to their kickstart campaign⁽¹⁾

1.2 INTERFACING WITH HOMEY

The interfaces of Homey are split in two kinds of interfaces. First there is the physical interface, which contains interfaces physically noticable. Second there is the interface of an application.

Physical interfaces

Physical interaction can for example be handy when the user wants to know when a speech command is interpreted or when Homey is busy. These physical interactions with Homey are possible by hardware components, namely with a LED ring and an onboard speaker. The LED ring can perform almost every visualization that can be imaged for a 30 LEDs, radial LED ring as seen in figure 5. The onboard speaker has a function to provide information and feedback to the user. The onboard speaker is not of sublime quality, but this has a reason. Homey wants to connect to the house, therefore external speakers will be sought upon first boot. And Homey will use from then on, with permission, the crisp audio set to interact.

To create physical interactions, certain situations which require physical interaction have to be searched.

Situations

- First boot of Homey
- Pairing device
- Updating software
- Software error (brick)
- Idle mode
- Active listening mode
- Loading
- Successful loading
- Error during action
- Speaking to the user
- Alarm
- Controlled by an application
 - Weather
 - Stocks

Interfacing using an application

Homey is equipped with a natural speech. Although speech is a great natural, swift interface, it is not perfect. It is likely that the user will only remember most used commands. And because Homey will have a lot of features, a little help will be useful. The wish of the costumer is that Homey can also be controlled without speech. That is why Athom chose to add a different interfaces without speech commands. This can be done via an application for the mobile phone, a webpage on the desktop or via a tablet. The interfaces and their interactions of all three options are completely different. Therefore they have different aspects and pros and cons. These will be covered in the paragraph "analyzing interactions". The three of the options will all be realized, but because of the big differences this will happen one by one. The main focus relies on the mobile application, because this is the biggest market demand.

The most imported cons of adding an application are a higher usability and more efficiency. Athom feels Homey is more complete with a speechless interface realized by a mobile application.

To prove a mobile application can be faster and more efficient than speech an experiment has been conducted (appendix I). With the results there can be conclude that speech is a very good interface. Speech can be very fast, but only when it is really optimized and when it is able to filter out noise. For more advanced settings speech will be too difficult, since speech does not hint the user for commands. In that case a mobile app will be faster and easier.



FIGURE 5: LED Ring of Homey, as can be found on www.athom.nl

1.3 STYLE ANALYSIS

To create mobile elements and parts of the interface, the style has to be mastered and therefore firstly analyzed. Materials created for project Homey are share a common style, although they still lack a documented common base. For this style analysis, previous work and contact with the makers will be essential and form the beginning off a well-documented style to continue to build on.

Homey, characteristics and looks

The friendly and intriguing character of Homey is created by its look. The simple globe is supported by three metal-shiny other globes as feet. The Homey is cut in half around an angle, with a LED ring in between the two parts. This LED ring has an animation of a rotating rainbow animation when idling.

Current material

All material created for Athom and for Homey have a corresponding style; they're both colorful and featuring a part of the rainbow colors. The materials that are already created are logos, poster, flyers, business cards and a website. These are all created by Athom during the start off the company. Before the Kickstarter went live, they also produced materials, namely a partially working Homey prototype, and a visual impression of the mobile interface. This interface is for demonstrating, it did not work, but it showed the idea and the functionality behind the future application and will be the base for future tests.

Logo: Athom and Homey

Fonts: Roboto⁽³⁾

Colors: Palette

Shapes/Character: Circle Rainbow

Decomposing the material

As already said, the previously created material consist of posters, interface prototype and a Kickstarter material. It consists of a clean look, as can be seen from the logo. The user is not overwhelmed with text, but has a good clearly divided readable document. This can be seen on the back side of the flyer. The idea of Athom is to impress the user with as little content as possible.

The website has its main focus on Homey. When entering the website, the first thing that will get the users attention is the white globe on a dark blurred background, with a glowing ring. It is possible to order Homey directly. And by scrolling down the page more information is disclosed in small proportions. Therefore, the user can read and interpret the information more easily.

Homey

Materials from Athom⁽²⁾, as found in their archives, website and kickstarter campaign

Homey



What is Homey?
Homey is your personal assistant who will make your home personal again. Whatever you want to do, Homey takes care of the technical parts, so you're left with the fun.

Interact with your home and your devices in the way you interact with anyone else: by talking to it!

Connectivity
Homey speaks with all your wireless devices, and internet services like e-mail and calendar.

Homey is so easy to use
Tell Homey to turn on the lights, play some smooth music or tell you today's weather when you wake up. It's so easy, everyone can do it!

Curious? www.heyhomey.nl

KICKSTARTER

Talk to your home to control everything:
From lights to music, from climate to TV

lights video music appliances security climate internet

Pre-order your Homey now!
www.heyhomey.nl

Stretch Goals

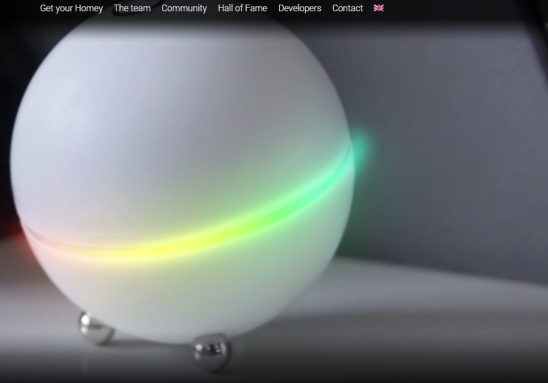
€ 200,000 +
Interactive flow-editor for your actions
Create dynamic flows when things happen, if this then that style. No code required!
For example: learn Homey that when you wake up it fills the bathtub and start your morning music after 15 minutes.

€ 300,000 +
Multiple colors Homey
Give Homey personality! You can choose between Fire Red, Apple Green, Aqua Blue or Ninja Black!

€ 400,000 +
This goal will be announced after € 200,000 has been pledged.

Homey

Get your Homey The team Community Hall of Fame Developers Contact



Get your Homey

BELL 4:21 PM 22%

Living room Hallway Kitchen

Thermostat
21.5 °C 23.5 °C
Turns off tonight

The Adventure
Angels & Airwaves
We Don't Need To Whi

Davey entered your house

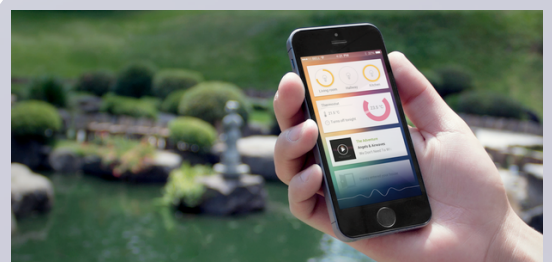
When you get home

Lights on off

Play music Favorites

lights video music appliances security climate internet

Athom



Color palette

By using materials made for the Kickstarter, demos and promotional material a color palette can be determined. The colors used are very saturated, thus giving a brighter color. This is attractive for the user, since it contains color transformations with bright intriguing colors. The content is displayed on a white surface which has 80% opacity, thus the background remains visible.

Text is created with dark, near black colors, but also contains various shades of gray. It's also possible to create opaque text or element, like the Homey logo itself. The text is spaced, thus easy readable.

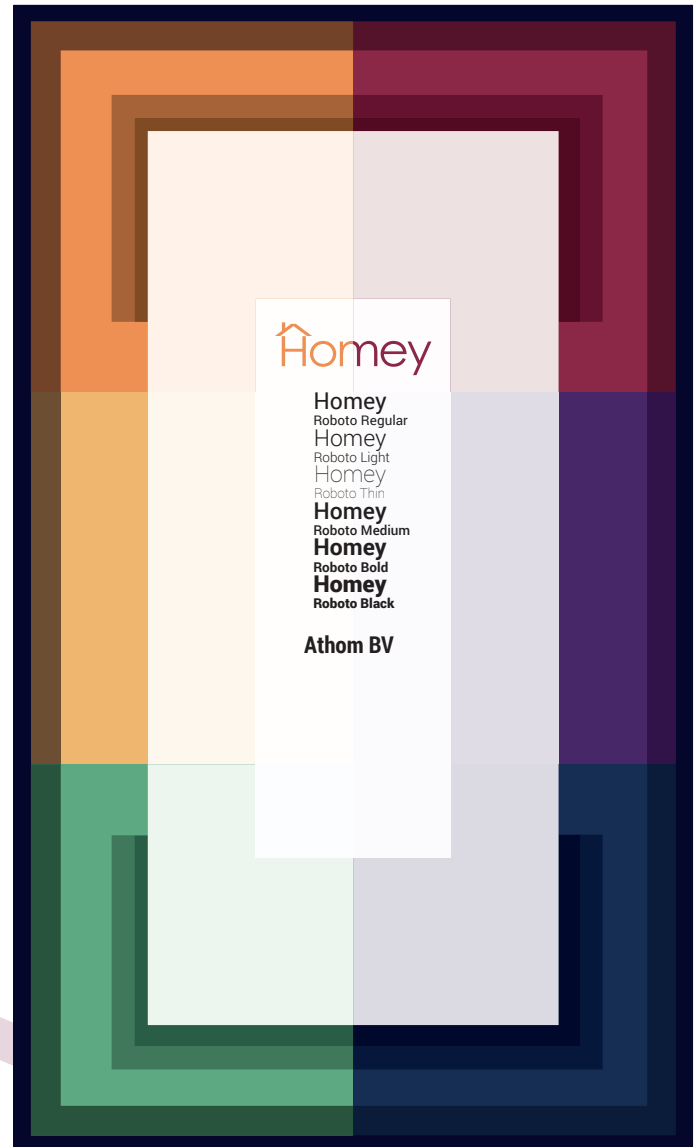


FIGURE 6: Color palette based on the the materials.

1.4 TARGET GROUP

Designing a part of the user interaction requires a good overview and knowledge of the future users. As a result of the project a Design Guidelines will be created for Developers. This guide is a partially technical guide, which can be used by future developers to create their own application for use with Homey. The design guidelines focus on the front end creation of an application in Homey, with explanation about the lay out and the choice of widgets for their device. The widgets and the lay out are elements which are designed for end users. The end users interaction is very important, therefore end users are a big part of the target group as well.

End users

Since the market is rapidly expanding and products are getting more and more affordable, the market and target audience is increasing. The target audience for home automation was the rich and the creative electro engineers or geeks. But now it is available for every consumer who wants to control the lights and the entertainment set by voice. Seen by the current backers, a lot of people are very involved and power users of home automation. The majority of backers already have lots of smart devices ⁽⁴⁾.

Currently not directly the main focus, but a possible expansion of the target audience could be by using Homeys in hospitals, for disabled or sick people who have difficulties to turn on and control every aspect and device of their needs separately. But Homey can also be of use inside offices. This could result in more agile and faster use of office equipment and devices inside the building. But it can also be used for more control, using data to adapt a smart heating plan, where the first floor is less heated by the heater then the ground floor. Homey is versatile and broadly usable. The target audience is broad, but usability is key. The regular user must be able to connect products and to control products.

Developers

Developers are part of the target group, since this assignment is about creating a guide for developers. The developers will be creating a large part of the applications themselves, because this is simply too big of a task for the current team. To support the developers and to ensure the usability of the Homey application, a set of rules combined with an easy to use developer's suite will be created. This will combine creative creating with the simplicity of building applications. A whole platform is thought out for developers, creating a great community, like for example Arduino also has.

The Arduino is used primarily by electro hobbyists for creating cool products for a relative low price. Developers write code, for example for an Arduino project. Their platform allow massive sharing of great ideas and collaborative problem solving⁽⁵⁾. This open platform idea, where people will enjoy creating for is a goal of Athom. A place where ideas and knowledge is shared and new applications for Homey will see the light of day.

1.5 COMPETITOR ANALYSIS

The market of home automation is in fact decennia's old. Early home automation was created using cabled constructions. These had to be placed during construction, or could be added later. The costs of these operations are extremely high, as were the cost of the controllers. Therefore the market was small, only available for hobbyists or the rich. Since the rise of cheap controllers, the emerging of internet, Wi-Fi and the smartphone market, the circumstances are ideal for companies to emerge on the 'old home automation market', bringing the new possibilities and new technologies to the consumers^(6,7).

A competitor chart is made to compare the current competition. Since the market is growing, expect the chart to be outdated soon, as it already changed a lot during the project.

This matrix is created using parts of data from S. Witkamp, for his project (Witkamp. S, End User requirements of a natural home automation system. 2014)⁽⁸⁾ with prices and technology research, together with own research a complete matrix is created.

Comparing competitors interfaces and the advantages of Homey compared to the competition, will create unique selling points and added attention for these unique selling points during design.



Confidential

For professional reasons, the comparison is confidential.

1.6 HOME AUTOMATION

The market for home automation is now. The connectivity of devices is increasing, and the needs of the consumers bigger. The consumer wants more control. Within a short period of time, most houses are equipped with smart devices.

But when the user has a large amount of smart devices in the house, it must still be easy to find the right device. To give the user a clear navigation of the devices, categorization is necessary. The choice for categories Athom has already made are: Entertainment, Climate, Security, Appliances and Services. These were adapted by Athom and can be found in the report of "Natural Home Automation System"⁽⁹⁾.

It is necessary that the Homey can group or pair devices, and can also control each room separately. This must be seen and accessible from within the application. These zones, rooms and categories are actually filters for which the Homey can manage media and the application can show the available devices with information. With preferences and priorities the devices can be sorted in a wishful and pleasant order.



lights



video



music



appliances



security



climate



internet

Devices and categories

Examples of underlying functions in the categories could be:

Lights

Video

Music

- Spotify
- Audiobook

Appliances

- Coffee maker
- Toaster
- Electric over

Security

- Locks
- Alaram
- Monitoring

Climate

- Thermostat
- Airconditioner

Services

- Email
- Facebook

To create the interface elements for the applications and to create widget, the products which are being supported or are already available, will be analysed.

Functions

To give insight in the widgets that will be created, an overview of functions is needed to understand the most functions and to find similar functionality. This will result in an overview of parameters and ranges, where the widgets can be based upon in the idea phase. Preferably controls will be uniform of understanding and working, if controlling an oven can be as easy as controlling a light switch, the widget that controls both, should have about the same handling and appearance.

The created list gives a clear overview of what parameters and degrees have to be taken in account for during the design of widgets.

The list with functions and parameters is available in appendix II with sources seen in number.

Conclusion

The devices, categories and functions have been analyzed. The broad support for devices and the trend of a future house with a lot of smart devices, smart navigating or filtering must be possible. Navigating through devices using zones, rooms and categories is being realized. The functionality of the devices is found by analyzing existing and brainstorming over future devices using scenarios. The functionalities have been extracted and an overview is created. This is a solid base for designing widgets of the Homey application.

1.7 DESIGN FOR DEVICES

The Homey application will be created using a cross-platform controllability. This means it will support a great range of devices and operating systems. This range of devices will be analyzed, to create an interface and its elements which will have a similar interaction on all devices.

The current project focusses mainly on a smartphone, but since it is cross platform, these aspects are a definite wish for Athom. A tablet will be most probably be the second most used device for Homey, so during analysis it can be taken in account too.

First all devices will be summarized and abstracted. Input possibilities will be compared. An interface must provide good readability, on all kind of devices. Apart from interaction, ergonomic aspects will also be tested, to ensure positive usability.

Cross-platform Design

When designing for a large portion of devices, a smart way of software building must be found. Emile found a great base to do so, using a 'website' like coding structure, where Node.js and JavaScript libraries are contained inside. Big part of the software could be rendered on operating systems such as an iOS or an Android device using web views. This hybrid building of the application will allow for a fast native application, with cross-platform elements which are controllable and updated on every device with the Homey application, or the possibility to browse the internet using a Chrome runtime enabled browser.

To comprehend this hybrid building of an application have a look at the illustration at figure 7.

For the assignment a prototype will be created, based on a website like structure, during the idea phase and the concept phase a choice of software will be argued. Input devices and sizes

What will be the devices of the users to interact with the Homey application? And what are the available devices that could control Homey? These are summed up with properties in figure 8.

Although not all smart devices will be chosen to build an application for, insights given by types and specifications are a good base to further expand building for

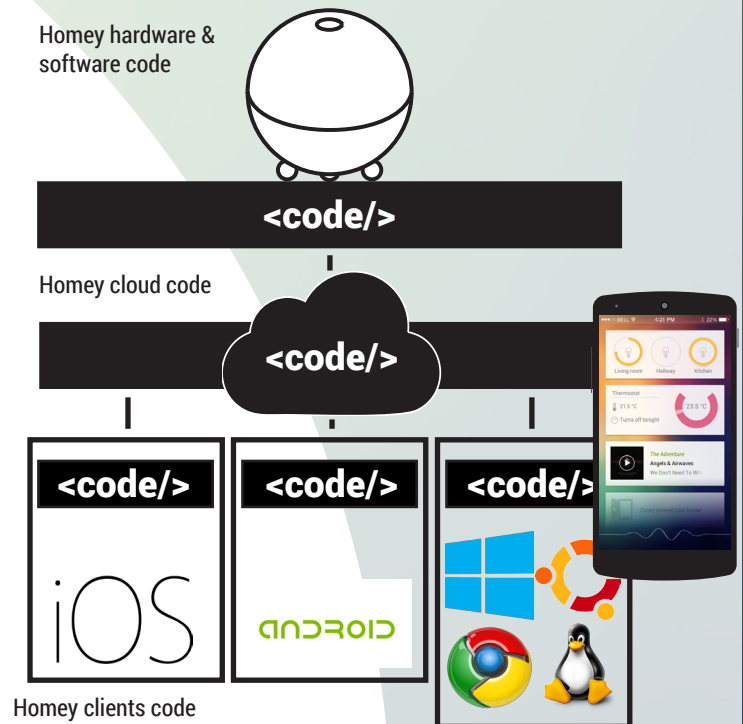


FIGURE 7: Hybrid code structure, Homey OS, Homey cloud software and native applications.

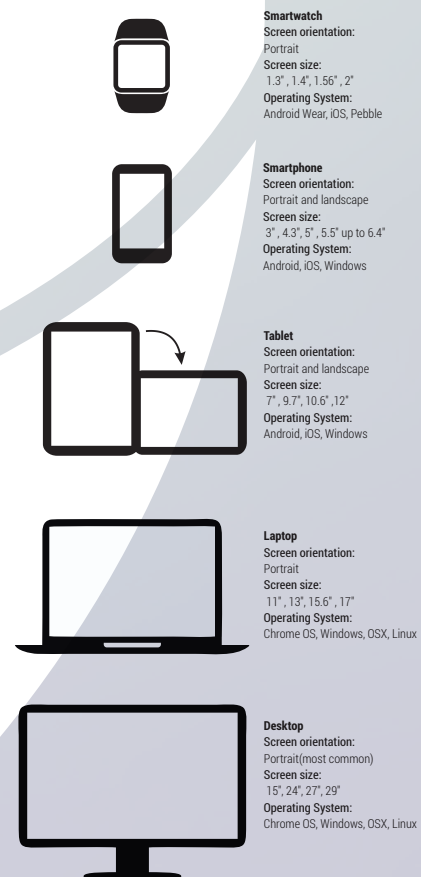


FIGURE 8: Summation of possible input devices with properties.

devices in the future.

A thorough investigation has been conducted for screen sizes of current phones on the market, and the trend of screen sizes in the next generation of phones. The trend of large touchscreens is still carrying on. Currently the iPhone and Android phones are of an average size of approximately 5".⁽¹⁰⁾

While the tablet is not my primary device to design for, an investigation and analysis of this device is still worth a lot to Athom and future cross platform application design. We also see an increase in size in the tablet market. The successor of the nexus 7 with 7 inch screen is the nexus 9 with 9 inch screen. The Surface tablets and the iPad also increase in size.⁽¹¹⁾

If the application can be used on smartphones as well as tablets, how does this impact the user interface and elements? The different screen sizes tend to ask for a specific lay out, which can adapt to different devices. A tablet, which has a 10" screen, should not show the interface with twice the size, but should adapt to the device, and give a good overview. Although the assignment focusses on a smartphone with 5" screen, the fundamentals must be scalable, downwards (e.g. smartwatch) or upwards (e.g. tablet). So smart building and parameterizing should be key.

Operating Systems

Touchscreen devices with capacitive touch screens, various screen sizes due to the amount of devices. The biggest platforms, iOS and Android both have a lot of devices on the market⁽¹²⁾, with an overwhelming market share and good forecast as seen in figure 9. Where iOS keeps it to a modest 8 smartphones and 7 tablets⁽¹³⁾, the Android devices are not countable, simply because there are so many devices. Android is open source and free to install, that explains why a lot of Chinese tablets

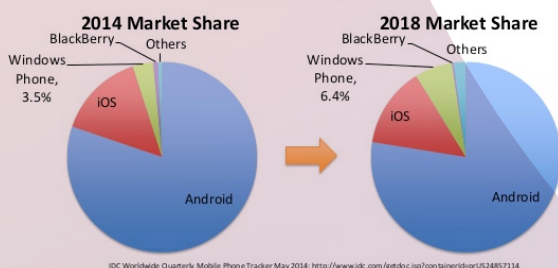
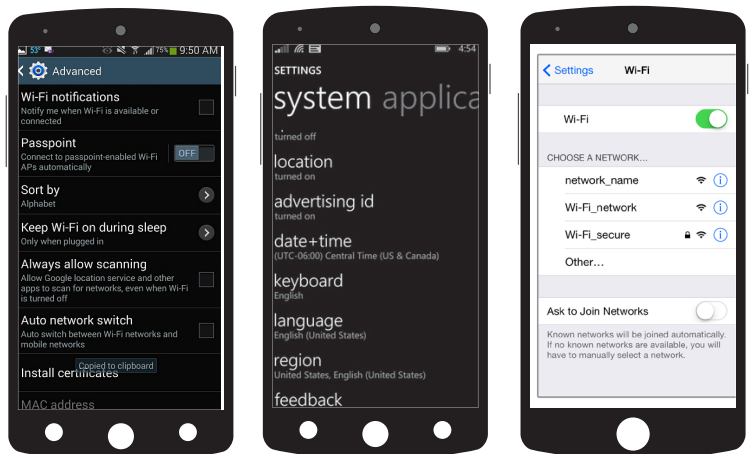


FIGURE 9: Market share prediction of mobile Operating Systems

and smartphones run on Android.

There are some big differences between the platforms and the interactions, but the biggest difference is in controlling the interface. Android and Windows allow for hardware buttons such as menu, back and search or home. Apple only has one home button. This directly translates to the interface as depicted in figure 10.



Android settings Windows Phone 8.1 settings iOS settings

FIGURE 10: Settings menus of mobile platforms⁽¹⁴⁾

You can clearly see the iPhone leaving a back button for the user (fig. 10 right), so navigation through the application is still possible, since the home button will minimize the application. In Android this is not necessary but still is done in some applications and menus.

Interaction of both platforms must be equal up to a certain point. The interface will be the same for the most part, but the navigation can slightly vary. Since the elements, which are going to be designed, are comparable with a website, the elements are surely equal and can be used on all platforms. This calls for smart design for the screen, which is expected due to the high amount of devices and screen sizes.

Design for one device?

The device which I'm specifically designing for, is a smartphone, the usability will be tested on this device, since it is expected to be most commonly used device. The looks and feel on a bigger screen, such as a (stationary) tablet, or a (laptop) screen are being adjusted in a slight manner, since they can carry more information.

The screen size for development will be on a 4.8" screen, this is an average of a range of devices currently on the market and is easily available. The size is between the Apple iPhone 6 (4.7") and a iPhone 6 Plus (5.5") and the current high end smartphones (HTC One M9, Sony Xperia Z4, Samsung S6) and their predecessors (HTC One M8, Sony Xperia Z3, Samsung S5).

HTC One M9	5.0"	HTC One M8	5.0"
Sony Xperia Z4	5.2"	Sony Xperia Z3	5.2"
Samsung Galaxy S6	5.1"	Samsung Galaxy S5	5.1"

Input using Touchscreens

Since the iPhone launched, in June 29, 2007, the touchscreen had a great growth as input hardware⁽¹⁵⁾. Before the iPhone there was a PDA, or a Pocket PC which also included a touchscreen. The main difference between these two devices are the difference in hardware. The iPhone contained a capacitive touchscreen, which is easily controllable with fingers, where the other devices mostly had resistive screens⁽¹⁶⁾, where input was possible by detecting a press with a finger, but mostly done by a stylus. This meant a very accurate tap with an area of approximately 2mm x 2mm. This allowed for small elements, but also, because the screen was resistive, a firm push from the hand. Since the announcement of the first iPad in April, 2010, a new market emerged for consumers. A market of tablets, bigger smartphones, which would be the electronic newspaper medium.

The markets for the tablets and smartphones are segmented primarily in two types of touchscreen techniques, these are: capacitive and resistive touchscreens⁽¹⁷⁾. Both with their own characteristics. To explain the restrictions a short overview of the two types is given in appendix III which also uses an estimated forecast for extra insight in the future market.

Summarized it means the capacitive screens are the most frequently used technique and still growing. It is more modern than resistive and capable of handling multi touch.

Touch interactions and expectations

Most people have expectations when using there smartphone. It has been around for quite some time and people have experience with all kinds of applications already. The two major platforms, Android and iOS, have different usability's. Which result in Android having different interactions compared to an iOS device also utilizing a touchscreen.

Interactions on screen which are commonly used by all mobile platforms are explained in the table below.

Interaction	How	Default behavior
Tap	Press once on the screen	Like a click, opening or interacting with an element
Double Tap	Press twice on the screen, quickly.	Zoom in/out,
Tap and hold	Press once on the screen and keexp your finger on the same place on the screen.	Context menu appears, commands or an action menu is shown.
Tap and, while holding, drag (Pan/Drag)	Press once and hold the finger on the screen, then move the finger around.	Dragging an element (unlock), opening a menu. Panning through a website. Moving an element.
Swipe	Press on the screen and quickly move your finger into a direction.	Quickly navigate to the next or previous screens. Unlock screen. Opening a menu. Or quickly scroll (photo, website)
Pinch to zoom	Use two finger on the screen and 'close' or 'open' them based on where the fingers are initially placed.	Zoom in or out, manipulating an element inside a game.

Based on these interactions, users will expect something when they have interacted with the interface. Users want to see a reaction on input. What you see is what you get, is a popular term for designers. In this case, if nothing happens... the user expects their input probably was not detected, possibly resulting in frustrations and repeating the interaction, and therefore also the commands.

To prevent miscommunication and wrong interactions, the design and its behavior should not go against the expectations of user. Above interactions can be used cross platform.

Readability

To create an easy readable application, the font, the size and the structure have to be analyzed. All these different screens have different screen properties, so the application must be smooth, flexible and 'responsive'.

Font

The Homey application will be contain the Roboto font, which is used by Android. An evolved font, developed for readability on the screen⁽¹⁸⁾. Important is what color is chosen for the font, since contrast is related to the readability⁽¹⁹⁾.

The size of the font is harder to formulate, since there are different sizes of screens. How do we display the font size?

Roboto Thin & *Thin Oblique*
Roboto Light & *Light Oblique*
Roboto Regular & *Oblique*
Roboto Medium & Medium Oblique
Roboto Bold & Bold Oblique
Roboto Black & Black Oblique
Roboto Condensed & *Condensed Oblique*
Roboto Bold Condensed & Bold Condensed Oblique

FIGURE 11: Roboto font⁽²⁰⁾

Font size

Based on previous data, a lot of devices with a lot of different screens and different densities are available. Density of a screen is measured in the amount of pixels contained in the screen. It is measured in Density per Inch, or DPI. This has an influence on the readability of the text. Both iOS and Android have accounted rendering on screen data like images for different DPI, so the overall looks are the same on each device. For Homey, it is important the user can read the text on their device properly and easily. On screen text has to be easily readable. Since Homey is a product which aims to be user friendly, the interface must be readable for a large audience. Part of this solution is, a lot of activity is also visualized instead of just being displayed in text.

But for the text, displayed on every device, a general 'font-size' has to be chosen. Since font size already is relative, a brief explanation on font sizes and their scalability and adaptability.

Pt Used in Word and many more text-editors the measurement of font is in points ("pt"). Points are a unit of measurement created based on printable media. One point stands for 1/72th of an inch. This measurement is not scalable, so a fixed font size is not desirable.

Px Pixels ("px") are the digital points. They are based on screen based units of measurements, a screen with full HD resolution will contain 1920 pixels on a horizontal line and 1080 pixels on a vertical line, together forming a screen with a ratio of 16:9 (widescreen). Pixels are a part of the display, so they are not scalable. A smartphone for example can have a full HD screen, but a desktop screen also. The data will be visually the same if you do not have other settings specified.

Em Scalable font sizes, based on these standards are: Ems ("em") and percent's ("%").

% An Em is a scalable unit which is based on the current or default font size. The scalable order makes it great scalable font size unit for mobile screens and the screens surpassing the full HD resolution (on which a lot of media is built with pixels).

The percent is actually a unit which is already used for a lot of on screen media sizing. Percent's are used for elements of a website. It is a scalable unit based of a standard size, which then creates an adapted size for this device's screen. The result of percentages and em's are 'printed' in pixels, because this is the used unit and needed data for a screen to display⁽²¹⁾. The versatility of percentages and the scalability make percentages a better way to render an on screen font. Percentages can be linked to the size of elements or to a font size.

Structure

When displaying text the user must be capable of reading and understanding as fast as possible. Using visual hints before placing text helps to support. The text must also be short and punctual.

Ergonomics

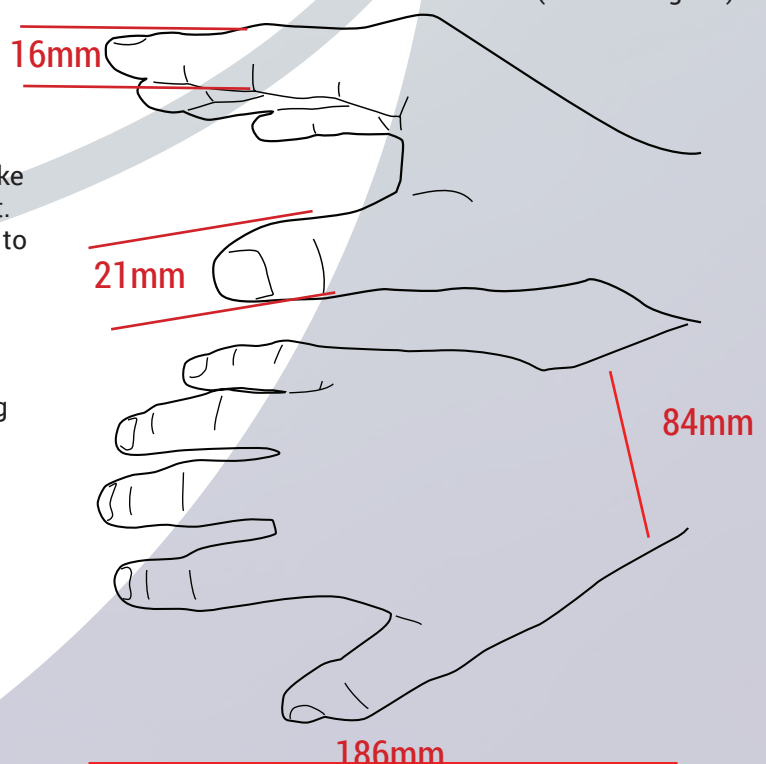
To design a mobile application which is user friendly and fast and efficient, certain aspects like element placement have to be determined. From previous experiences and ergonomic perspectives, the physical properties of the hand and the reachability of the fingers on the ever growing screens must be investigated.

Data of measurements of the fingers
Positions of the hand and fingers.
Reachability of the fingers

Data of the hand
Previous input on touchscreens was using a stylus on a resistive screen. This eliminated the possibility of one handed usage. Using capacitive screens one handed usage is possible and does not allow a lot of strength for a tap, compared to a push of a stylus. The touch area is increased with this new technology. A hand is analyzed with data from DiNED(Fig. 12), a tool created by the TU Delft⁽²²⁾. It uses data of Dutch adults measured in 2004. This population is big enough to give a representation of the human hand.

Some measurements of the hand

FIGURE 12: DINED dimensionated hand (use with fig. 16)



Hand positions and hand dexterity

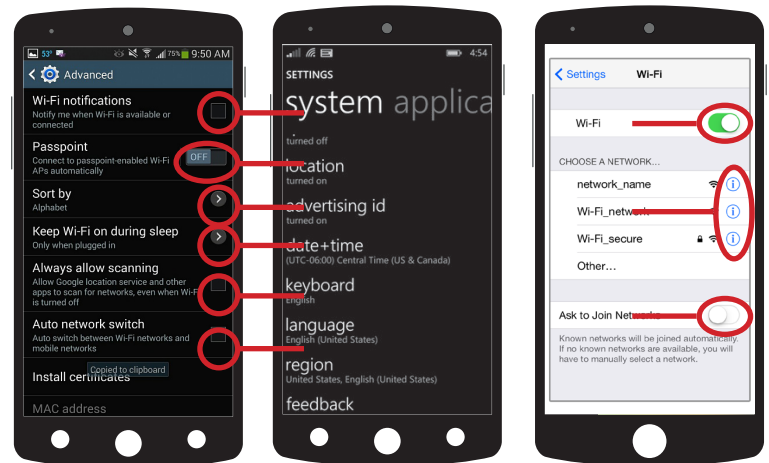
Being left or most likely right handed, the users will have a preferred hand to interact with their smartphone. An estimated 70% – 90% of the people in the world are right handed⁽²³⁾.

For smartphone usage and handedness not a lot of data is available. It is also a relation a lot of User Interaction Designers are currently interested in. An article by Cornelia, on realites-paralleles.com describes and visualizes a lot of data from different surveys and uses another gathered set of data which uses over a hundred participants and therefore can be considered a medium sized experiment. The results of this experiment are being analyzed more in depth in the article⁽²⁴⁾.

These results give insights of how the users interact with their smartphone. A notable result is that thumbs are used in interactions for about 70% of the time. Cradled with two hands or by holding the smartphone in one hand. Using the index finger for about 14% of the time, or with two hands with the smartphone placed on a table or other attribute 9% of the times. The other 7% the user is idling and checking for notifications or the time.

The results are of great value and can be used. Although the source is not known as scientifically proven, it gives an impression. A logical step for me would be analyzing usage and handedness of the users in a user test as well.

Most interfaces are build left to right. This is because we read left to right, but also because the majority of the users are right handed. This can be seen in figure 13. Dominance with handedness is not directly correlated with dominance in usage of smartphones⁽²⁵⁾. This trend is seen on Android and iOS settings menus. Both have the same layout and handedness. Interaction, left text and on the right the user can control.



Android settings Windows Phone 8.1 settings iOS settings

FIGURE 13: Settings menus of mobile platforms

The position of the hand is formed around the device, using a cradle, or holding the device and controlling the device with just one hand are the most common interactions. While cradling, the device can be used with one or two hands.

Typing is the most common cradled position, with two thumb typing on the screen.

Navigating is the most common cradled position with one hand holding and one hand interacting with the interface, which is mostly using just the index finger.

Thumb interaction is most common, the experiment shows around 70% uses their thumb with one finger interaction, and another 9% is added when the user is using both hands. The thumb is therefore, by far the most used finger⁽²⁶⁾.

Reachability on the screen(s)

All data from above raises a big question.. What is most used and preferred area for the interface of a mobile device.

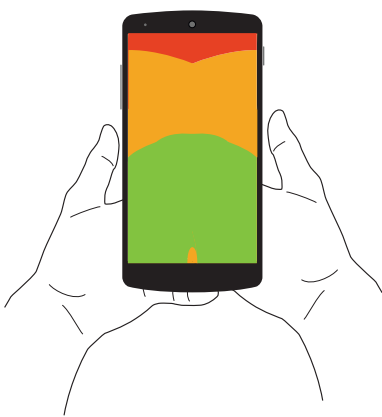


FIGURE 14: Cradled with thumb use and using an index finger

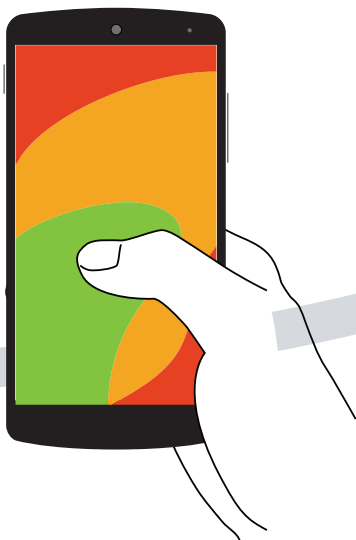
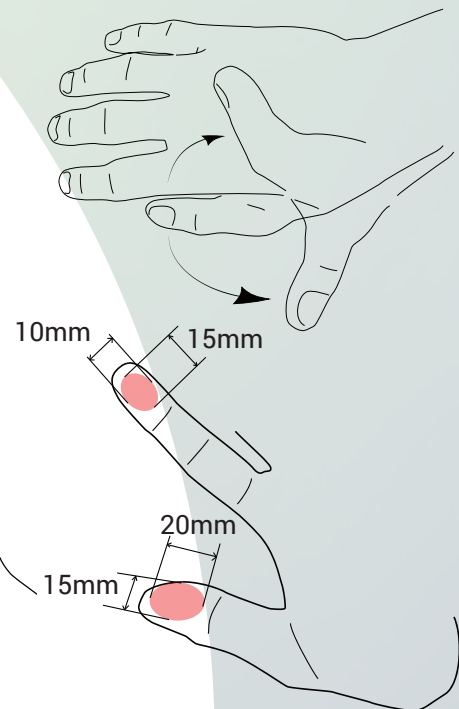


FIGURE 15: Right hand, thumb optimum area

FIGURE 16: Sizes and extreme positions of the thumb



Using a cradle, or index finger creates a real optimal areas are found for touch interaction. This has a pretty good overlap with the existing idea using cards.

View

When the user is interacting with the application, the view of the user is partially blocked by the user's hand(s). This is acceptable when no interaction is taking place, but could become an issue when the user is touching and controlling a widget.

The view can be distorted in different ways, depending on the hand which is interacting, or both hands. Also the place of controlling will block the view of the user. It is important that when these actions are taking place, the user still remains to see the feedback of what is currently being controlled. If this is not possible, there must be a redundant method to still provide this necessary feedback. This means placement of feedback is important. Redundant ways of feedback, like haptic feedback can also be given if it is a fitting reaction to an action.

Conclusion

A lot is analyzed in this paragraph.

To create a cross-platform application, or design elements, the devices and their operating systems were analyzed. Resulting in creating a design for a 4.8" screen, with an Android operating system. Although the Android OS has been chosen, all platforms will have the same 'website' like handling using smartphone navigation and interactions, this will be explained further in the next paragraph.

Designing with ergonomic aspects and by studies based on observations of users, an especially thumb friendly interface must be created. The smartphone has most common use with thumbs. When the users are going to interact for a longer time, the possibility of a cradle with two hands and two thumbs is about the same as using one thumb. The cradle position with the index finger is used in about 14%.

Because of the area which is most used by the thumbs, I've asked Emile about a possible redesign of the current menu. This is added to the to-do list and will be tested during future user tests. With speed and ergonomics taking in account it can be a challenge.

1.9 ELEMENTS AND PLACEMENT: CARDS AND INFORMATION

The elements that need to be designed for this assignment need to be specified.

What elements to design?

Elements which are already once thought of, are depicted in figure 18 and 19. As seen on the current prototype, devices are displayed on a 'card' inside the application. Within this card there are elements like a device label, text, icon and a widget.

Displayed below are the elements which will be designed during the assignment.



FIGURE 17: Elements to design.

Element design properties

Cards also contain the controls. The controls take up space. As seen in the paragraph of ergonomics, the users are mostly right handed. With smartphones

Card

The application for a device as seen by the users.

Device label

A name or function of the device.

Device status text

A small status report, with upcoming events, for the device. In the case of the thermostat it could display when it going to turn off.

Device icon

An icon for the device, a visual representation of the device.

Widget

A controlling element, which can be used to send commands to the device.

Widget text

Text to help the widget, for example feedback, or a specific name can be given.

Special cards/Media card

Media will be a special card, this

Homey voice control

Not creating the element, but building around the element. The Homey is also voice controlled using the application, and that is represented here. This element needs to be placed on the screen. Ideas of placement and representation are always welcome.

1.10 CURRENT SITUATION

As seen in the section current materials, a visual prototype of the application is created to give people an idea of the future interface. To test the 'prototype' a heuristic test is created and evaluated.

It is based on the prototype below.

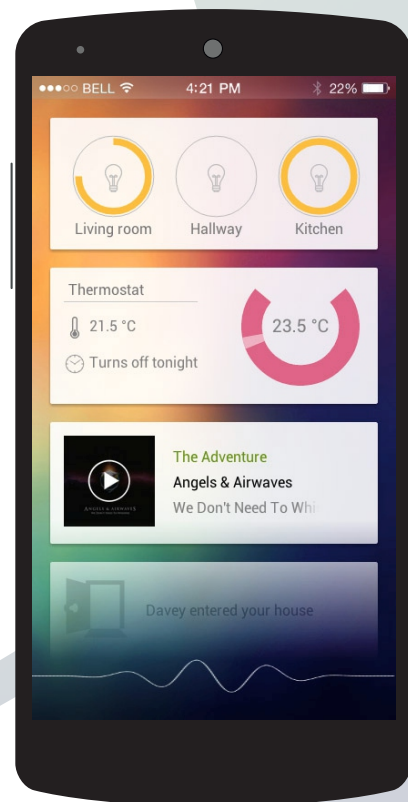


FIGURE 18: Visual prototype

Interfaces have been around for a long time, theories, principles and guidelines in the form of heuristics can predict the behavior of users and usability. There are eight golden principles created by Shneiderman (1997), which apply generally to all interfaces. The eight usability principles are as following:

1) Strive for consistency.

Consistent sequences of actions should be required in similar situations; identical terminology should be used in prompts, menus, and help screens; and consistent commands should be employed throughout. While not directly said, usability and interaction also should be consistent. Deviation of this rule must be minimized.

2) Enable frequent users to user shortcuts.

As the frequency of use increases, so do the user's desires to reduce the number of interactions and to increase the pace of interaction. Abbreviations, function keys, hidden commands, and macro facilities are very helpful to an expert user.

3) Offer informative feedback.

For every operator action, there should be some system feedback. For frequent and minor actions, the response can be modest, while for infrequent and major actions, the response should be more substantial.

4) Design dialogs to yield closure.

Sequences of actions should be organized into groups with a beginning, middle, and end. The informative feedback at the completion of a group of actions gives the operators the satisfaction of accomplishment, a sense of relief, the signal to drop contingency plans and options from their minds, and an indication that the way is clear to prepare for the next group of actions.

5) Offer error prevention and simple error handling.

As much as possible, design the system so the user cannot make a serious error. If an error is made, the system should be able to detect the error and offer simple, comprehensible mechanisms for handling the error.

6) Permit easy reversal of actions.

This feature relieves anxiety, since the user knows that errors can be undone; it thus encourages exploration of unfamiliar options. The units of reversibility may be a single action, a data entry, or a complete group of actions.

7) Support internal locus of control.

Experienced operators strongly desire the sense that they are in charge of the system and that the system responds to their actions. Design the system to make users the initiators of actions rather than the responders.

8) Reduce short-term memory load.

The limitation of human information processing in short-term memory requires that displays be kept simple, multiple page displays be consolidated, window-motion frequency be reduced, and sufficient training time be allotted for codes, mnemonics, and sequences of actions.

These principles are tested and awarded a score for a quick visual representation.

Heuristic evaluation

For each heuristic an explanation and corresponding score have been given. The score and argumentation can be seen in appendix IV, where the visual representation can be seen here below in figure 19.

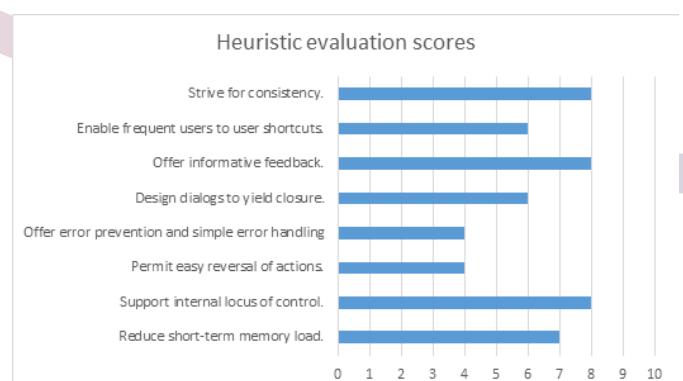


FIGURE 19: Results based on heuristic evaluation as seen in appendix IV.

Conclusion

What can be concluded, based on the heuristic evaluation, is the visual prototype is superficial, but already has good scores on multiple heuristics.

The interface excels on consistency, using a rather uniform look and will carry this on to every interface with the same controlling elements. The feedback as a reaction to an interaction is given using textual feedback, but also visually using color.

Internal locus, or advanced usability is given by providing the user an extensive controllability of the device. A goal is create overview and control.

Short memory load is reduced by keeping the interface simple and using visual and textual information, but the absence of mnemonics are a miss. Error prevention and undoing actions are not yet present inside the visual prototype.

The heuristics can be used for creating demands and wishes for the design brief.

1.11 SCENARIO

A short powerfull scenario, which represents some wishes of the consumer.

‘What a weather.’ Sarah complains as she is entering her house. ‘Hey Homey, I’m Home’, unaware the house is already at a nice warm temperature, Sarah walks into the living room with a large bag. Sarah has done all the groceries shopping’s for the week. She opens the fridge and creates some room for the new groceries. She scans the new items and places them in the fridge. The labels are automatically scanned and the expiration dates are added to the memory.

Sarah appreciates style, that is noticable through the furniture in the house, which is also very natural. She walks to her garden and is asked by Homey if tap water may be used for watering, since the clean water reservoir is almost out of water. Sarah goes on her phone, and decides that she wants a coffee.. she is having. A lovely espresso, with the touch of a button. While the people in the neighbourhood sleep, Sarah is still wide awake of the coffee.

She’s playing a bit with her lights around the house and activates scenes which make her house look like a nightclub from far away.

Sarah is getting tired.. “Bye Homey, I’m going to sleep!”

1.12 DESIGN BRIEF BASED ON THE ANALYSIS

Combining all the demands and wishes of consumers and Athom results in a design brief.

When all demands and wishes are fulfilled a suitable, usable interface and controls for Homey should have been created.

Created from scenarios and the analysis the demands and wishes of consumers can be derived.

Demands of end -users

Create a uniform look of the application

Allow casual users to control the devices

Do not allow casual users to adjust expert settings without prompts

Allow expert users to control many aspects of their devices.

Make controlling Homey (your home) be as easy as touching one button. (AI, suggestions)

Create an overview of all upcoming events

Show important device information:

- On or off
- Events
- Status

Control all lights in a zone at once.

Make grouping on a card possible in the case of many similar devices e.g. lights.

Provide sharing data outside the application (share groceries or timeline)

Make navigating to a specific devices fast

Make possible to turn scene on or off

Show where the user is located inside the app.

Use interactions equal to the expectations of interactions.

Provide feedback 'before' (display status), during and after and interaction.

Provide textual feedback

Provide visual feedback

Provide physical feedback in the form of audio and/or LED ring animation.

Provide a help option for the users

Inform the user of the input

Warn the user of abnormal input

Warn the user in case of dangerous variables.

Warn the user in case of a priority event.

Demands of developers

Provide appearance details of elements

Provide parameters and variables of the elements

Provide interaction behavior of the elements

Create scalable elements

Provide behavior of elements in different environments (flow editor, developer's suite and application)

Demands of Athom

During conversations with the team, and understanding the ideology of the Homey application, demands of Athom can be formulated.

Maintain the use of a cards like in the prototype

Element placement inside the card, widgets etc.

Maintain a uniform look

High readability also for visuals, by contrast and looks.

Interactions should be as simple as possible

Use of gestures for speed

Efficient switching through device functions

Demands by analysis and heuristic evaluation

As a result of the analysis and the heuristic evaluation, more demands for a great user interface and usability can be derived.

Make sure a lot of cards and controls are centered around the comfortable area.

Create visual LED feedback according to expectations (green for success etc.)

Allow elements to be controlled by the finger as displayed in figure 14 and 15.

Provide widget control inside the ergonomic responsible area.

Do not use interfering interactions, e.g. swipe up for more than scrolling.

Provide interaction feedback using haptic feedback.

The application must provide child and abuse protection.

Based on the heuristic evaluation

Strive for consisted interaction within the application

- Equal looking widgets must have the same interactions
- Same behaving devices must have the same looking cards.

Create a dialog containing information about the action entered.

Allow consistent interaction within a card

Provide shortcuts for multiple settings

Allow undo of the action entered

Make error prevention possible

Actions which contain one or multiple errors are not directly performed

Mnemonic support for navigating and displaying options

1.13 CONCLUSION OF THE ANALYSIS PHASE

During the analysis phase Homey was analyzed and the potential was spotted. The style of Athom was analyzed to provide good uniform looking materials during the assignment.

The competitors and the market have been analyzed and conclude the Homey has a leap over the competition. The future and present smart devices were gathered and abstracted to basic functionalities and with that list, abstract and device specific widgets can be build during the idea phase.

The application will be cross-platform, so designing for more then one screen is preferred or build the elements with good parameters, so they scale right on every device. With ergonomy in mind, the application and elements must be easily usable.

The current situation is analyzed. And with that some elements to design. The current situation is subjected to a heuristic evaluation, meaning the interface has been tested for 8 heuristics a good interface should have, it passed even while being a visual prototype. With a future scenario of usage more demands and wished can be found.

Using all the knowledge gained a design brief is created for the assignment.



CHAPTER 2

Idea generation & sketches

After the gathered information during the analysis phase, it's time to structure the idea phase and start generating ideas for parts of interface.

A focus is created on the physical interfaces and the application interfaces. The application interface contains menu navigation and the elements of the interface which will be designed; cards, the layout structure and placement.

In the concept phase more attention will be put in realisation methods and parameters of the concepts. The idea phase remains mostly visual.

2.1 MINDMAP

To create structure in the idea phase a mindmap has been created with results from the analysis phase. The mindmap is an overview of parts taken into consideration during the idea phase.

The mindmap is pictured in appendix V. By

Seen in the mindmap is the focus on ergonomic, fast and efficient interactions, including navigation through devices via menus.

Firstly Physical interfaces of Homey will be used

The physical interfaces, the LED ring and the audio are focussed on delivering feedback, which needs to be as simple and uniform as possible.

The application also features these focusses, but also adds a lot more in terms of elements and interactions.

2.2 PHYSICAL INTERFACES

LED Ring

Physical interactions which can be perceived by the user must be appealing. The voice of Homey is adjustable, therefore the audio feedback can be tweaked to the likings of the user, but the LED ring is a fixed component with endless possibilities.

Using 30 independent controlled LEDs placed around the contour of Homey, a lot of animations are possible. Despite of the seemingly low amount of LEDs, the contour is fairly small with around 38 centimeter, which would mean a LED to light a line of 1,25 centimeters.

Since there is also a diffuse material on top of the LEDs, the spread of color will be good.

Audio

Homey is equipped with a speaker, but also connects to the speakers in house. The speaker of Homey is needed for initial setup, but is a great tool to alert the user of any problems of Homey itself. When situations are discussed audio is external unless stated otherwise. When the audio output comes from an external source, it is using the users available speakers. Internal source is the speaker inside Homey itself.

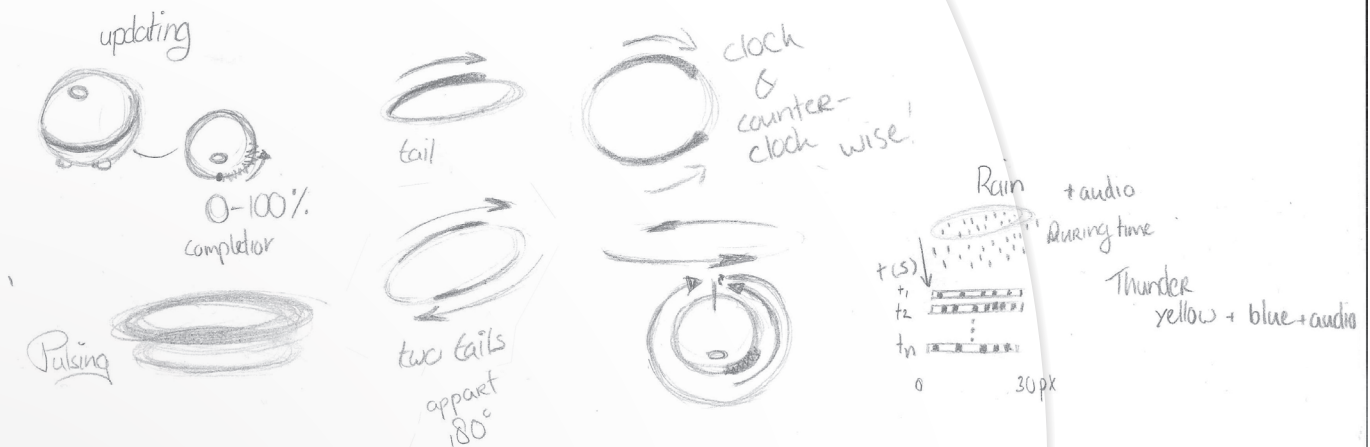


FIGURE 20: Sketches of LED ring animations.

The situations

Situations of Homey events are linked to an LED animation, which are also sketched above in figure 20. Combined with an audio event.

First boot of Homey

LED ring animation: Homey's rainbow animation pulsing.

Audio (internal): A short introduction of Homey and how to setup.

Pairing device

LED ring animation: Like Homey is busy, a pulsing orange, or yellow light. Followed by a succes or error situation.

Audio: Beeps you hear during bluetooth pairing, which are mostly positive high sounds.

Updating

LED ring animation: Starting at the front, clockwise

completing the LED ring. With intensity difference (glow) a nice completion loading animation can be created.

Audio: No audio feedback given, unless an error occurs.

Software error (brick)

LED ring animation: One to three LEDs on the front color red, This could be a code to check in the manual.

Audio (internal): low, negative beep, with big pauses in between.

Idle mode

LED ring animation: Homey rainbow animation or custom animation settable using an application.

Audio: No audio feedback given.

Event triggered

LED ring animation: Homey's rainbow animation glows, speech intensity of Homey is linked to a pulsing LED ring.

Audio: Information about the event using speech.

Listening mode

LED ring animation: Homey lights up in a neutral color and pulses linked to the user speech intensity,
Audio: If there is audio present, it will be muted.

Loading

LED ring animation: An intriguing loading animation will be displayed, a cluster of 5 LEDs will feature a fading tail which is circulating. More intriguing would be using two tails going in opposed directions.
Audio: Not necessary.

Successful loading

LED ring animation: A green pulse on the LED ring will show the user a positive action has taken place.
Audio: Confirmation and/or summary of the action, if the user has set this in his preference file.

Error during action

LED ring animation: A red pulse on the LED ring will show the user an error has occurred.
Audio: Summary of the error.

Speaking to the user

LED ring animation: Homey lights up in a neutral color and pulses linked to the Homey speech intensity,
Audio: If there is audio present, it will be muted and Homey's voice will be heard.

Alarm

LED ring animation: Homey lights up in a red color and will show a red tail when it is performing actions.
Audio (internal & external): If there is audio present, it will be canceled and Homey will inform the user off the situation (using voice and the application).

For example when CO is detected (red pulse), the closest window will be opened (red loading tail) and the user will be wakened by an alarm over the speakers and the Homey will inform using notifications and speech.

Controlled by an application

e.g. Weather
e.g. Disco

Custom application e.g. weather application:
Homey can use the external speaker if asked What's the weather and respond with the current temperature and weather conditions.

Beautiful weather:

Light blue with a few clustered pixels showing an orange/yellow sun

Snow:

Slow animation, using 2 LEDs next to each other, with white color where one fades to another in a few seconds. This happens around the whole globe.

Rain:

Fast animation using pixels which appear 'off' a dark space between the drops can be made, which makes it an active shower.

Thunder:

During rain, or during a normal weather bright yellow/white pixels flash. So the a few blue pixels will flash blue, yellow, blue, yellow.

2.3 APPLICATION INTERFACES

Navigation: menu and flow

Navigation can be done via filtering using device categories. This filtering will occur when the user goes through the category menu.

The current situation, as pictured in figure 21, lacks an ergonomic perspective, when the user wants the most top category, the lights.

Some more ergonomic menus have been created as seen in figure 21.

Where the names of categories are not always depicted immediately, it would still be clear for the user, since it will make use of icons, just like in the current situation.

Holding the finger over the icon, shows the corresponding text, for example: Appliances.

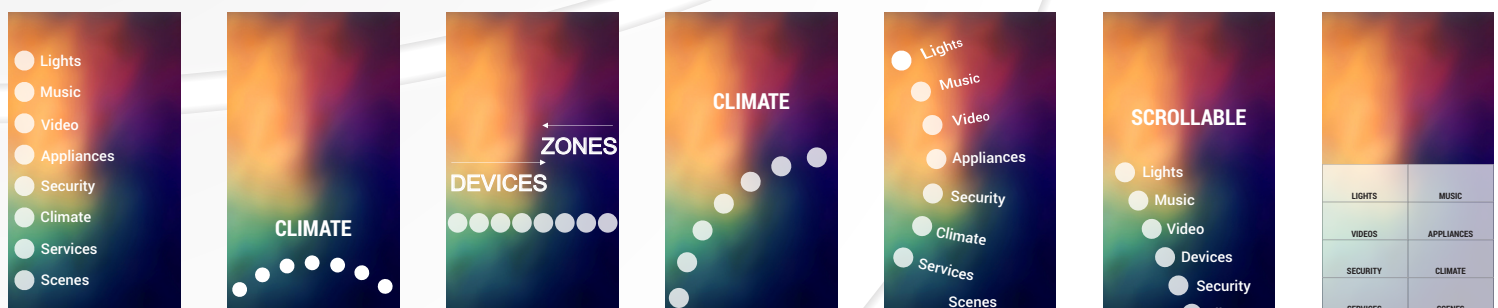
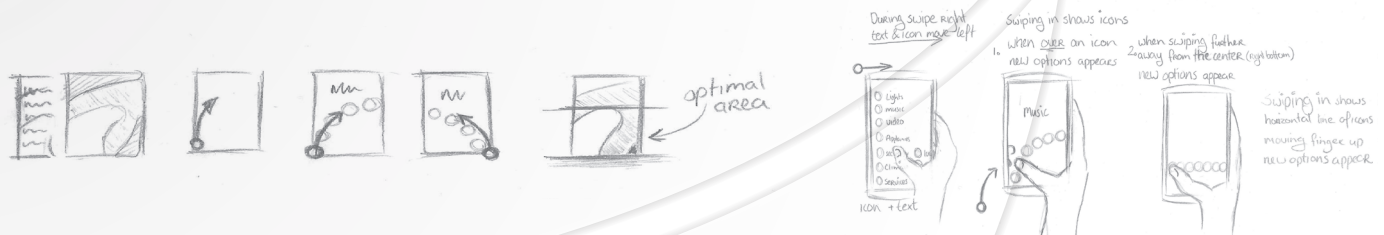


FIGURE 21: Sketches and visual representations of menus created for a fast, ergonomic responsible menu.

Element: Homey's speech recognition inside the application.

Homey has the power to listen on the users smartphone. The input of the user is then represented as a sinus shaped line, mixed with speech intensities and values.

Some users are not charmed by an always listening smartphone, when using the application, therefore there should be a setting to turn it off.

If the voice control from the smartphone is turned off, the fading background is going to be less high, allowing for more space inside the application.

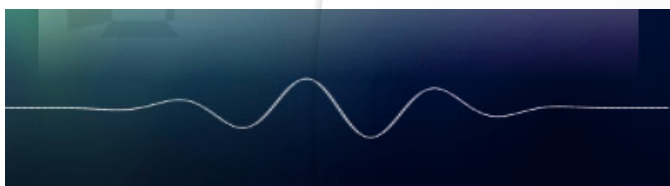


FIGURE 24: The original Homey speech line on the mobile interface, as presented in the visual prototype by Athom.

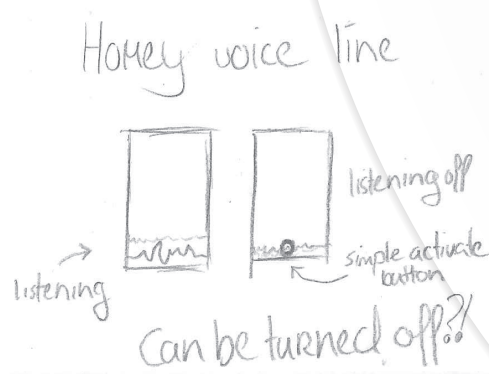


FIGURE 22: Turn voice control off in the application?

Elements: the application card

Navigation filters devices, but more importantly, what happens next? The device which is controllable is shown on a card. This application card contains information about the device. Is it turned on, what is its status and more if the device supports it.

The card is a small surface on which the device has to be controlled. This is a challenge. But since there is no limitation about what a card is, the ideas for a consistent, easy to use and powerful ideas for a card have been made.

Imagine the application card of the device being one of many cards of this device where you can scroll through. The card is essentially a window behind which houses many cards.

The size of a card is not predetermined, but during conversation with Athom, ideas regarding bigger cards are possible and are also possibly desired. Creating the possibility to enlarge the cards allows for more controls and information to be shown.

These ideas will be visualized, creating ideas for a structure to be used for the cards. Sketches are available in appendix VI.

Navigation in a card?

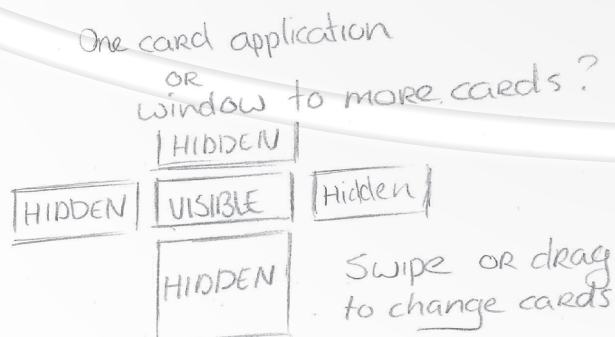


FIGURE 23: Using a card as a window, hiding other cards behind the window. The placements provides visual tracking

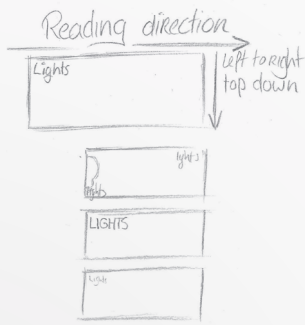


FIGURE 25: Visual interpretation of the reading direction on the left and examples of placements on the right.

Elements: Placement of elements

The application will consist of a certain elements. These are:

- Label
- Device icon
- Device text
- Device status
- Widgets
- Widget text

The reading direction is crucial for a lot of western civilized countries. The reading direction also causes the first association with what you are seeing usually is the center, or the top left of the screen. Whatever draws enough attention. Icons on the left give a great idea of the card, followed by the text as seen in figure 25 and figure 26.

The widgets could be placed on the right, but controlling is preferred in the green area as seen on figure 26 and the device icon must be present for recognition. What about combining?

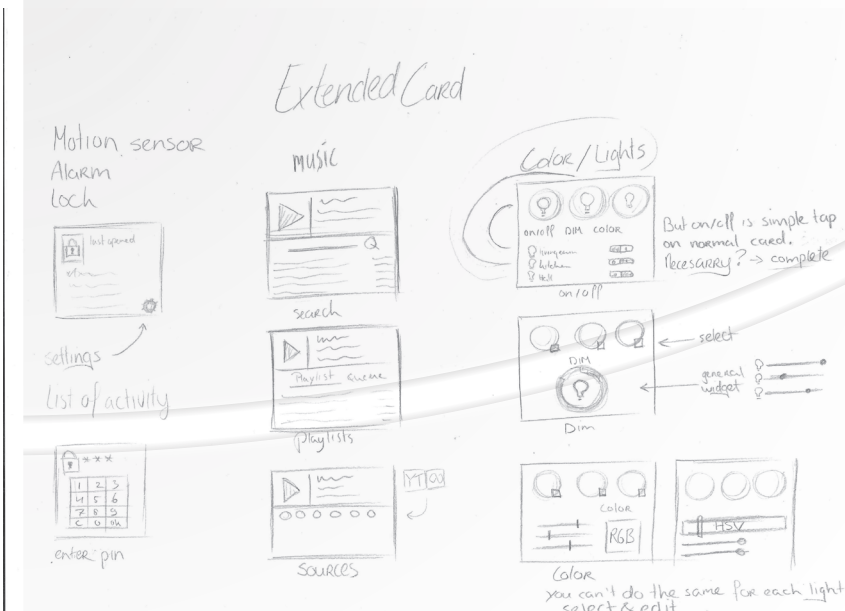


FIGURE 27: A sketch of the placement on the extended card, using functional examples. (also available in appendix VI).

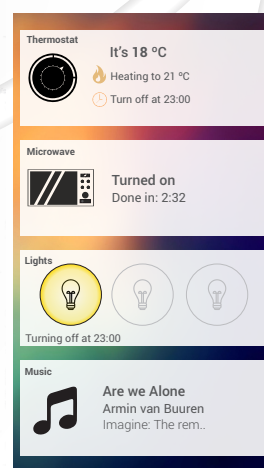


FIGURE 26: A detailed image which enhances placement of elements with ergonomic preferred placement.

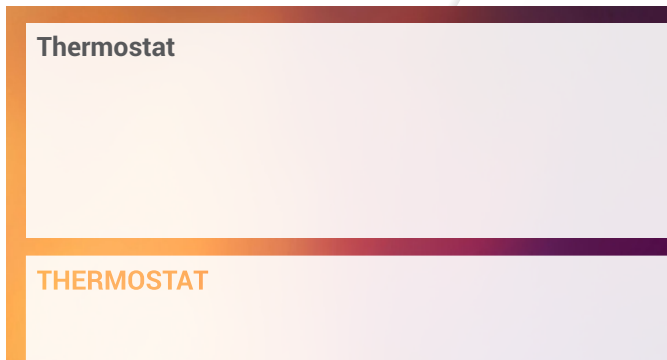


FIGURE 28: Two cards showing a bold label. One is colored with dark grey, the other one is capitalized and is transparent.

The device label

For placement of the label, it is key that it is readable. A bold font is chosen with the color of the background, or a dark grey color for contrast. Depicted in figure 28, the label with different colors and capitalization is shown. What can be concluded is the capitalized 'THERMOSTAT' is harder to read for the eye.

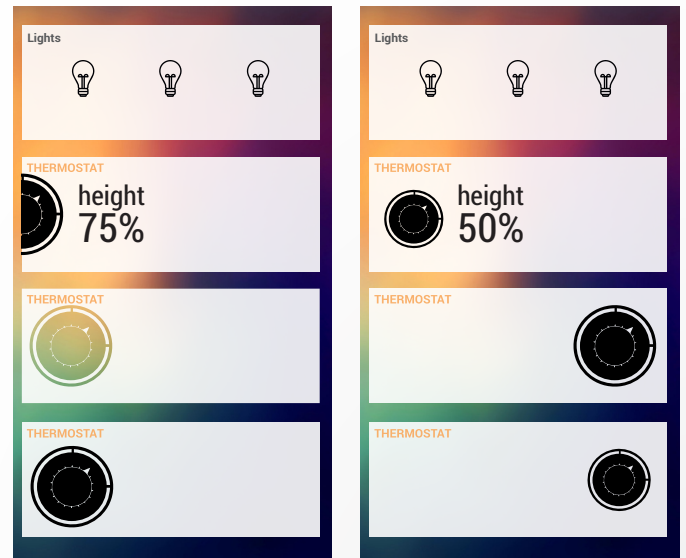


FIGURE 29: Eight cards shown with different placement and different sizes of the icon.

The device icon

Since it is true what they say, a picture says more than a thousand words, icons and good visual material saves a lot of text.

In case of the Homey application, a good representation of the device can cause recognition and the need to read the label is removed.

In case of a device icon, placement also abides the rule of reading left to right. When the placement is done on the right, as depicted in figure 29, the user will first read the text and then mind the icon. Whilst it is bigger in size and stands out, this will most likely be the case in many situations.

The amount of details in the icon must be spared in order to create a pleasant image for the mind. A lot of small details can cause the icon to be displayed poorly on older smartphones with low resolution.

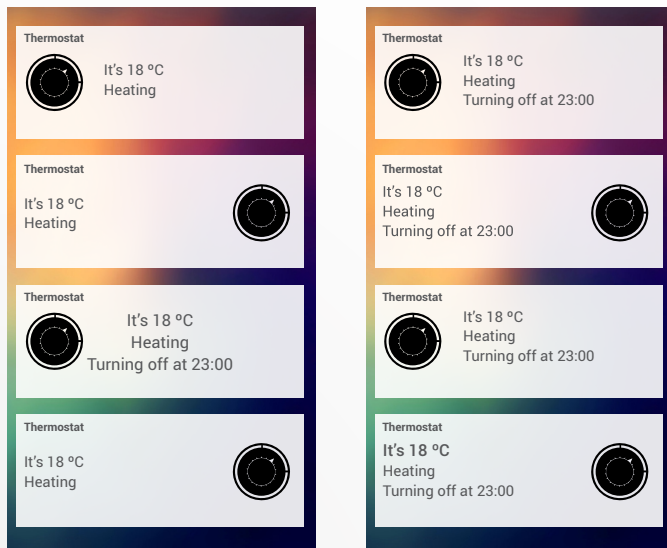


FIGURE 30: Eight cards shown with different placement of the device status and text.

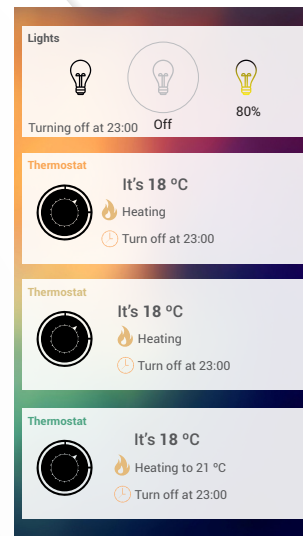


FIGURE 31: A few explanations regarding the placement and use of icons as visual backup.

Device status and text

When the information within a card is read and interpreted, the user should be well informed about the device.

Even a simple device like a thermostat can have a lot of parameters and a lot of information which can be shown. In figure 30 iterations of placement are illustrated.

For example:

- The current temperature
- The heaters are on
- The goal temperature
- A timer or a time to turn off heating

While the space is limited, the needed information must be displayed.

Combining a status in an icon would be an option. Since visuals, possibly combined with text, are great communicative resources.

Changing an icon or animating an icon should be kept elegant, thus not a lot of blinking and animating should be present.

So combining both device text and status text with the device icon, would leave an informative first interpretation of the current status of the device.

Combining icon and the device status

Using the combined force of icon and status text creates a more personal card. It allows for more information on the card, since room is spared.

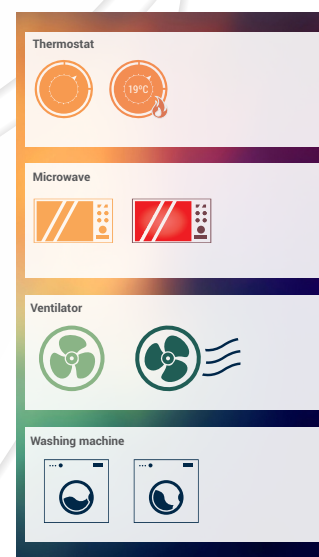


FIGURE 32: Combination of device icons and their device status.

2.4 WIDGETS GENERATION

Creating a set of widgets based on the functionality researched in the analysis and can be seen in appendix VII.

To find usable widgets for the functions, creation will be structured by generating ideas according to the function list.

Abstract functions:

On/off: 0 or 1

Regress/progress, : -1 or +1

On time, or timer: N or X-N

Linear: 0-100%

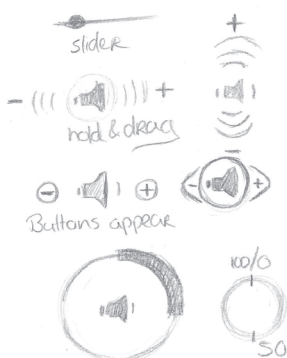
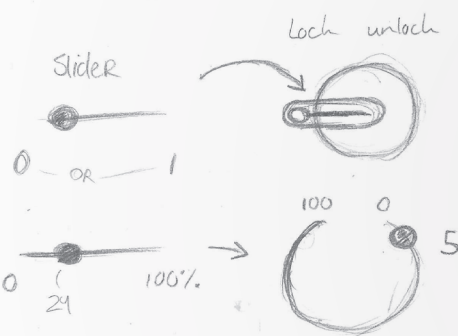
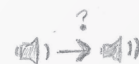
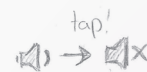
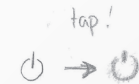
Color:

CMYK (0-100%)

RGB (0-255)

HSV (Hue is 0-360°, S and V values: 0.00-1.00)

Controlling



Circular widget

Buttons appear

75, 0, 25

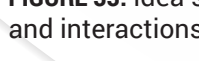
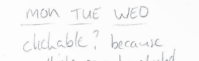
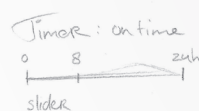
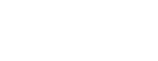
50%

Hold & options appear

Repeat: none tap/swipe

SUN Mon Tue wed Thu SAT

Music



Open/close lock/unlock

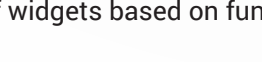
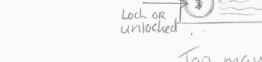
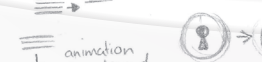
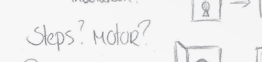
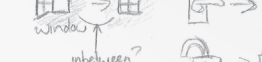


FIGURE 33: Idea sketches of widgets based on functions and interactions.

On/off

Using an on/off button the device can have a 0/1 handling. This is by tapping a button, or integrating the button with an existing device icon.

The change in status can be represented in visual feedback, an animation or color change in the button clear for the user.

A simple button can also be used to enter native apps or (help) websites.

Circular widget

A slider transformed to a circular widget is an astatic looking widget, which could be very powerfull.

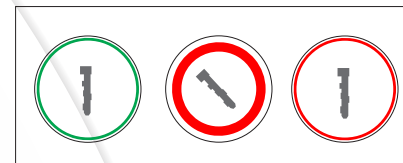
Based on sketches, a simple value changing circular widget looks very user and touch friendly. This could be the widget to for chosing a value on a linear scale.

It can also be loaded with different kinds of visual feedback. A thermostat widget can show temperature, the current status: heating by letting the circular ring glow. The interaction, going left or right of the center to cool or heat, is different than by changing a light brightness, but this could be a different set of parameters, instead of a totally different widget. This creates an uniform interface.

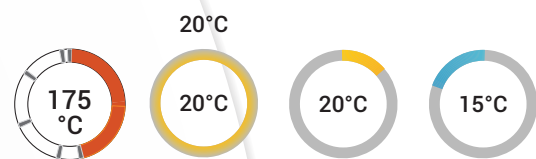
It is also possible to combine multiple functions in the circular widget. For example, lights can turn on and off, but are also dimmable. Some lights also feature color and temperature changes. This could all be integrated in one button. A simple tap turns the light on or off, a finger touch and drag changes value and the color values can be changed by cycling though the widget.

For time this could also be used, but it has to be tested if this is as user friendly as a timeline. It is though, very recognizable as a clock considering the shape. First setting the hours, then setting the minutes. For picking a day it would not seen handy. A horizontal date picker can be used.

More specific widgets, for specific devices can be created off the current models.

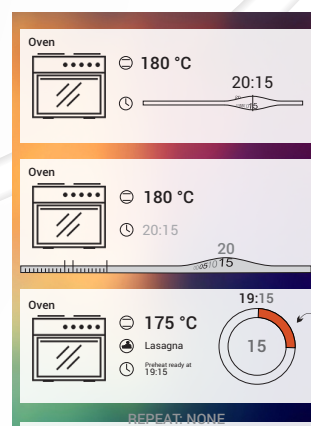
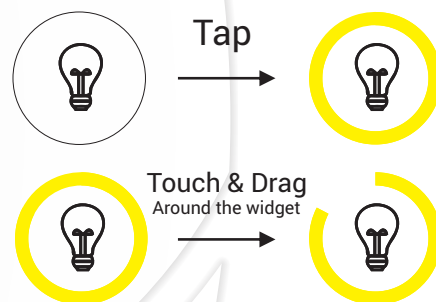


Tap, then visual feedback
Circle animation and color change



Circular widgets

Combining functions



A timeline appears
out of the icon ⌚

A timeline appears
at the bottom of the card

First set hour
then minutes

REPEAT:
SUN MON TUE WED THU FRI SAT
REPEAT WEEKLY REPEAT MONTHLY OK
REPEAT: MON THU SAT

FIGURE 34: Ideas of widgets more function specific orientated.

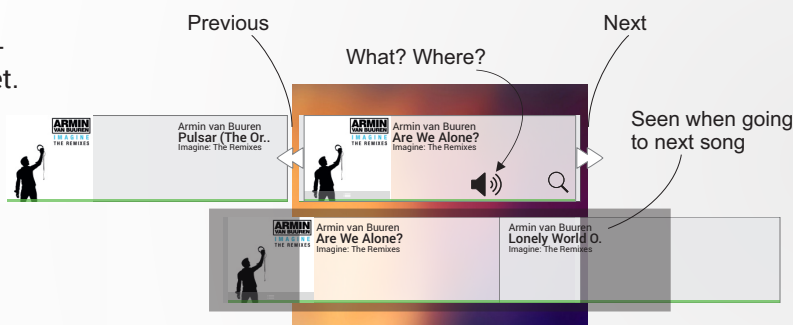
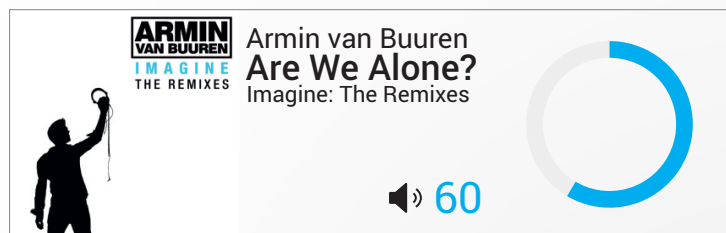
Media widget

A more specific widget is the media widget. This widget manages all media input and can control one of the 'probably' most used functions; music. A specific card is desired, which brings more functionality for the user. An interactive card, which 'cycles' through your songs. The user needs to be able to control the most important functions. These are:

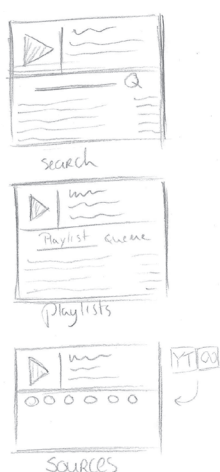
- Play/pause
- Next/Previous
- Volume
- Check playlist
- Search
- Source (of media and of output)

Since the extended card is created to provide more information and control, this is used in the media widget. The extended card ensures the playlist and possibly search can be integrated without over populating the normal card..

This music could also be used for managing the video media.



What will happen with the playlist



ARMIN VAN BUUREN IMAGINE THE REMIXES		
Armin van Buuren Are We Alone? Imagine: The Remixes		
PLAYLIST	QUEUE	
Intense (The More Intense Edit...	Armin van Buuren	4:30
Save My Night (The Original M...	Armin van Buuren	3:22
Are We Alone (The Original Mix...	Armin van Buuren	3:50
Pulsar (The More Intense Editi...	Armin van Buuren	2:52
Lunar (The More Intense Editio...	Armin van Buuren	7:56
Won't Let You Go (FEATURING...	Armin van Buuren	6:43
Love Never Came (FEAT. Richa...	Armin van Buuren	7:00
Sound of the Drums (FEAT. Lau...	Armin van Buuren	6:54
Don't Want To Fight Love Away	Armin van Buuren	4:55

PLAYLIST			QUEUE
Intense (The More Intense Edit...	Armin van Buuren	4:30	
Save My Night (The Original M...	Armin van Buuren	3:22	
Are We Alone (The Original Mix...	Armin van Buuren	3:50	
Pulsar (The More Intense Editi...	Armin van Buuren	2:52	
Lunar (The More Intense Editio...	Armin van Buuren	7:56	
Won't Let You Go (FEATURING...	Armin van Buuren	6:43	
Love Never Came (FEAT. Richa...	Armin van Buuren	7:00	
Sound of the Drums (FEAT. Lau...	Armin van Buuren	6:54	
Don't Want To Fight Love Away	Armin van Buuren	4:55	
Intense	Armin van Buuren	4:20	
LIFE Is Always Smiling	Armin van Buuren	1:11	

FIGURE 35: Media widget sketches and visual representations.

Extended card

The use of extended card can be used in a variety of situations. For displaying more information than can be seen directly like extending a list created by a motion sensor, or accessing bigger controls. This can be seen below in figure 36(right side).

To provide better controls the original widgets could be enlarged, as depicted in figure 36(left side). But this means that the user is not capable of controlling all devices on the card, in case of three lights on a card. So it means thinking of a way of selecting some or all devices on the card, or lights.

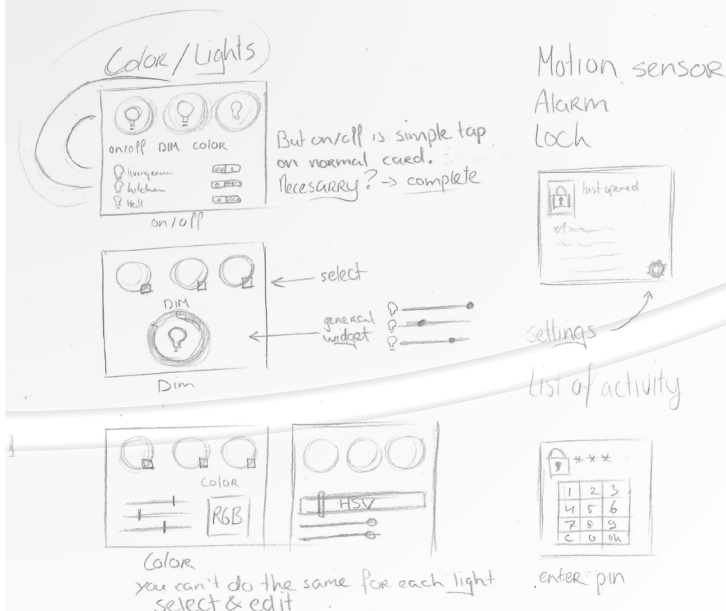


FIGURE 36: Extended card sketches. Left the color card and right an example for security.

2.5 CONCLUSION

The ideas created are varied and should be tested more in dept.

The use of round widgets and icons gives a familiar feel, since the iconic shape of Homey is a globe.

The physical interactions are based on situations and a following action with effects that create awareness of the user using speech and an animation on the LED ring.

A structure based on multiple cards behind a card 'window' is an effective way to hide more expert functionality or provide better usability since one of the cards enlarges the card. This card is the extended card. Navigation is optimized using menus, which are sketched and a more detailed visual representation. This could provide for a more ergonomic, faster use of the device menu.

Ideas of elements placed on the cards, already in context of a possible device.

Widgets are created based on the abstracted function and the functionality of the devices which have been analyzed before. Widgets that can handle multiple functions, are being created to provide a compact yet powerful interface. Currently there are ideas for specific widgets, these are:

- Button
- Circular widget
- List
- Extended card, (play)list

The ideas of cards and widgets are presented as sketches to Athom, which resulted in positive feedback and even more additional feedback for further development, based on

Physical interactions created will be handed to Athom, it can be used as is, or tweaked more to the likings of Athom.

Proceeding on to the concept phase, off to creating concrete concepts.



CHAPTER 3

Concepts and realisation

INTRODUCTION

To create parts of the interfaces, the analysis and the idea phase prove a good base to work out conceptual models of these interface parts. During the concept phase the workable and capable ideas created will be picked and discussed. These concepts will be developed and transformed into visual concepts and functional models to test it with users. The user test will provide results on which further development is possible. This iterative process is finally tested using a heuristic evaluation by Athom.

3.1 IDEAS TO VISUAL CONCEPTS

For this paragraph the elements are further optimized, so they can be used for testing and comparing. This means the physical interactions will be handled in the next paragraph.

In this paragraph the ideas of the application interface elements will be optimized. Not all elements will have different concepts, but in the case of doubt or multiple seemingly good ideas different concepts will be created.

Navigation: menu and flow

A navigation structure that is more ergonomic and better matching with the current style of Homey. What the users prefer is not clear, do they like the conservative icon combined with text in a vertical menu, or do they open up for an easy to reach, more iconic approach of the menu. In the case of a more ergonomic menu, both new menus offer better use of the menu with one hand and cause less strain on the thumb when using gestures.

Current menu

Seen in figure 37.

To test the user's preferences the current menu is being recreated. This menu causes users to move their thumb to the top left position of the screen, which is not reachable with normal sized hands, without changing the position of the hand. This does not fulfill the wish of fast and efficient navigation.

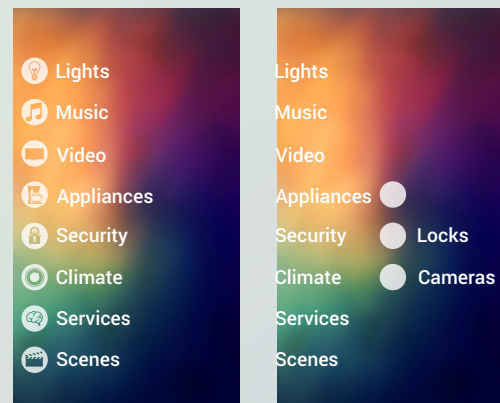


FIGURE 37: Recreation of current menu.

Horizontal menu

Seen in figure 38.

The positive ergonomic aspects are the easy to reach icons and the good interaction using gestures for all navigation options. It allows for fast navigation, without forcing the user in uncomfortable hand positions. The horizontal menu creates more strain on the thumb when using the options which are far right, in this case service and climate. In figure 38 it is seen that when the user touches an icon, or drags away from the 'ring', the new options emerge from the 'ring' and the original menu is decreased in size. The finger is immediately on the right spot.

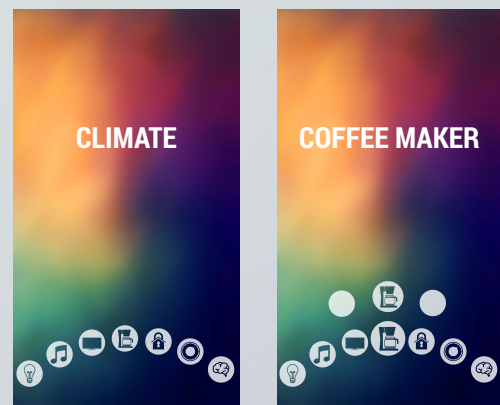


FIGURE 38: Horizontal menu.

Circular menu

Seen in figure 39.

The circular menu allows for a great reach of the thumb. This allows a great reachability with one hand, without straining the thumb. More easy control via thumb, and using gestures is possible without too much strain on the thumb. This menu handles the same as the horizontal menu, decreasing the original ring, from which the new options emerge.

Which of these menus is preferred by users? That is to be figured out in a user test.

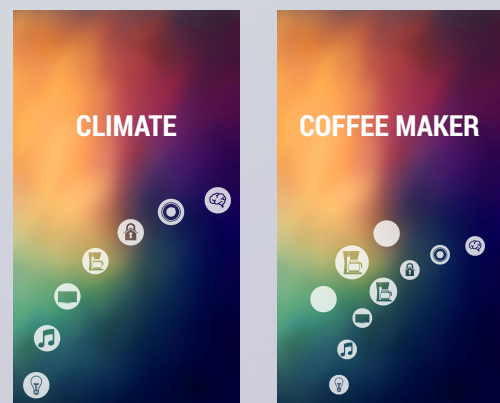


FIGURE 39: Circular menu.

Elements: card structure

Structure

Via idea generation a concrete structure was created. An extra card for personalization and a card with 'extended functionality', with increased read- and controllability. Visualization of this structure is seen in figure 40.

Dismissing a card

During a conversation with Athom, it seemed there was no concrete method of placing a card at the bottom of the 'stack'. It must be done via an interaction with the card. The idea was to create a dismiss function just like the Android OS has on its smartphone. This means swiping a card to the right could be used to place a card at the bottom of the stack.

Right card.. enhancement or addition?

The right card could be used as an enhancement of a feature. For example changing the color of a light with a widget the size of a card. But is it more preferable that the user can access the settings or scenes he has created specifically for that device.

Since home automation means that everyone can tweak their own house, does not mean every user will do it the exact same. Maybe someone wants a light to change in color over time, but does not want to set this manually each time. So saving a scene which is accessible by the touch of a button. This is device specific, so it is not like triggering a scene in which multiple devices can be adjusted.

Extended card

To extend the usability of a card, extra features can be added on, what is essentially, a card placed extra beneath the previous card. The usage will be widget specific and will be demonstrated in the concept generation of the widgets.

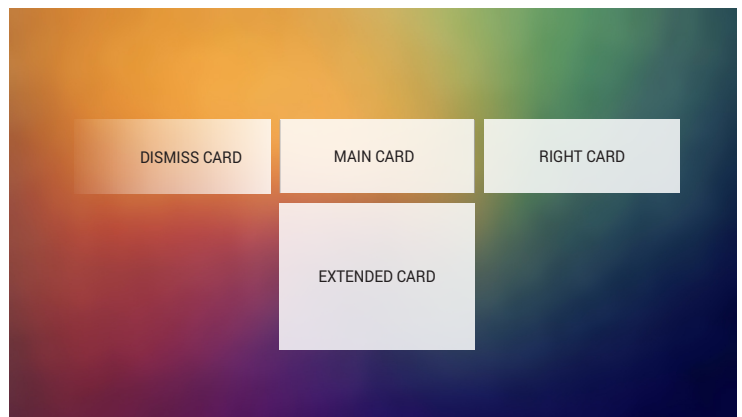


FIGURE 40: Structure of the cards

Elements: placement

The best ideas all featured similar placement. Visualized in figure 41 placement of elements in the most common card is shown. There are certain exceptions to this rule, for example the lights card. When a room has multiple lights, it is possible to place up to four light widgets next to each other, this rule can be used in other situations as well, one more example could be smoke detectors. Multiple detectors in a home can be viewed on one card (depends on the current zone, now house), a shared logging list can be shared on the extended view of the detectors.

The text which can is a textual feedback can be used as a shortcut to call the widget. In case of the oven card, the temperature or the time widget could be called by pressing the respective text.

Considering the safety of the devices and the house, the widgets are not directly visible, thus not controllable.

A notification, an element which has not been mentioned, has been designed to meet with a demand created out a heuristic; notify the user of an entered action (figure 43). This widget summarizes the action, and the action can be adjusted if the notification is being tapped. It send the user directly to the card. It is placed on top of all elements, with a black gradient behind it. It has a small margin from the top(2%) and from the sides (2%). Enough space for a summary.

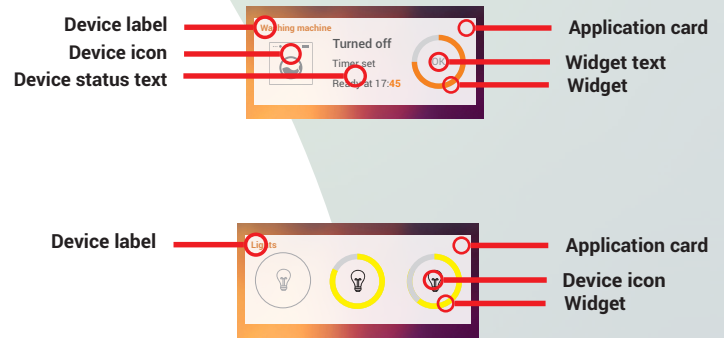


FIGURE 41: Placement of elements on the application card. Above is the normal card, below are multiple similar devices placed on one card.

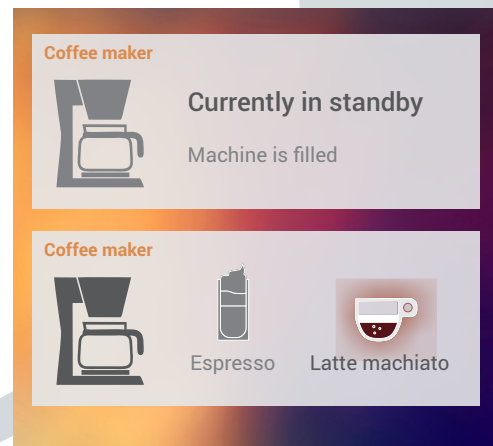


FIGURE 42: Coffee maker card. Above placement, below, active card with selected program.

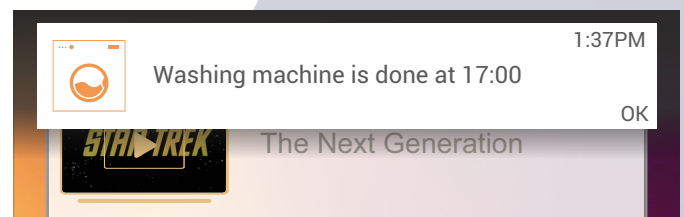


FIGURE 43: Notification of a washing machine turning on.

Widgets:

On/off

A widget which operates a change in status according to the 0/1 states. There are 4 examples of a button:

Simple button inside the card

When a card uses buttons on a card to provide functionality, for instance a cup of cappuccino, when there are multiple options available.

A small icon, if necessary with text can be placed. This custom icon will lit up with a glow, and will animate a zoom in and out when touched. Other device specific animations could also be added, like the fill of button being gradually filled just like a cup of coffee (figure 46).

Small icon

Animation upon tap interaction: Glow, button icon zooms in and out.

Possible icon fill layer animations

Confirm button inside a widget

Confirming, just a simple OK or a checkmark will confirm what the user has done.

Shortcut button on the shortcut card.

A shortcut button is much like a simple button inside the card, but a big difference compared to the simple button, but has a predefined default icon. The icon is accompanied by text. The icon animates with increasing size and a glow, but this glow remains active until any setting is changed, it does however returns back to its original size. The text also fades to a different color, emphasizing the shortcut settings are active.

Device icon button.

A device icon is an icon which reflects the device it is from (figure 45). This icon can be a representation of the device, or has inherited the icon of the category. The device icon could be used as a button. The icon can be used as an on/off switch for the device, or a shortcut to the widget that is hidden on the card.

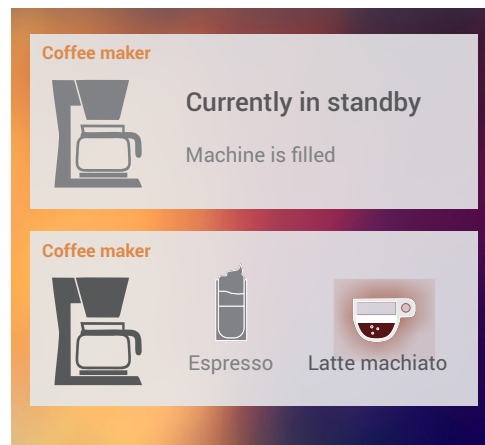


FIGURE 46: Coffee maker card. Above placement, below, active card with selected program.

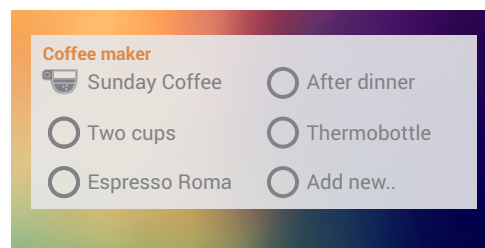


FIGURE 44: Shortcut buttons, these are simple, but can be changed by developers.



FIGURE 45: Pressing the device icon starts the Robot cleaner, this makes the icon animate and change color.

Circular widget

The versatile widget that has a touch friendly look and feel. While small, this widget acts as a slider, which is capable of hosting a lot of functionality. Intensity, colors, distance. Every single parameter linear formula could be represented in this widget.

The thermostat which moves different then a normal linear knob, can also be represented in a circular widget, it just needs other parameters to make it work. By adjusting settings and parameters in such a way, the thermostat could be represented as seen in figure 48. The thermostat has a temperature range of 10°C-30°C, The look and feel of an older thermostat, turning the wheel, using an animated icon inside the widget. The color options discussed in the idea generation can be integrated as seen in figure 49. The linear values are realized inside a formula. Where the color temperature is created from a range of about 100 - 10000°K with a white spot around the 5000°K, the normal color values that will be passed on to the RGB LEDs are approached via a more difficult function. Using the HSV(Hue, saturation, value) a nice color representation can be made. Hue from 0-360° will show a full rainbow. The function of the widget will then be: $3,6 \times X$.

Also a more complicated code can be generated, if it has better performance, using direct R, G and B values. Mixing the values between 0 till 255 creates a rainbow. The circular widget can be equipped with a button, as stated in the idea generation. For the lights this is the on and off button for that particular light. For time this is the confirm button(OK).

A special version of the circular button is the creation of a circular button which is only covering half a circle as seen in figure 51. This widget is cognitive better for actions as:

- Up or down (blindings)
- Move left or right (curtains)

A lot of variation and options are available, using parameters. Summed up below are the ones changeable by developers. The other parameters will be defined by Athom.

- Value range
- Value changing formula
- Start position and value
- Step size
- Animations
- Interaction(s)



FIGURE 47: Circular widget for brightness



FIGURE 50: Volume widget for media control.

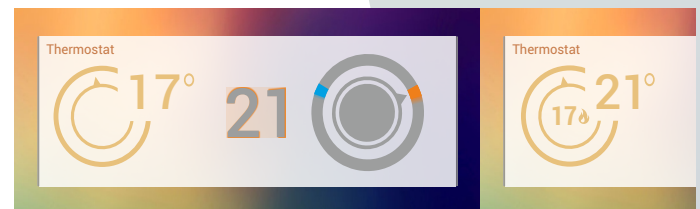


FIGURE 48: Thermostat like circular widget(middle) and multiple states communicated via the device icon. Idle, setting and heating.

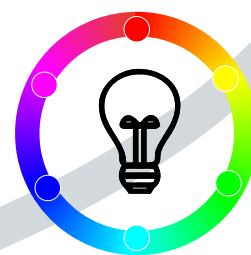


FIGURE 49: Hue color circular widget (left) and color temperature represented in a circular widget.

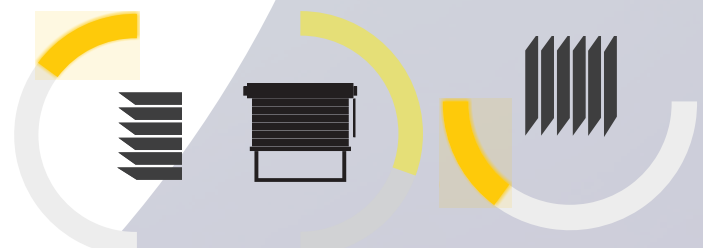


FIGURE 51: Half a circle as widget for blindings elevation(left), angle(middle) and curtain position(right).

Media widget

A widget that is completely filling a card. The media widget controls the music throughout the house. It houses a lot of features in a small card. Since the handling of this card is different than regular cards, this card does not support a right card.

Swiping and dragging on the music card controls the music. Dragging the card to the left shows the next song. When the card is released beyond a threshold (+60%), the next song will play. This functionality gives opportunity for a new function. When the next song in the playlist is not as desired, swiping the card down, while still dragged to the left (the next song is visible), will cause the next song card to 'break' and a new next number to appear.

In extended form the media widget houses a playlist, options to search and select sources. After iterations in the idea generation phase, the extended card was created and tested on the screen.

The wish was to implement playlist, search, source and output, this is done via tabs with icons.

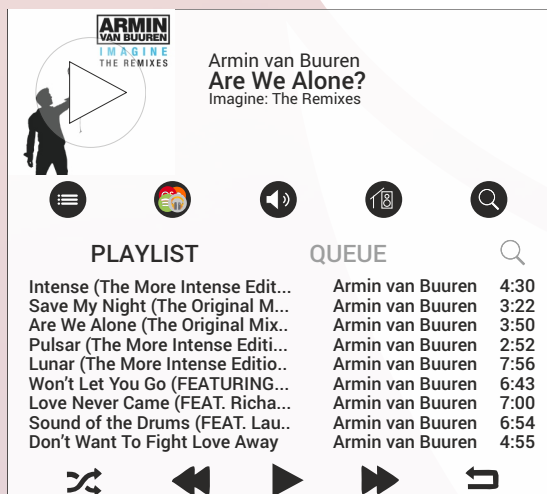


FIGURE 54: Extended card of the media card

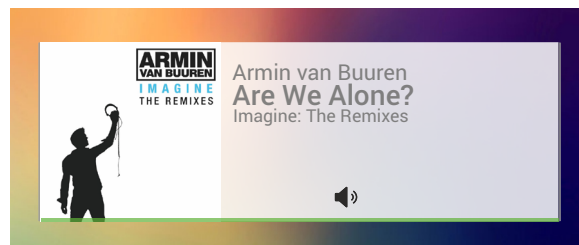


FIGURE 52: Normal state

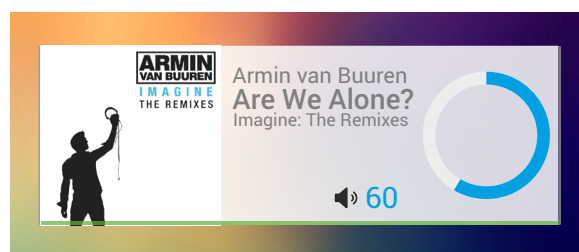


FIGURE 56: Volume widget visible



FIGURE 53: Dragging left to check the next song



FIGURE 55: 'Breaking' the next card

Time and date widgets

Multiple good ideas for setting time have been generated. The timeline is a good example of a simple yet very effective slider, it speaks for itself by simplicity. The round widget allows the user to input values just like on a clock, it is therefore possible to quickly see and input the desired input. With an OK button in the center, the user can switch from the hour circle to the minute circle. Reentering values is done by setting time again. Another timeline has been created, this timeline however is full screen. Not wished for by Athom. Since I feel the users are cramped on space, the timeline will appear as a way of inputting time, during the user test. This will give insight about the users preferred widget size. The concepts can be seen in figure 57, 58 and 59 seen on the right.

The date is picked differently. The Homey application is not going to be as versatile as the flow editor or web application, but there will possibly be an option to select one or multiple days on which the device can repeat the just entered settings. For example the curtains to be moved in front of the window at 7 PM, can be inputted once, saved as a custom shortcut or can be repeated by pressing repeat. A selector will then appear, which works in the same way as a tick box really. The days are visible and when the user 'ticks' a day, the text of that day will appear in color. This visual feedback is handy to check the values entered, after pressing ok the day disappear and the repeat:none has changed in repeat: days which are selected. This is seen in figure 60.

REPEAT: NONE

REPEAT:

SUN MON TUE WED THU FRI SAT

REPEAT WEEKLY REPEAT MONTHLY OK

REPEAT: MON THU SAT

FIGURE 60: Date via a date picker.

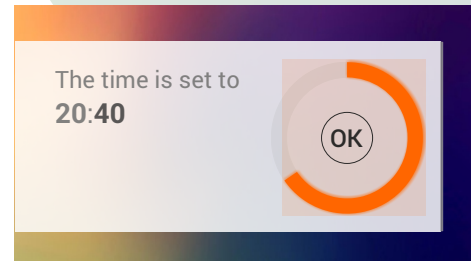


FIGURE 57: Time via a circular widget

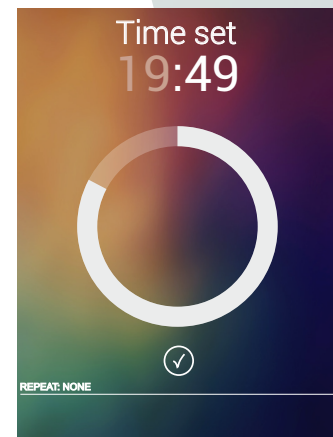


FIGURE 58: Time via an enlarged circular widget..

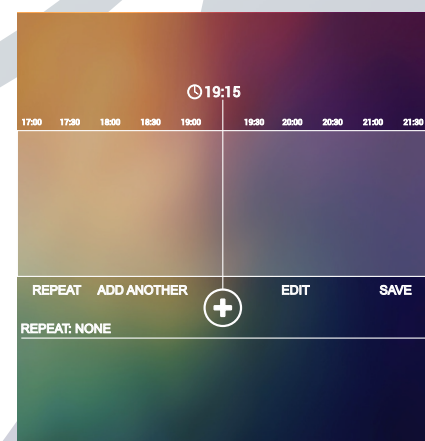


FIGURE 59: Time via a timeline.

Selector widget

Multiple options can be selected using a selector widget.

Standard the selection is off, or the default setting. This widget came forth off the date picker, because sometimes a user wants to select a program.

In the case of one possibility it is an OR treatment off the options, allowing only one option. When there are multiple options to choose from, for example the date picker, it is an AND relation between the options. It is comparable to a radiobox (OR) or a checkbox (AND) element which are frequently seen on websites. In figure 61, the basic elements: a radio box and checkbox are seen. In figure 62, the concepts of a selector widget is shown. Using a selector widget based on the circular widget and a selector based on the date picker.

Specific: lights and all the options

Lights can be controlled via the main card. Besides on and off, the different functionalities are color picking, color temperature picking and setting the brightness level. Using the right card for color picking, or using the extended mode to pick a color are good options.

As seen in figure 63. Creation of the concept is seen using multiple more detailed visual ideas.

The use of a color picker on a card could also hint on another card for the color temperature. This is not according to a uniform structure. The choice has fallen for an all-round widget to turn the light on/off, change the color and the color temperature. This versatility is created by embedding 4 functions in one circular widget. A tap can will turn the light on or off. Moving the values on the circle mean change in color or color temperature in the same way as the brightness, but with different values and scale..

Scrolling through these functions quickly must be done in the quickest action, according to expectations of users during interaction. While the tap and hold function is recognized to edit the current element, a double tap is significantly faster. So implementation of the double tap is preferred in terms of efficiency. The results have to be tested, but since it is a not frequently used interaction, the interaction could be used for expert functionality.

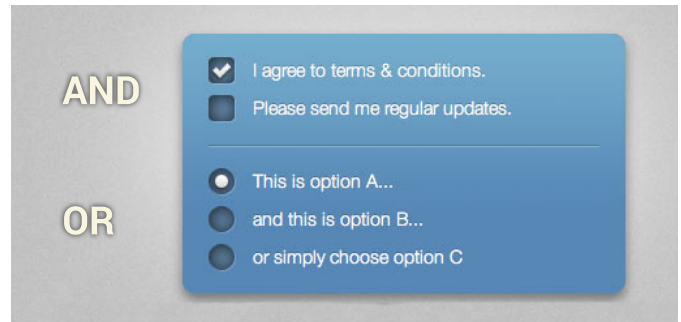


FIGURE 61: Radio- and checkboxes as seen on websites⁽²⁷⁾.

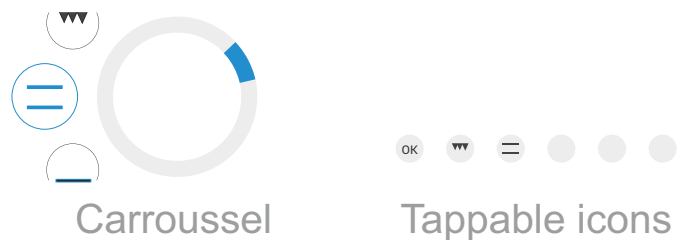


FIGURE 62: Circular selector(radio) and tappable icons(-checkbox) for selecting one or multiple options..

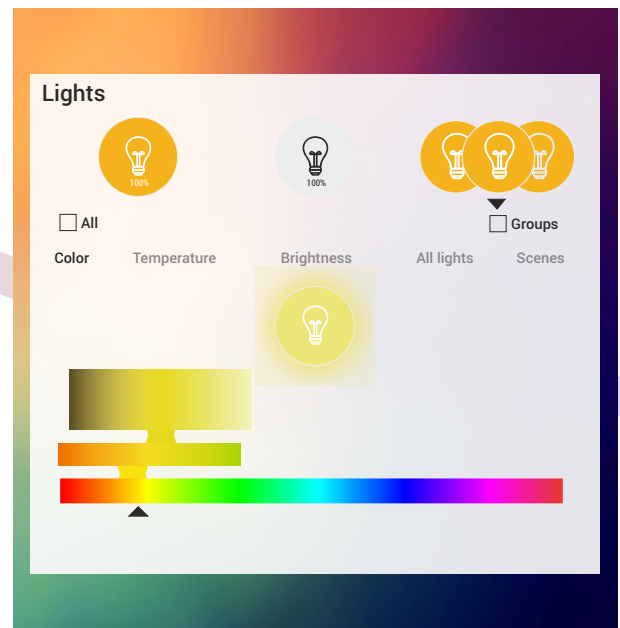


FIGURE 63: One extended card of the lights card.

Extended card of a lights card

On the extended card the widgets can be enlarged, so they are more touch friendly and accurate for the user. A different widget can be displayed, or a more versatile widget can be created based off the original circular widget. Two concepts have been created based on the controllability and increasing functionality.

Extended card and the widgets

Extended cards mean for the largest part enlarging the information, and improving controls. Cases which use the extended card are:

Detectors (motion, fluid, open/close etc.), which create a list of logs. Enlarging the list shows an overview, where priorities are visible with a last known time and date, seen in figure 65.

Possibly provide option to export the log immediately for reviewing purposes, or maybe in the future change settings, but that is way ahead of plans.

An extended card of your personal vehicle could give you a view which is comparable to the loose application causes given by the manufacturer. The overview more room and places to change or view parameters, such as climate, locks, battery level and location. This concept is shown in figure 64.

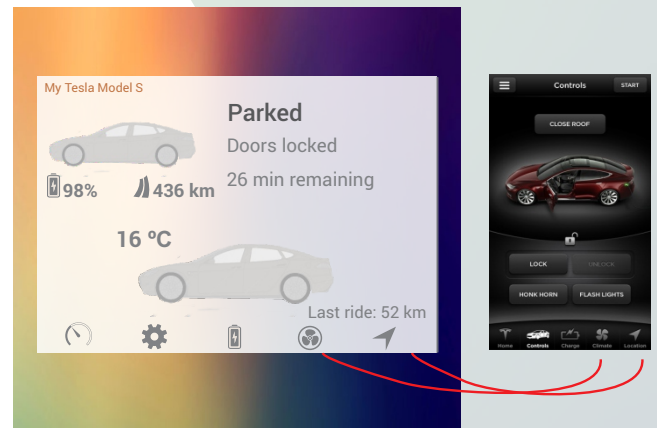


FIGURE 64: One extended card of the Tesla car, which is possible to integrate the app.

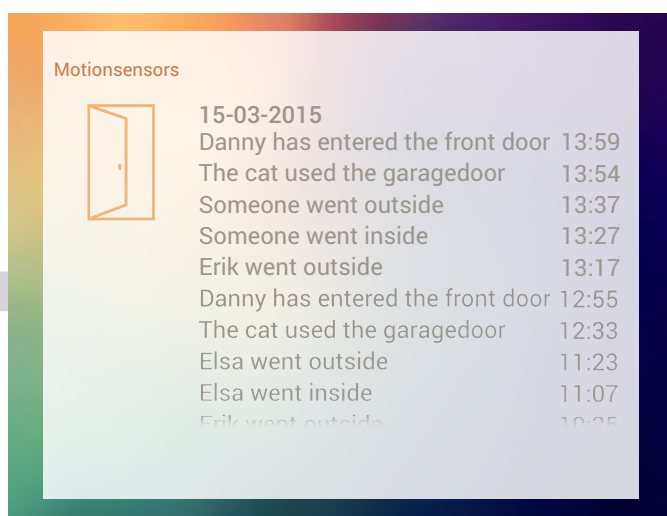


FIGURE 65: An extended log list.

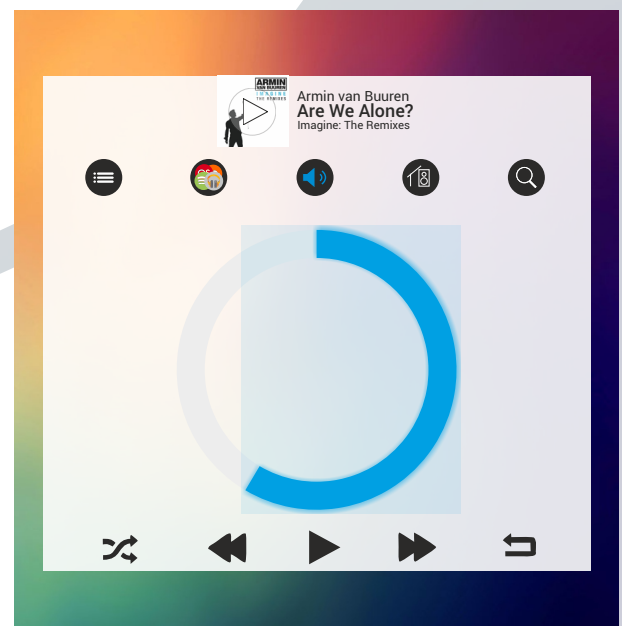


FIGURE 66: One extended card of the music extended volume card. An enlarged circular widget.

3.2 IDEAS TO FUNCTIONAL CONCEPTS

Preparations

Creating working functional concepts of the ideas generated and the visual concepts.

To create functional concepts, a few steps have to be taken first. Determine the tools and how to evaluate.

Building: how?

To create functional concepts, the elements have to be placed in a prototype. In this prototype a lot of functional elements and interaction must be built to create a good test prototype. Building a prototype in a 'website' like environment requires the right tools. It can be built by hand or using a program, which generates the code.

Additional knowledge of programming has to be learned prior to creating functional prototypes.

Physical LED ring building – first touch with JavaScript.

The first step of getting (back) in touch with JavaScript, the situations of the LED ring created were translated to functional animations on the Homey prototype.

Homey was already a viable prototype to test the LED ring on, since the demo housed software with a working LED ring.

For creating a Homey LED ring animation, the steps are:

- Create an application with JavaScript – Or editing an existing JavaScript application seen in figure 67.
- Load and run the application on Homey using Node.js as seen in figure 68.

The powerful software of Homey converts the software code to manipulate the RGB LEDs on the Homey prototype.

Since there already was an application which created a rainbow effect, there was a sample code available. Using this code animations where made like pulsing, and one LED which ran across the ring gradually changing its color. An example of code is visible in figure 67.

The Homey prototype was then used for demo purposes, and I was provided a 'LED ring simulator' with more up to date code. Basically using the same method, but simpler as before, changing the R, G and B values of

```
139 } else if( whichAnimation == 5 ) {
140
141     console.log('Wiggle Dance');
142
143     var active = 0;
144
145     // loop frames
146     for( var f = 0; f < 30; f++ ) {
147         var frame = {
148             duration: 1,
149             pixels: []
150         };
```

FIGURE 67: JavaScript code of animation number 5.

```
C:\WINDOWS\system32\cmd.exe
C:\Users\Ivo\Desktop\Homey\LED states and interactions\HomeyLed\tester>node app.js
Wiggle Dance
r: 255, g: 0, b: 0 >
r: 255, g: 50.999999999999986, b: 0 >
r: 255, g: 100, b: 0 >
r: 255, g: 153.00000000000003, b: 0 >
r: 255, g: 204, b: 0 >
r: 255, g: 255, b: 0 >
r: 203.99999999999994, g: 255, b: 0 >
r: 153.00000000000003, g: 255, b: 0 >
r: 101.99999999999997, g: 255, b: 0 >
r: 51.00000000000004, g: 255, b: 0 >
r: 0, g: 255, b: 0 >
r: 0, g: 255, b: 50.999999999999992 >
r: 0, g: 255, b: 102.00000000000009 >
r: 0, g: 255, b: 153.00000000000003 >
r: 0, g: 255, b: 203.99999999999994 >
r: 0, g: 255, b: 255 >
r: 203.99999999999994, g: 255, b: 255 >
r: 153.00000000000003, g: 255, b: 255 >
r: 102.00000000000009, g: 255, b: 255 >
r: 51.00000000000004, g: 255, b: 255 >
r: 0, g: 255, b: 255 >
r: 50.999999999999986, g: 0, b: 255 >
r: 101.99999999999997, g: 0, b: 255 >
r: 153.00000000000003, g: 0, b: 255 >
r: 204.00000000000007, g: 0, b: 255 >
r: 255, g: 0, b: 255 >
r: 255, g: 0, b: 203.99999999999994 >
r: 255, g: 0, b: 152.99999999999991 >
r: 255, g: 0, b: 102.00000000000009 >
r: 255, g: 0, b: 51.00000000000004 >
[Error: getaddrinfo ENOTFOUND] code: 'ENOTFOUND', errno: 'ENOTFOUND', syscall: 'getaddrinfo'
C:\Users\Ivo\Desktop\Homey\LED states and interactions\HomeyLed\tester>
```

FIGURE 68: Node.js pushing the LED ring application to Homey with animation number 5, Displaying the output(RGB) for the LEDs.

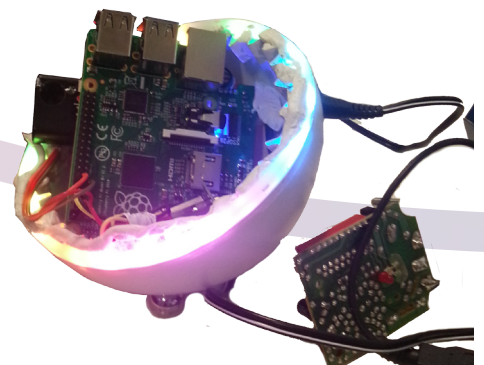


FIGURE 69: The physical Homey demo showing a LED ring animation.

the LED, animations could be made. The change in pixels however, was not send to Homey, but visible on a webpage as seen in figure 70. This was created by Athom for use with the Development Kit in the near future.

Using what program?

Since a prototype for testing needed to be created. A piece of software for creating cards, elements and functional widgets has to be found.

Good options were found in:

- Axure⁽²⁸⁾
- Pixate⁽²⁹⁾
- Pure code, JavaScript, jQuery and HTML with CSS⁽³⁰⁾.

Axure is a software mockup tool, which works very simple and intuitive. Easy creating a tool, but then generates out a very 'closed' website which can be used for testing. The limitations that come with this are big when custom elements have to be placed.

The same goes for Pixate, which is focused on mobile platforms. Pixate shows your creating almost live on the smartphone via an application. This is very neat and looked promising. Yet it does not integrate with plugins or custom content. It does create nice low fidelity prototypes for behaviors and interactions.

Pure code is immerse and versatile, integration is possible with plugins and own content. Viewing on mobile is possible by using a web server, XAMPP is a solution that handles this. This way the smartphone can navigate to the concepts (websites), so building and optimizing for the screen is possible.

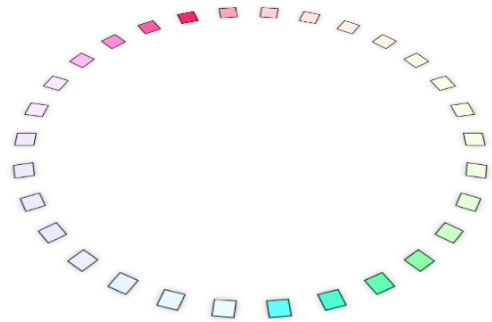


FIGURE 70: Complicated loading animation created with the LED simulator.

axure

pixate



XAMPP

Low-Fi or High Fi and Tools?

The choice of the tools is leading for the kind of prototype. The limitations of the prototyping tools Axure and Pixate causes a restriction on the possibilities, where using pure code is only restricted by knowledge and time.

Since the Homey application is going to look pretty different than current applications, it is desired that flexibility and possible integration of plugins is possible.

The choice, after testing all for a methods short amount of time, is using pure code, because of the flexibility, power and the good integration with mobile testing using the right software.

Investigation

Setting up the workflow for a pure code prototype.

Create structure in and for building and determine what is necessary. A small list is compiled and used for creating the visual concepts.

HTML

- Elements

CSS

- Placement and appearance

JavaScript

- Functionality beyond HTML and CSS animations

Plugins

- Written scripts with functionality

3.3 VISUAL TO FUNCTIONAL CONCEPTS

Building touch

First a few plugins have been tested to check if touch is easily to integrate in a webpage. A first bump in the coding road, it did not seem as easy as estimated. Touch events were therefore coded by hand, by detecting the touches and the difference in X and Y values, during and after touch. Challenging but satisfying when it worked.

Building the 'frame'

The now famous wallpaper was translated into the application. All the elements were built slowly into the application. Using a combination of HTML and CSS, the application was quickly taking shape and looking like a real application on a smartphone. Elements were placed on the screen.

Where necessary solutions were created in JavaScript, such as resizing based on percentages. Shapes like squares are not easy to build with percentages, but solutions can be created by using JavaScript to control these values.

Building interaction

Using touch detection in JavaScript and adding functions to certain touch events, the menu and swiping through cards have been realized. Creating widgets and the possibility of interacting with the light widget – tap to turn on and off, double tap to switch and to the control the widget are realized for the functional menu.

A jQuery plugin called 'Knob' by Anthony Terrien⁽³¹⁾ served as base, which was heavily modified to set color, brightness and color temperature, and combined in a single light widget. Not all interactions could be build in, but some can be simulated in the test in case of a hard to build widget.

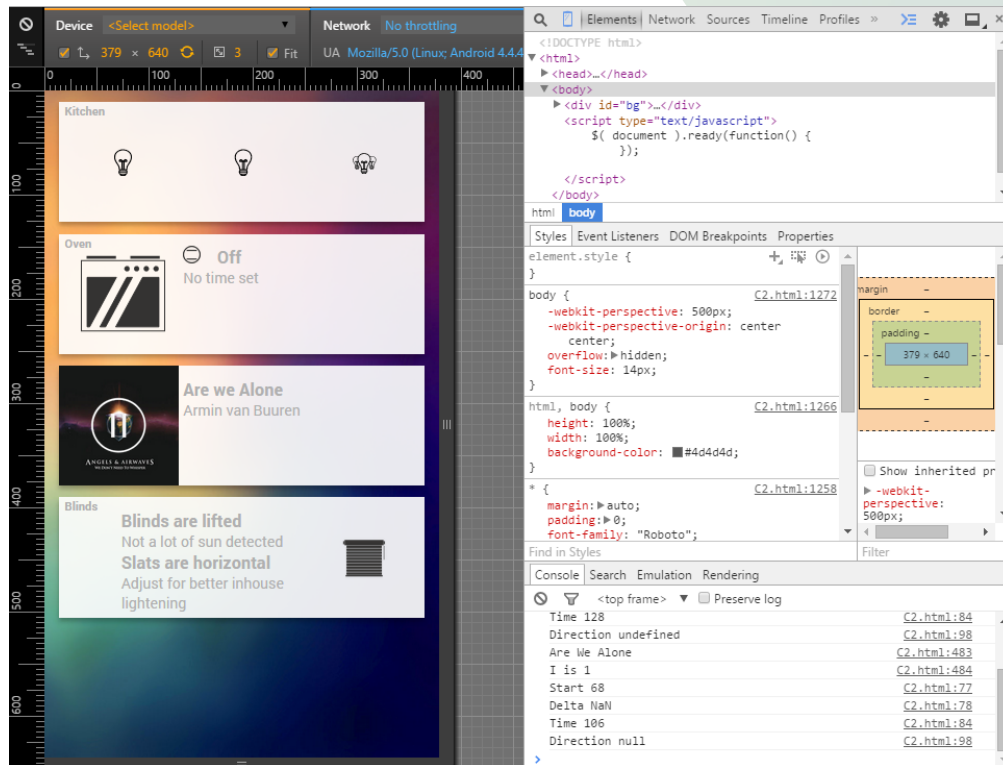


FIGURE 71: Visual of functional concept

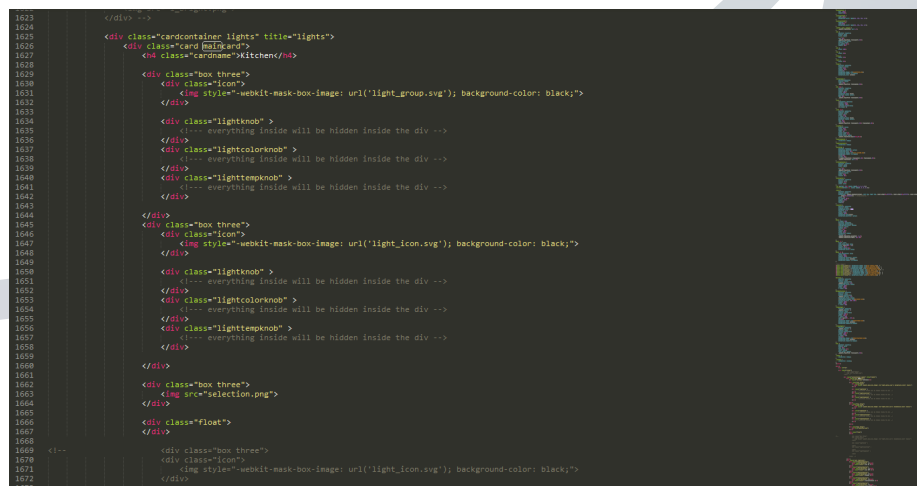


FIGURE 72: Piece of code from the concepts. It shows the HTML construction of a card, filled with multiple light widgets.

Adding dimensions

What parameters are in the functional model?
Not all elements, but the essential elements are shown with dimensions in figure 73.

The card

Main card with space between the sides and the top and bottom. The height is 18% of the screen height and the width of a card is 92% of the width of the screen.

The extended card

The card is extended to 50% off the height of the screen.

The device label

80% of the standard font size, using the Roboto bold font.

The device icon

The device icon is placed in an element which is placed on one third of the card. The device icon then has a margin of 10% on all sides, adding up to an element which has 80% off the width and height of the element (which results in a wide rectangle). The device icon can be used as a button or a status indicator. To make animations and adding color possible, the icons are SVG's (Scaled Vector Graphics), and can contain multiple SVG's layered in the space of the device icon.

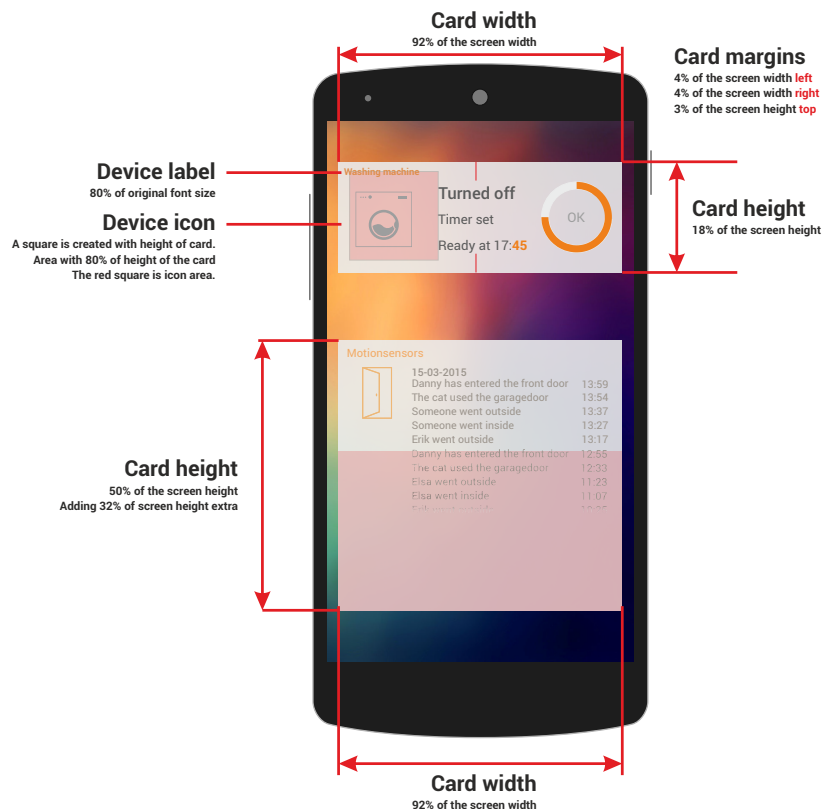


FIGURE 73: Dimensions of the cards and elements

The status text

The first line, which is most informative has a bold font, with font size 120%.

The second and following lines have normal font appearance and size. Up to four lines can be placed. An equal spacing between the first and last line must be made. The top (measures from the card) of the status text has the same margin as the bottom (measures from the card) of the status text.

The widget

The widget is placed in the same element as the device icon. This creates a more uniform look between icon and widget, when the same elements are used for example circles.

The widget icon/button

The background icon is the size of 50% of the widget. This is enough size for a readable icon and creates readability between the widget and the icon, by not clustering both elements.

The notification

The notification is placed over all elements and even places a dark gradient behind itself. This attracts attention and contains information about the just entered action.



FIGURE 74: Dimensions of a widget, the icon inside a widget and the device status.

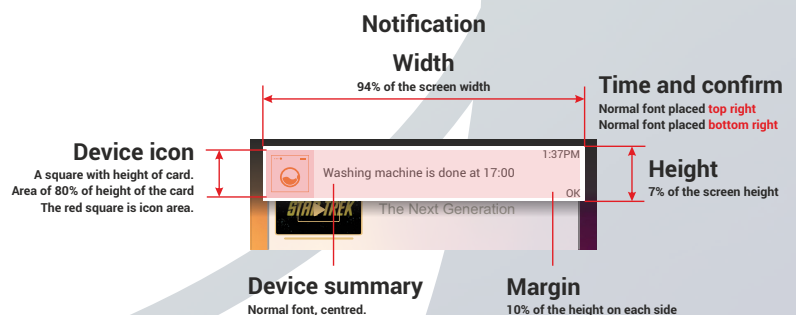


FIGURE 75: Dimensions of a widget, the icon inside a widget and the device status.

3.4 HIGH FIDELITY PROTOTYPE TESTING

Concepts for testing

Concept #1

Time input via the circular widget. Confirming the time set by waiting or pressing the clock icon inside the widget.

Menu navigation is done via the original menu, swiping in from the left, the vertical menu appears.

Concept #2

Time input via a much bigger circular widget. Confirming the time set by waiting or pressing the OK text inside the widget.

Menu navigation is done via a quarter circular menu, swiping in from the left, the menu appears and can be used by the user.

Concept #3

Time input via a full screen timeline widget. Confirming the time set by waiting or pressing the + icon off the widget. It is also possible to set more timed events and repeat the events.

Menu navigation is done via a quarter circular menu, swiping in from the left, the menu appears and can be used by the user.

Test setup

A user test has been conducted between fifteen participants. The participants have tested two concepts, of the three available. The user test will provide more information about the cognitive approach of the interface and how the participants interact with the designed concepts and if necessary what to improve about the interface.

The full test and results are available in appendix IX.

Brief explanation of the usability test

The user gets to test two of three concepts. depicted in the figures below.

What is tested?

- Ease of use of the widgets.
- Intuitive design.
- Menu and ergonomics.
- Efficiency
- Swiping of cards and navigating to advanced functions.
- Desired input size for a widget.
- Learnability.

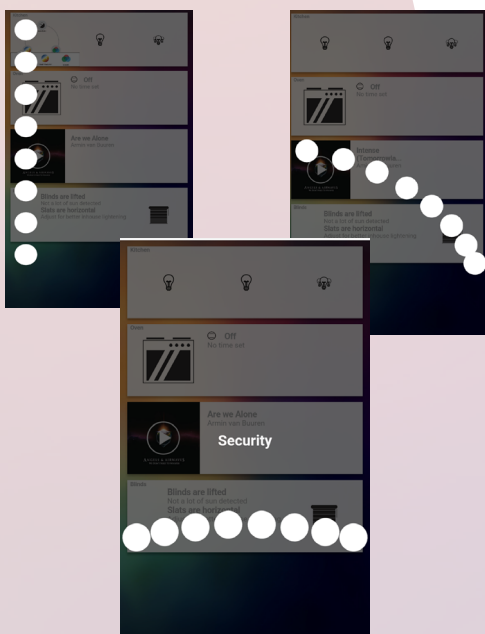


FIGURE 76: Device menus of concept 1(left), 2(right) and 3(center).

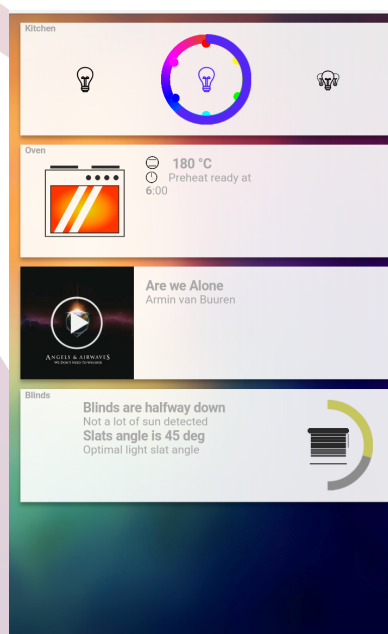


FIGURE 77: Blinding's half circular widget and the light color widget.



FIGURE 78: Media card viewing the next song.

This was tested with these variables:

- Time input
- Menu navigation
- Shortcuts
- Efficiency of input (time and movement)
- Find ability (intuitive & placement)
- Usability (ergonomics)
- Logics and intuition
- Preferences

Goals

Minimize input time, to increase efficiency and usability using a fast intuitive, efficient interface.
An interface which is easy to learn and adapt to, supported by explanatory visuals.

Hypotheses

We expect that..

Using the widgets

Using the widgets takes some time to get used to. But once mastered, the use is simple, fast and efficient. The time needed will be half of the original time. This effect is called the learnability.

Swift menu flow improves

Using a menu which is optimized for fingers on a smartphone screen. Different sizes and optimization for speed are made to improve the first vertical concept

for a menu. The preferences will be tested via the questionnaire and the time will be measured.

Menu ergonomics

Using the vertical menu the user has to switch hand positions with the smartphone in hand. This operations cause an unbalance for the smartphone and is causing overextension in the thumb joint. This can be seen by observing the position and the time.

Setting time.

Using a large timeline, in which a part of the day is projected, seems easier to reach the needed time.

When dragging the timeline, precision is key. The timeline zooms to get more accurate, although the speed of this process has to be tested.

Using a circular timer widget means an extra move, though recognition of the original clock means it is fast and accurate. The most intuitive way, and therefore guessing a larger and circular shaped control is preferred by the participants. This can be tested via time and preferences

Input size of widgets

Via different concepts several time setting options are tested, predicted is the larger widgets are preferred. The user can pick a preference in the questionnaire.

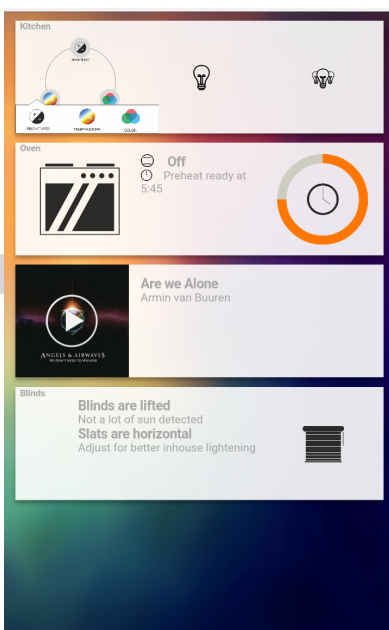


FIGURE 79: Setting time in concept 1

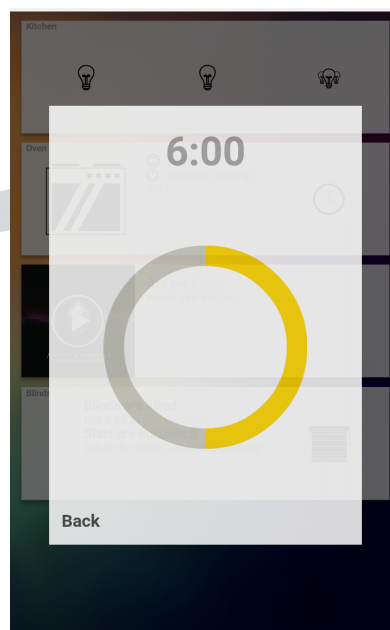


FIGURE 80: Setting time in concept 2

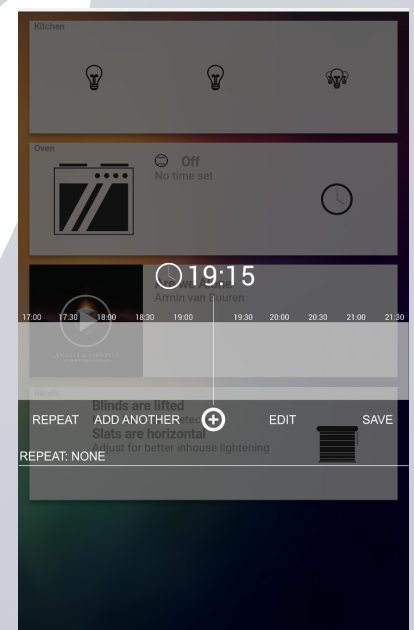


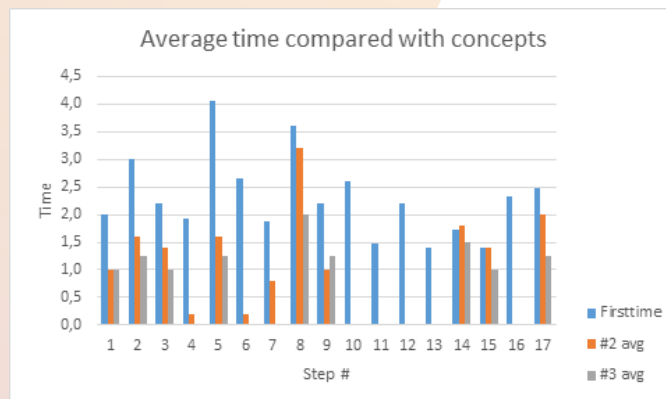
FIGURE 81: Setting time in concept 3

Results

Observations

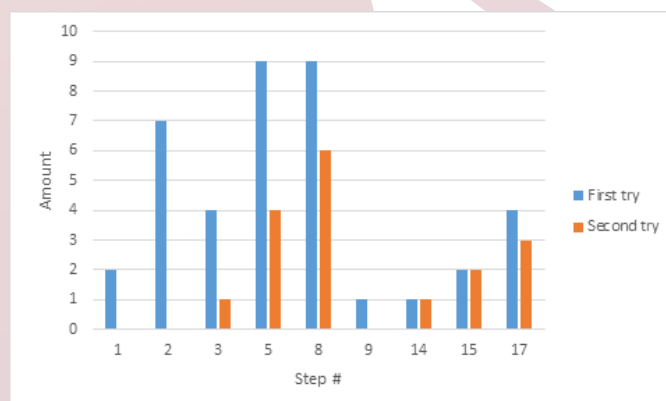
Results based on observations.

Time



The time of steps are significantly smaller the second time trying a concept. Except for step #8, #14, #15 and #17, where the time was less, but not significant. The blindings widget, menu calling which is fast enough. Step #17 is setting the time, which was faster then expected, but the larger widgets had a shorter interaction time.

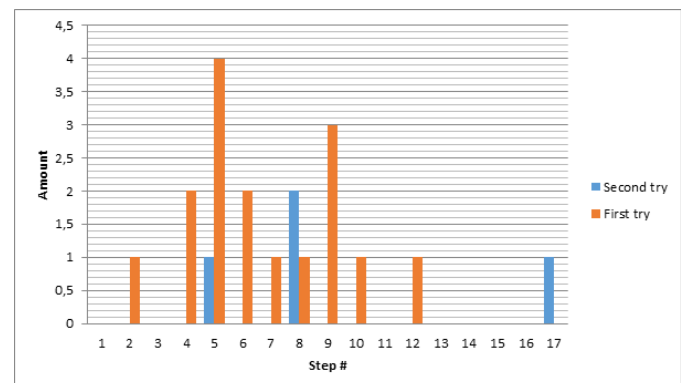
Errors



The errors are decrease significantly at step #5, the shortcut, double tap is recognized and used. Still errors occur at the blinding widget and setting the time.

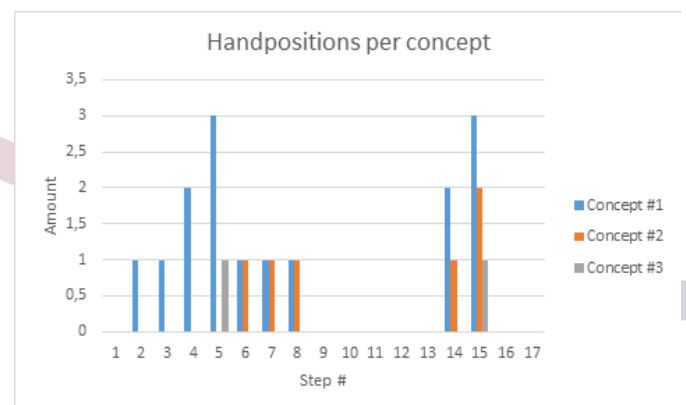
Where the errors in setting time were created because of the accidental touch of the confirm button and the concepts #3's fairly complex interface compared to a circular widget.

Questions



Less questions were asked during the second time. Questions about navigation to a second light widget and questions about the blinding widget were asked. The menu of concept #3 raised a question as well, quite possibly due to the complexity.

Handpositions



Decreased hand positions mean the position of hand did not have to move, and the participant can be more efficient. The decrease is due to the ergonomic friendly menus of concept #2 and #3.

Answers to the hypotheses:

Using the widgets takes some time to get used to..

The widgets indeed need some time to understand. The blindings widget needed the most time, but the other options behind the light widget was also unexpected.

Swift menu flow improves

No significant change in time, mainly a change in hand position. This reduces time a little.

Menu ergonomics

Have been improved, a lot less change in hand position and strain is noticeable. Unfortunately the user does not recognize the use of these menus or prefers the old menu for a reason.

Setting time

The larger time widgets are preferred above the smaller circular time widget. Of the options, the large circular widget is most preferred.

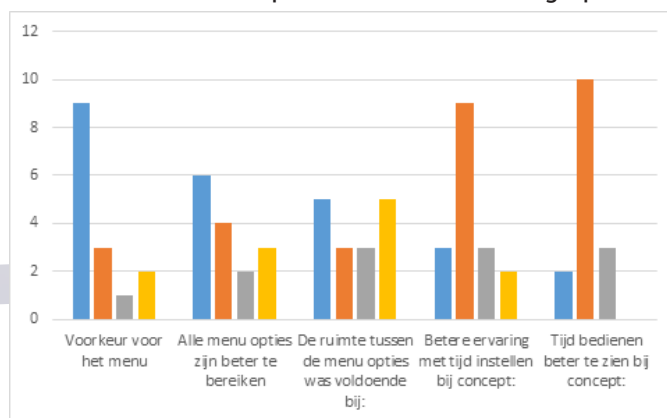
Input size of widgets

The user does indeed prefer bigger input controls, it was resulted from the questionnaire.

Questionnaire results

The user preferences have been analyzed with a questionnaire. In all cases the participants were mostly satisfied with the usability. The circular temperature widget could be bigger and have more space surrounding the widget.

Preferences for concepts are visible via this graph



Note: concept #1 is always tested, so a fair comparison can be made when the values of concept #2 and #3 are cumulated.

Remarkably the participants chose for the less ergonomic vertical menu to navigate with. Reachability was more evenly. The big winner is concept #2 at setting the time and reading the feedback.

Conclusion of the User test

People have a positive experience using the interface. Although a lot of features feel slightly new, the initial response is more positive change, then a neglection. This is supported by the results of the user test. The decrease in time, errors and questions are significant and in some cases extremely significant.

Results of the test

Ease of use of the widgets.

There is learn- and carry-over effect present, but also some limitations and usability problems regarding the size of the circular widget and text.

Intuitive design.

The controllability was considered fairly intuitive, the users stated it was clear what was expected when the widget appeared. Some aspects were less intuitive then others. Double tapping was not expected as behavior to cycle through the options, participant were often seen holding the button to check for additional options.

Menu and ergonomics.

Remarkably the participants preferred the vertical menu. If it is habitual or really ergonomically preferred is still questionable.

Swiping of cards and navigating to advanced functions.

Participants found the swiping easy, although dragging was sometimes their first action, which did not respond on the swipe command.

Desired input size for a widget.

The widgets for time and temperature were both used, but when asked for a preference, the most participants chose a larger size for input. This has a better usability since the interaction can be more one on one, then a little cramped.

Learnability

The learnability is fairly high. A learn-over effect can be concluded since almost every aspect; time, error and questions were significantly reduced the second time around, which was tested concept independent.

3.5 REDESIGN ELEMENTS

Concluded from the user test and using the heuristic demands, the following changes will be proposed. Visuals are provided, but also enlarged in appendix X.

Navigation

Navigation through the vertical menu is preferable, a known menu with better placement for textual placement next to the icons (figure 82).

Music widget

The music card will be equipped with a duration bar, showing the current duration of a song (figure 83).

Card hints

Card hints will be made, a single grey border as used in the concepts is not enough. This will be a more eye catching hint, a dark gradient to lighter, suggests the card is 'on top' and more actions can be performed. For the extended card this is also the case, using an element to show the card is extendable. A hint of three bullets with different sizes will hint a direction of swiping or dragging, by forming an optical triangle with unobtrusive, uniform styled bullets as seen in figure 84.

Setting time widget

Time input would be proposed as an external widget. A modal window animating from the card just tapped presents a widget which is of good size to use and falls within the ergonomic optimal area of the thumbs, so it is multi handed and user centered. This idea for a widget viewed in a modal, which is easier to use, can be used for every widget which requires more accurate interaction. Setting temperature, color or color temperature, it can all be placed in a bigger modal window. In figure 85 examples of color and time are given.

Hide widgets by default

Widgets which could potentially harm the house, or your energy bill must have a second interaction before it turns on. For a washing machine this could be an extra start button which must be pressed, else the washing machine does not turn on. Using two steps consciousness is gained and errors are prevented better.

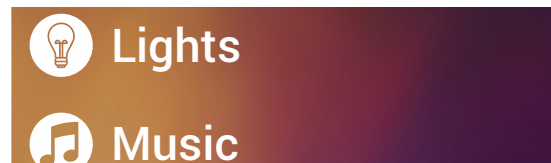


FIGURE 82: Preferred vertical menu.

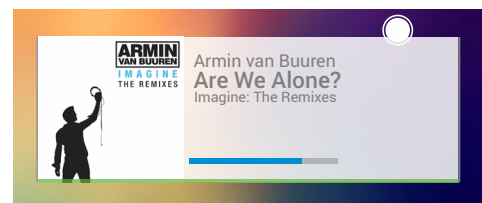


FIGURE 83: Media card with duration

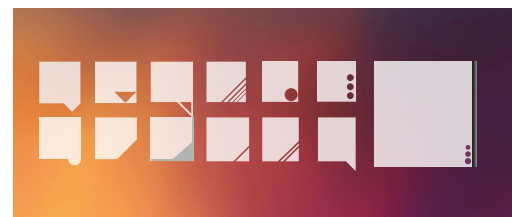


FIGURE 84: Card hints for extending and swiping. The hints have resulted in the most right square.

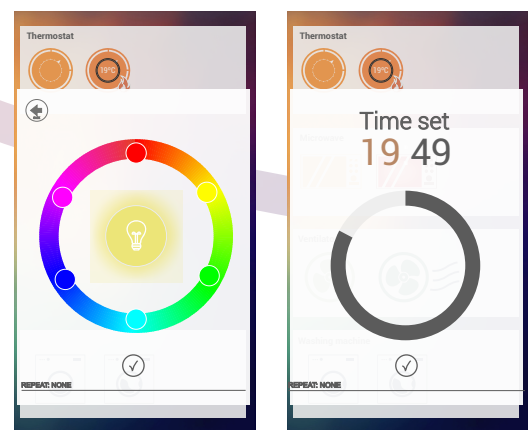


FIGURE 85: Setting color (left) and Setting time (right)

Notification

Another element which must be redesigned is the notification. While informing of the action, it is not directly capable of undoing a mistake. Therefore a simple UNDO will be added, to quickly revert a possible faulty input. The notification can be swiped away if obtrusive, tapped if needed adjustments of parameters, or undone by tapping 'undo'. The notification is seen in figure 86.

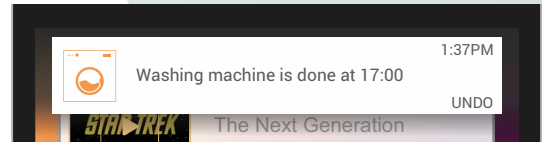


FIGURE 86: Notification with an undo button.

First usage help

An first usage widget is also created. It behaves like a notification and offers the user help. There is a mini tutorial, with steps that can be navigated through. It contains the title: First time usage help. And is equipped with a next, previous and an 'I get it' button. It has the width of a notification, with the height of 4 time the notification bar (28% of the height of the screen). An illustration with the device is shown in figure 87.

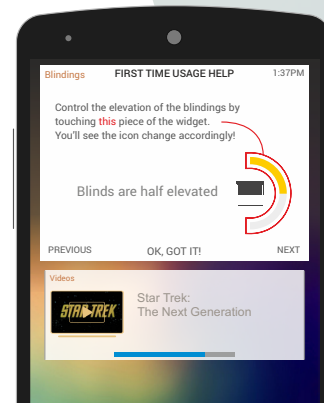


FIGURE 87: First usage help

Pop up

A Pop up. Not really a neat solution, but the reaction of a lot of participants was touch and hold, which brings them to an extended options menu, or shows the editing capabilities. This is illustrated in figure 88. This widget will appear on the card and cover it, with a margin of 10% of the height on all sides. The pop up darkens the original card, giving the idea, the popup must first be dealt with (or canceled).

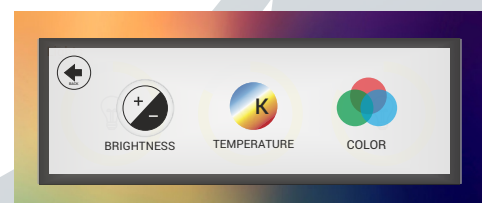


FIGURE 88: Media card with duration

Conclusion

By performing these redesigns wishes based on the user test and new insights regarding the demands of the heuristic evaluation have been implemented. This is a good step nearing finalization of the assignment and creating usable interface elements for the Homey application.

3.6 EVALUATION OF THE CONCEPTS

Rank to design brief

The total rank table can be seen in appendix XI. In this paragraph the rank will be shortly summarized.

From the design brief, which contains 45 demands, about one third is not completely succeeded.

This means 30 demands are honoured. 12 Demands are not fully honoured because of multiple reasons.

One of them is:

Sharing. It's too detailed. A function which maybe is going to be built; like exporting and sharing with people, but has no priority now.

Using AI to make controllable partially automated. This has to be communicated to the user. Using notifications or First Usage sized prompts to 'learn' preferences and to notify the user of automated tasks is an good option of improvement.

Demands where further investigation could be wishfull are:

- Do not allow casual user to set expert functions.
- Child and abuse protection using a security.
- Allow virtual grouping inside cards.
- Event logs and overview for coming period.
- Turning scenes on and off using cards?
- Warn the user of strange or dangerous input.
- Widgets usable in other enviroments?
- Swiping in up or down in a card is conflicting, pinch or tapping a better solution?
- Built in haptic feedback.
- Show breadcrumb navigation structure.
- Prevent errors and prevent an event with error to completely run.

Heuristic evaluations

After redesigning the elements which have been tested and hopefully improved the usability of these elements, another heuristic test has been done.

By Athom and by myself.

Completely worked out heuristic evaluations can be found in appendix XII. In this paragraph the remarks and conclusive findings will be treated.

Own heuristic evaluation

Compared to the visual prototype this conceptual model, combined with the visual models are a big step in the right direction.

More consistency is created due to structure and rules. The user has the option to create and execute his own shortcuts.

Feedback is given visually and textually, not to busy, but it is catching attention.

Notifications solve, revert and prevent errors greatly. They do however undo all settings of that device. which might not be desirable.

The user is capable of using advanced features using the extended card and double tapping on elements.

The use of icons and visuals for communication reduces memory load greatly.

Athom's heuristic evaluation

A summary of the biggest conclusions by Athom.

Consistency of interaction with elements can be more precisely executed in the concept.

Double tapping an icon should always make you cycle through functions, or never do it.

Shortcuts are currently seen as a treat of scenes, which can be easily made by users. Although these scenes house multiple applications and the shortcut card just device specific shortcuts, it seems they are competing instead of working together.

3.7 CONCLUSION

The generated ideas have been transformed to visual concepts.

The visual concepts were transformed into functional prototype, which would be used for user testing.

The right tools for the job have been chosen, and application interfaces, as well as physical interfaces have been transformed into functional prototypes.

The concepts varied on these elements:

- The navigation menu
- The way of setting the time
- Interaction expectations

The interface elements, widgets, and new menu structures were tested via a user test.

This test looked between subjects and between concepts. Between subjects was not varied enough. But between concepts lead to interesting results.

The carry-over was present. The amount of time needed, errors made and questions asked were decreased a lot the second time testen the prototype. The double tap interaction is learned quickly, while new.

The ergonomic menus were observable less agitating than the original vertical menu, because the hand positions were changed less often.

During the questionnaire however, the participants preferred the vertical menu, instead of an ergonomic menu.

The participants also preferred larger widgets to interact with, but had no problems with the smaller widgets.

Redesign of elements took place to incorporate the results of the user test.

The new concepts were then tested with the design brief, which led to 30 of 45 demands to be passed in full. and raised some questions for future development.

The conceptual elements were then subjected to a heuristic evaluation by Athom and myself.

3.8 DESIGN GUIDELINE FOR DEVELOPERS

The detail phase aims to finalizing details and building the product. However the product of this assignment is a Design Guidelines for Developers, with a set of widgets and does and don'ts for the Homey application. Most of what has been researched and created is mainly conceptual, except for the Design Guidelines which can be used by Athom for inspiration and creation of interface elements and interactions.

The Design Guidelines for Developers is part of a special appendix XIII. The final result is too big and too repeating to spend many pages on. It is available online.

The Design Guidelines for Developers consists of:

Welcome

Your application

- Function and
- Target group

Layout

- Structure
- Type of cards
- Placement
- Ergonomic rules
- Shortcuts

Navigation

- Cycling through cards
- Feedback

Content and context

- Amount of information
- What goes where
- Displaying text or icons
- Dynamic content
- Feedback

Interactions and feedback

- Prevent unwanted behavior
 - Dynamic feedback
 - LED Ring
 - Audio feedback
 - Notifications
 - First time usage help Widgets
 - Standardized widgets with guidelines of usage
- Secondary functions



CHAPTER 4

Conclusion and recommendations

INTRODUCTION

After the Design Guidelines for Developers was made, the concepts are finished. The elements and widgets created are proposed elements for Athom, and with that the assignment can be finalized. The assignment will be concluded with aspects learned and intel gathered from research and testing. The whole process has lead to a set of interface elements and guidelines for implementation inside the Homey application.

Recommendations can be made over the total process and the results. This could help the team of Athom when the elements are being created.

4.1 CONCLUSION

As detailed as currently possible a document with Design Guidelines for Developers is created.

Research has led to a good knowledge of Athom and their approach and style. With this knowledge new elements could be made in the style of Homey.

The difference between the competitors is the fact that Homey supports a lot of devices. Where other devices stop support, Homey can live on if the community builds further on the base. All these devices, which are currently available, are tried to grasp in a document. This list is decomposed to functions and stripped down to the basic functions.

The basic functions are:

On/off – 0/1

Timer – N or X-N

Next/Previous – +1 or -1

Linear 0 – 100

During the analysis phase the knowledge was gained for development on the screen and the methods of

creating a user friendly widget. Using the previous visual prototype as a base for testing the interface against the eight interface heuristics of Shneiderman. The results were already positive.

Generating ideas based on the gather knowledge started with the physical interfaces LED ring, and the audio out. Shortly after idea generation for the elements followed. A lot of ideas for elements have been drawn and then visualized.

Concepts created of the ideas were good representations of the functional models. The functional models were created using HTML, CSS and JS, creating a nice front end which is working and is usable for testing with users.

Variations were made in the menu, where more ergonomic and estimated faster menus are created and, later on, tested.

Variations in time setting were created to move a widget out of a card, creating a larger widget, with better feedback possibilities, this widget however does not meet the demand of fitting inside a card. The reason it was still done, was because of the expected

preference of the participants.

The user test was performed and concluded that navigation via a more ergonomic menu was not preferred. But larger widgets were preferred for users. The gives positive feedback about the interface and handling, although a bit more consistency in interaction could be made. This is done via a general mark-up which is presented in the concepts and the design guidelines.

In the time of the assignment it became more and more clear the concepts were created for insight and not for direct usage within the application. Investigation and user testing has been very resourceful to gain knowledge of the end users and they're expectations. Although the test has been conducted with a relative low number of participants.

4.2 RECOMMENDATIONS BASED ON THE DESIGN BRIEF

Recommendations concerning the assignment will be suggestion for further development.

First, the amount of participants of the user test were fairly low to be directly conclusive. Therefore I wouldn't throw the navigation menus overboard.

Based on the test and outcome of the test, a recommend action would be creating bigger widgets, which remain simple, just like the big circular time widget.
From ranking to the the design brief there were also

conclusions to be found:

- Do not allow casual user to set expert functions.
- Child and abuse protection using a security.
- Allow virtual grouping inside cards.
- Event logs and overview for coming period.
- Turning scenes on and off using cards?
- Warn the user of strange or dangerous input. Widgets usable in other enviroments?
- Swiping in up or down in a card is conflicting, pinch or tapping a better solution?
- Built in haptic feedback.
- Show breadcrumb navigation structure.
- Prevent errors and prevent an event with error to completely run.

The most important recommendations are:

Track logging events, make navigation to scenes possible. and show a navigation hint, in what room or category the current filter is active for instance.

For security measures, it would also be smart to add a pin or lock to the application to prevent misuse and protect valuable devices.



CHAPTER 5

Evaluation and reflection

INTRODUCTION

A hard part of the assignment is self evaluation and reflecting on the assignment in total. From process to product, the learning curve and the usage of the design tools and knowledge gained during the bachelor of Industrial Design. Some words will be spoken about the company Athom first.

5.1 EVALUATION AND REFLECTION

Athom has been a very good place to discover and experience a lot about the world after college. There is always someone around, and something to do, which was really great when I was stuck during designing or writing code for the test.

Late nights, but also good discussions were normal. Discussions about the widgets and usability. The elements and the interaction were a challenge to design and an even greater challenge to produce in working conceptual models. Finalizing a working concept for a test was a hard task. After preparing a test was conducted with 15 participants, which gave a lot of insight.

There were enough distractions, good and bad, which resulted in laying off work sometimes.

But delays because the model was not yet perfect was also troubling for me, since it was during the holidays that I would have wanted to create and finalize my report, but here we are.

Realistic goals and time planning is hard for me to cope with, but it is something that has to go away by experience in my belief.

With a huge delay, I must say that I have enjoyed my stay here, more then I'd like to say maybe, since these guys show work can be fun, flexible and productive. Much like group work during study, with a great group of people, it feels good.

Athom was and is helpfull during doubts, an together decisions could be made. My attitude is, unlike you may believe, that I must prevail by my self. Unfortunately when there is doubt, and this problem could not be resolved directly, this led to delay on points . This doubt, and not wanting to fail might be a part of my delay..

Unlike individual projects, I do tend to go full in, motivated with a group assignment, were there is drive and someone besides you helping you stay focussed and on track. My assignment was unlike most work at Athom, focussed on research and creating a head start for user interaction design, I did not want to delay the team, with 'not so pressing' issues.

I've certainly learned a lot during the Bachelor assignment.

My focus, and plans for the future, has been explored and found. I'd like to continue in this branch, creating user friendly interfaces for great products.

The tests, I hope, could be more unobtrusive than was used in this Bachelor assignment, since that was not the most preferred part of the assignment. I've talked about A-B testing, with a large group of participants, and this will become possible and used by Athom by presenting a group a different version/concept and compare statistics. This way of testing, combined with an observational test does seem very interesting and promising.

I've learned a lot, and hopefully learn even more with help of Athom as a company in my network, since it is such a user centered company.

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ONLINE FILES

USER TEST

http://portfolio.io.utwente.nl/student/derkseni/bo/hosted_files/user_test_full.pdf

GUIDELINES

http://portfolio.io.utwente.nl/student/derkseni/bo/hosted_files/guidelines_final.pdf

PLAN VAN AANPAK (NL/EN)

http://portfolio.io.utwente.nl/student/derkseni/bo/Hosted_files/PvA_Athom.pdf

PLANNING (EN)

http://portfolio.io.utwente.nl/student/derkseni/bo/Hosted_files/Planning_BO_Athom.pdf

I SPEECH VERSUS APPLICATION

Comparing input ways on speed, completeness and efficiency.

Actions to perform

Turn on all the lights upstairs (on the first floor).
 Turn the kitchen spotlights to magenta.
 Start the living room Roomba.
 Start an episode of Stargate SG-1.
 Resume the music.
 Set the oven in the kitchen to preheat at 200 degrees and be done at 18:00.
 Let Homey tell a joke.
 Look up music on Spotify.
 Check who entered the house just now.
 Check the current temperature of the living room.
 Activate the scene: Lazy Sunday.
 Set the wash machine to 40 degrees, on the program for mixed wash.

Activity	Speech (time in s)	Application (time in s) (+5s)	Regards
Turn on all the lights upstairs (on the first floor).	3	5	Grab smartphone, unlocking and starting the application takes atleast 5 extra seconds
Turn the kitchen spotlights to magenta.	6	8	
Start the living room Roomba.	3	4	
Start an episode of Stargate SG-1.	15	6	Conversation with Homey over the episode
Resume the music.	2	2	
Set the oven in the kitchen to preheat at 200 degrees and be done at 18:00.	25	15	Better control and feedback
Let Homey tell a joke	3	6	Chuck norris joke is a service
Look up music on Spotify	6	5	Homey can't browse, just search and play/
Check who entered the house just now	5	2	
Check the current temperature of the living room	6	2	
Activate the scene: Lazy Sunday	6	5	
Set the wash machine to 40 degrees, on the program for mixed wash	30	15	
TOTAL	110	75	Taken in account the cellphone and Homey app are directly available

II CATEGORIES AND FUNCTIONALITIES

Devices will be categorized based on the functionality. The functionalities are important for generating usable widgets.

Functionality is split in certain modules which control the functions.

There is a Manager module running who keeps track of all actions that can currently be activated and what functions have to be run to get to achieve that action.

Displaying the devices inside the application

The priority of the smart devices in the vicinity displayed inside the application is created by prioritizing the devices. This could be done once by Athom and be editable inside the web application.

This will create a custom list with a preferred order of devices by priority and/or preferences.

Controllability

Building on the information from the categories, rooms and functions. Using an overview a clearer image can be created of all functions and states which already can be driven by a Homey.

Since apps are always loaded on a Homey, an app can be active or on the background. When an app becomes active, it has to perform an action. He has to talk to manager first. The app registers and exposes itself. This is me; the app, this is what I can do. This is obvious when exposing a Philips Hue, but when a user plugs in a socket switch, the user has to define the functions.

There is a manager, which keeps track of current operations. These are also controllable from outside the specific program app. For instance, music can be played on certain apps: Spotify, Google Play Music or Youtube. The manager can control every one of these when they are active. Besides these manager functions, there are also program specific functions. Think about pre-heating an oven.

//Casting, or running application on screen/device
This is a future option, but this function is desired. Currently only Android smartphone screens can be cast, or iPhone screens can be mirrored, but for media this would be a great addition, choosing on what device the Netflix application will cast the media (also any media or other media sources could be used as example). This casting should be controlled with speech and a button in the (media) interface.

Lights

- Lights on/off
- Sensor input
- Lights brightness
- Lights temperature
- Lights color
- Lights pair
- Lights scene
- Light sequence
- Light animations (LED strip)
- Light programs (on holiday automated a few lights turning on)
- Blinds

Video

- Controlling products: TV - DVD player – Netflix – Plex
- Random based on my previous watched movies (Netflix/Plex integration)
- Channel
- Play/Pause
- Stop
- Back/previous
- Volume up/down
- Speaker group (one time only, then settings)

Music

- Source
- Radio
- Search in.. Source/Library
- Random
- Library
- Genre
- Shuffle
- Repeat
- Playlist
- Artist
- Play/Pause
- Stop
- Back/previous
- Volume up/down

Climate

- Thermostat
- Airconditioning
- Wall heaters (using electronic knobs).
- Heater (simple card| IO socket switch. Cat climate en room)
- Ventilator (depening on connection wifi or, socketplug is one speed by klikaan) (NFC tag op verbinding connective die wordt afgevangen door homey), Possible, if smart to control speed via an app if so then: 0-100 else 0/1.
- Air Quality
- Air (de-)humidifier
- Air purifiers
- Special category

Appliances/Devices

Using sources combined with experiences and future scenarios:

<http://webtrends.about.com/od/Mobile-Web-Beginner/tp/Wi-fi-Appliances.htm>

<http://www.tomsguide.com/us/best-smart-home-gadgets,review-2008.html>

Oven

- Temperature
- Time ("Turn Oven on for 30 and a half minutes")
- Time of completion ("Oven must be finished at 17:30, my bread needs 13 minutes on 180 degrees")
- Time for pre-heat completion
- Program
- What kind of food & portion

Microwave (combi can be seen as separate functions oven/grill and microwave)

- Wattage
- Time
- Time of completion
- Completion of defrosting
- What kind of food/program

Everything with a powerplug, with KlikAanKlikUit or same kind of product

- Can be added and registered with device
- Can be turned on/off
- Can be timed
- Can be event driven

For example:

Waffle Iron

Pre heating in 1 minute, so can be controlled.

Coffeemaker

Coffeemaker

- Connectivity via Bluetooth, Wi-Fi
- Chose coffee program
- Wake up (start heating boiler)
- Grinding
- All settings of machine, think off (amount of cups, amount of coffee (grams), milk (foam), cleaning)

Washing machine

- Programs
- Time of completion
- On/off
- If supported checking the air liquidity

Dishwasher

- Programs
- Time of completion
- On/off
- If supported checking the amount of dishes and

Refrigerator

- Temperature
- Ice
- Status of components

Blender

- On/off
- Speed in RPM
- Timer

Cooking devices (e.g. Philips Airfryer)

- Temperature
- Programs
- Time
- Time for completion
- On/off

Vacuum cleaner robots

- Start cleaning
- Choose room
- Battery level

Cleaning robot (e.g. iRobot Scooba)

- Start cleaning
- Choose room
- Battery level

Fireplace (Gas, Electronic)

- On/off
- Intensity

Car

- Unlock/lock
- Trunk open/trunk close
- Car climate: Temperature
- Car climate: Airflow
- Horn
- Lights
- Location
- Statistics (e.g. battery and radius)

Security

Locks

- Lock/Unlock
- Share door key
- Timed lock
- Automated lock and unlock
- Fingerprint?

Alarms

- Automated actions based on sensor data
- Push alert
- Open action center e.g. camera

(Garage)doors

- Open/Close
- Automated proximity
- Timing for open

Best Smoke/Carbon Monoxide Detector

- Alert user when problems occur
- Notify user of status system (battery)
- Alert user when out of the house
- Allow further actions

Sensors

- Motion
- Open/close
- Humidity
- IR
- Movement

Proximity

- Measure
- Event launcher

Camera's

- Move
- Zoom
- On/off

Baby Monitor

- Sound
- Image
- Snapshot
- Push notification when reached a defined level

Smart meters (Voltage e.o.)

- Data insight
- Data plotting
- Give insight
- Suggest improvements

Outdoor

Sprinklers

- On/off
- Timer
- Schedule
- Based on data

Robot mower

- On/off
- Battery level
- Timer

Garden house

- Speakers on/off
- Lights on/off

Personal / Services

Calendar

- Check
- Remind
- Create
- Connect others
- Notify

Email

- Read
- Compose
- Search
- Notify

Smartwatch

- Motivate
- Inform
- Suggest activities based on feel

Facebook

- Timeline post
- Timeline cast to TV

To Do list

- Inform
- Ask
- Timeline cast to TV

Pet information

- Location
- Feeding time
- Reminders

Social

Weather

- Advice for garden
- Advice for travel
- Advice for clothing

Insights

- Electricity usage
- Devices usage
- Favorites
- Timeline

General functions

FUNCTION	STATES
On/off	0/1
Timer	n
On-time	
Repeat daily	x-n

S,M,T,W,T,F,S	
Status	String
Play/Pauze	0/1
Stop	0/1
Volume up/down/mute	0-100
Previous	-1
Next	+1
Search	String
Source	Manager
Equalizer	Manager

Specific functions

FUNCTION	STATE
Color	CMYK, RGB, HSV, HSL (3 – 4 parameters)
Brightness	0-100 (%)
Blinds/Curtains	0-100 (%), angle of flaps (-90° till +90°)
Sunscreen	0-100 (%)
Random	Algorithm
Genre	Program defined algorithm and/or string search
Playlist	0/1, combined with an playlist ID or string
Shuffle	Algorithm of application turned on 0/1
Repeat	If end then -1
Artist	String
Color temperature	1000°K -12000°K
Oven Temperature	0 (40) - 250°C
Thermostat Temperature	(1)0 - 30°C
Cool	0/1
Heat	0/1
Air Quality	0/1
Pre-Heat	Algorithm
Programs	Turn on a defined algorithm and/or setting

Status	List/array of string + n consisting of data
Data	Data – transformed
Open/Close	0/1, possible 0-1
Lock/Unlock	0/1
Notification	0/1 (audio & push)
Movement	X,Y axles > movement on X is +X or –X movement on Y is +Y or –Y. N+1 or N-1
Zoom	0-100
Record	Record/write to disk, 0/1.

Most used function?

0/1, true/false, a Boolean is the most common function of a device. A device can have multiple on/off functions combined. For example music with shuffle and repeat on is still:

Music play = Music on

Shuffle = Shuffle on

Repeat playlist = Repeat on (one of both repeat functions, repeat song or repeat list is turned on).

It is understandable, since the

Setting functions

Groups – speakers/lights/lights/systems

Rooms – Define a room.

Preferences – Fine tune settings for application

Flow editor:

The user has the options to implement automation and combine multiple functions in a flow, hence the name: Flow editor. This allows for automation with great ease and multiple (specific) flows are possible.

The user has freedom, but must be prompted when there are security risks, playing with locks and ovens must be done while being conscious about the consequences.

Automation will be done via an 'If This Then That' happens event triggering. Something a user can predefine himself. Using the flow editor to automate the house is great way to minimize interfaces with Homey. The flow editor will be a big unique selling point and will be heavily subjected to changes and updates, since it is never finished.

III DEVICES & TOUCHSCREENS

Types of touchscreens

A short insight to resistive and capacitive touchscreens and their pros and cons.

Since the emerging technology of PCs and pocket personal computers (PPC) and the recent trend of smart phones and tablets, a great shift in input technology has taken place. In the early phase the most common used input for touchscreens was a resistive screen. Using a plastic film, with an electrical conducting grid, which pressed onto the devices other conducting layer over the screen; the digitizer. The specific current running through the screen is then translated via a controller and passed as usable input data for the device. This can be easily visualized.

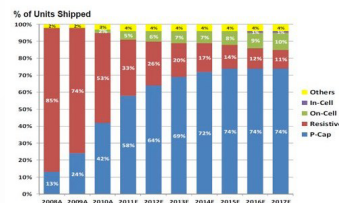
Since the emerging of the smartphone, the touchscreen has been subjected to wishes of the customer. The screen display was of low intensity, because of the extra screen. It's also a pain to look of from when in the sun, because it reflected and breaks the light. The screen wears out and needs calibration over time. These are some disadvantages, which were enough to produce new types of screens; capacitive screens. These screens have better light emission, which is also useful when the sun is on the screen. But the biggest advantage, was the use of new technology made multi touch possible. This is a revolution for screen input.

Although an old technique, resistive touchscreen have big advantages. They are cheap, and very accurate. The PPCs usually contained a resistive screen and stylus. The amount of information on the screen was relatively high. Also compared to current smartphones. Input on a resistive screens is also possible with anything, a thumb, a nail, a normal pen, a stylus actually almost anything. A capacitive screen, though must be subjected to an organic, or conducting material touching the screen. A finger can be used for example, but the nail is not working. The accuracy of the finger is relatively lower, because a larger surface is triggered. From another ergonomic point, the pressure needed for a simple tap is much lower. A simple touch, or even very closely hovering above the screen can be registered by the screen. This makes tapping, and movement over the screen less intensive and easier for every user.

Since the market is totally overrun by new smartphones and tablets low and high end. The resistive touchscreen is being used a lot less frequent and will make way for the capacitive screens.

Using a foresight of a company established on this field, a clear assumption can be made. Capacitive is going to take a huge amount of the market share, at the cost of the market share of resistive screens. This

Worldwide Touchscreen Market Unit Share by Technology



means the biggest part of the consumers will be in possession of a capacitive device. Although cheap electronics like tablets could still be outfitted with resistive touchscreens.

http://infocentre.gesatech.com/files/2012/10/ts_marketshare_titled_508.jpg

Devices

Previously the Pocket Portable Computers (PPC) was mentioned. Containing mostly resistive screens and working on Windows CE, Symbian, or PalmOS. These are still available, but a dying breed. They are expensive, and very complex for the regular user. The popularity of these smart devices came with the more user friendly interfaces and the possibility of internet connection on the device. The take-off of smartphones was at the era of the first iPhone, in 2007 [source]. With the promise of unlimited worldwide internet for a handheld device, the consumers were more aware of the possibilities. The iPhone was one of the first phones containing a capacitive screen and utilizing multi touch. The interface was user friendly and the device could do everything the PPCs were capable of, and do it even better in terms of user experience.

The evolution grew, and from smartphones a device was produced which was capable of more information projection, by simply enlarging the screen. The birth of the tablet.

A same concept, although not focused on telephony, the tablet is used as an informative device. Mostly advertised as a newspaper replacement, an additional entertainment screen, but also used for (informative) games and communication.

The same is happening on the laptop market. These devices are becoming hybrid; a tablet, laptop hybrid. Combining the battery life, input and speed of a laptop, with the ease of use and usability of a tablet.

The devices are still evolving, currently the smartwatches are growing on the mobile accessories market, enabling a smart watch to interact with your mobile, and thus your connected products. Also the transition to devices with totally different interfaces are emerging. The way of motion tracking via a Kinect or Leap motion, but even further in development, possibly combined with motion tracking, virtual reality and augmented reality are possible for controlling your home and devices. Although these techniques are upcoming, they are not yet going to be supported for the time being.

IV HEURISTIC EVALUATION

Heuristic evaluation of the visual prototype

1) Strive for consistency.

Consistent sequences of actions should be required in similar situations; identical terminology should be used in prompts, menus, and help screens; and consistent commands should be employed throughout. While not directly said, usability and interaction also should be consistent. Deviation of this rule must be minimized.

Consistency is realized by creating an equally looking interface based off all materials they have created. The flow and terminology will be the same throughout all interfaces, and equal to the commands which can be spoken.

(8/10)

[Screenshot of visual interface in FIG 18]

2) Enable frequent users to use shortcuts.

As the frequency of use increases, so do the user's desires to reduce the number of interactions and to increase the pace of interaction. Abbreviations, function keys, hidden commands, and macro facilities are very helpful to an expert user.

Using shortcuts is not yet available throughout the mobile interface, this is a possible design improvement. Using smart, fast and efficient ways to navigate through to interface and interact with elements is a definite pro. The navigation method, by filtering by device or rooms is in essence a shortcut.

(6/10)

3) Offer informative feedback.

For every operator action, there should be some system feedback. For frequent and minor actions, the response can be modest, while for infrequent and major actions, the response should be more substantial.

Feedback is currently given using textual and visual information. The thermostat is a good example, it changes colour when the user deviates of the standard input, and the new value is also represented above the widget.

(8/10)

4) Design dialogs to yield closure.

Sequences of actions should be organized into groups with a beginning, middle, and end. The informative feedback at the completion of a group of actions gives the operators the satisfaction of accomplishment, a sense of relief, the signal to drop contingency plans and options from their minds, and an indication that the way is clear to prepare for the next group of actions.

The search for a function or device and then controlling it should give the user a satisfactory feeling. The input is almost instantly translated in a device

action, although not returned as a dialog, or notification. This means the action is registered and carried out. This should provide the signal the user can continue, or perform another action,
(6/10)

5) Offer error prevention and simple error handling.

As much as possible, design the system so the user cannot make a serious error. If an error is made, the system should be able to detect the error and offer simple, comprehensible mechanisms for handling the error.

Error prevention is not really available. A change of input means a change in device state. This is a heuristic which will be taken in account for during designing, since it is easily able to implement.

(4/10)

6) Permit easy reversal of actions.

This feature relieves anxiety, since the user knows that errors can be undone; it thus encourages exploration of unfamiliar options. The units of reversibility may be a single action, a data entry, or a complete group of actions.

When an action is performed the user will be looking at the card and looking at the textual and visual feedback. This should ring a bell, although after navigating away from the card it is not possible to see the 'error' made, which can also not be undone.

(4/10)

7) Support internal locus of control.

Experienced operators strongly desire the sense that they are in charge of the system and that the system responds to their actions. Design the system to make users the initiators of actions rather than the responders.

Giving the user a sense of advanced control is exactly what is aimed for in the design, although not seen in the visual prototype, the idea is to create an extended card, which hosts a larger set of controls.

(8/10)

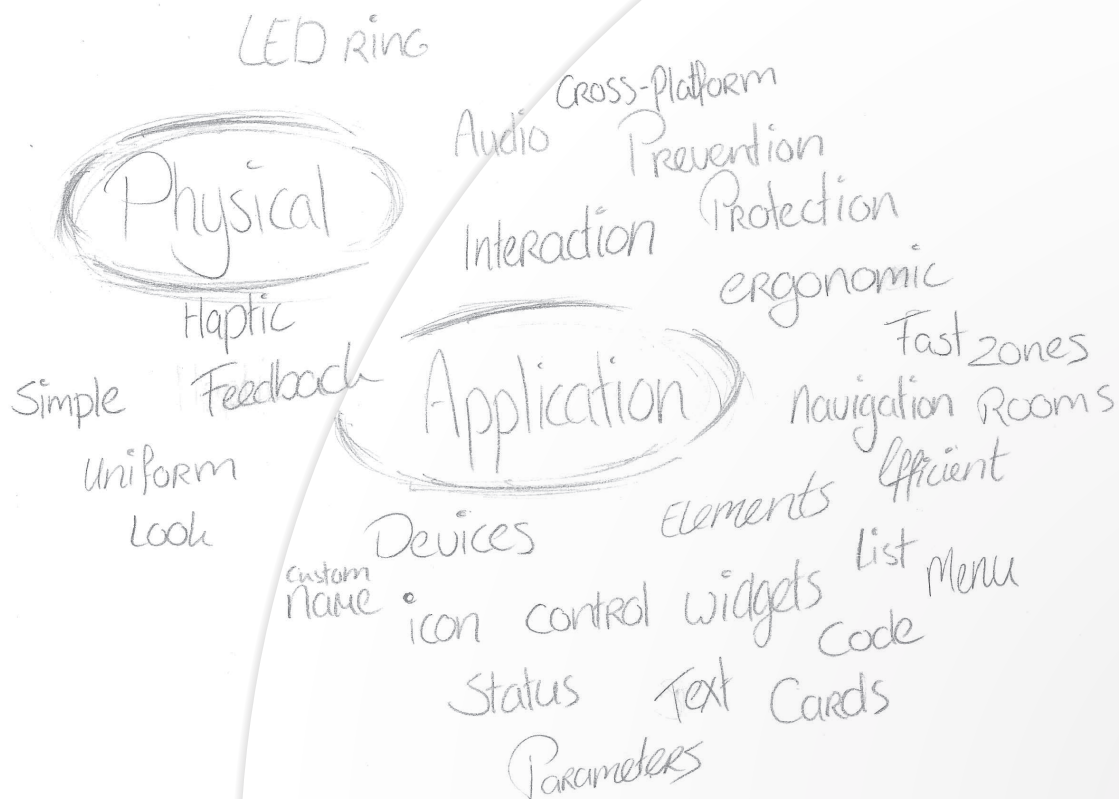
8) Reduce short-term memory load.

The limitation of human information processing in short-term memory requires that displays be kept simple, multiple page displays be consolidated, window-motion frequency be reduced, and sufficient training time be allotted for codes, mnemonics, and sequences of actions.

The interface tends to be giving a great, simple, easy to view interface. This reduces memory load. What the user must remember is navigation via swiping in from the left or right. Not a lot of actions have to be taken to get the action desired. Not a lot of mnemonics are added initially, this might be interesting if users experience difficulties.

(7/10)

V MINDMAP

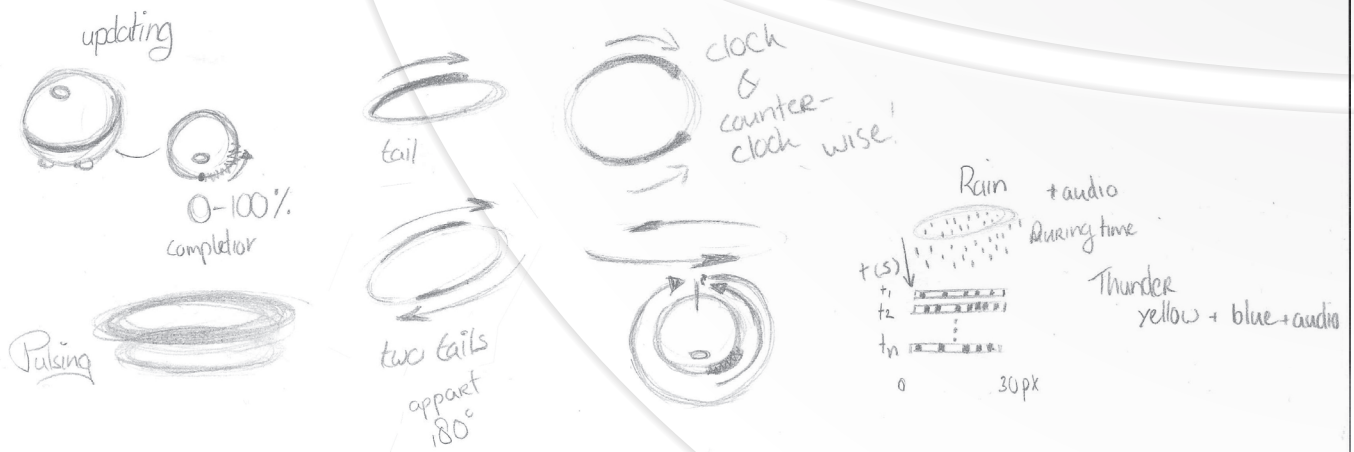


VI IDEA SKETCHES: PHYSICAL INTERFACES

The situations

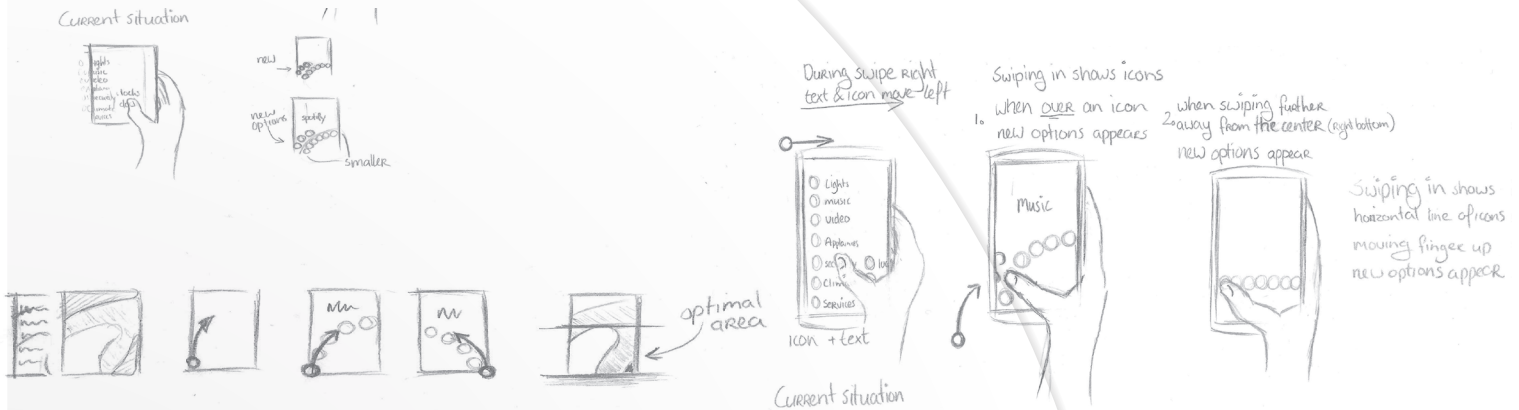
First boot of Homey
Pairing device
Updating
Software error (brick)
Idle mode
Event triggered
Listening mode

Loading
Successful loading
Error during action
Speaking to the user
Alarm
Controlled by an application
e.g. Weather
e.g. Disco



VI IDEA SKETCHES: APPLICATION INTERFACES

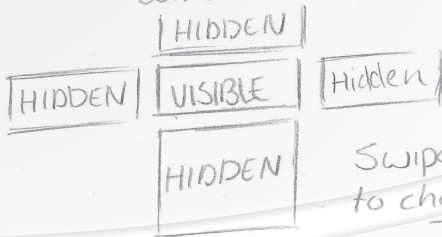
Menus and navigation



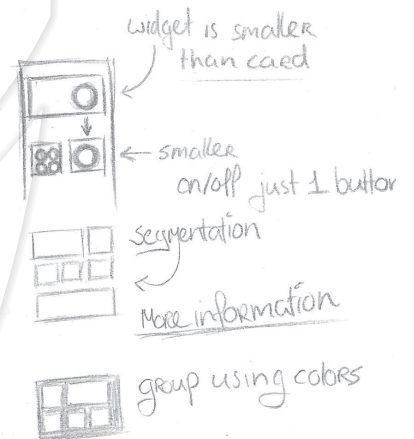
Elements: Cards

Navigation in a card?

One card application
OR
window to more cards?



Cards



CARDS

Display info
Control device

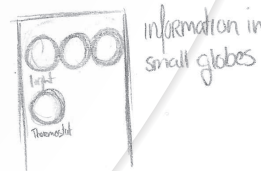
Future - automation

Some cards just don't show much!
integration

SIZE simple expanded.

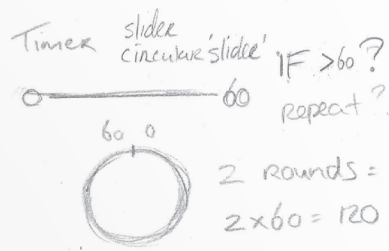
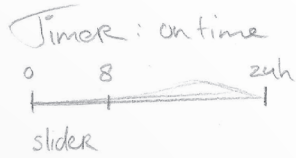
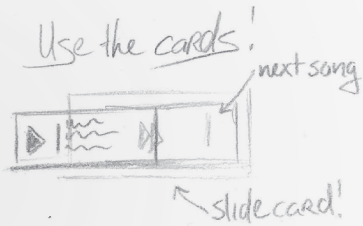
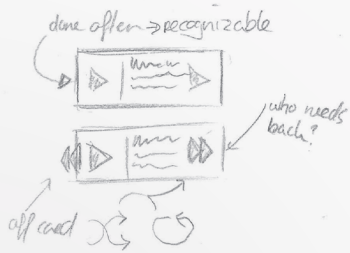
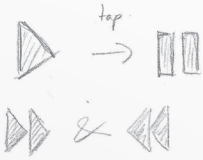
Widgets simple expanded.

INFO static dynamic



Tap and card
flips!
controls visible

Music



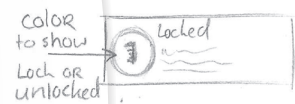
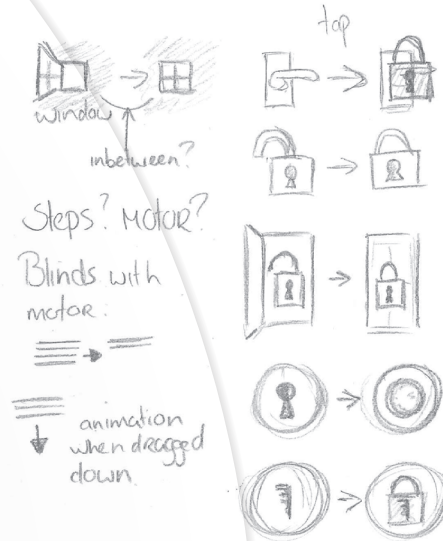
Daily repeater

MON TUE WED
clickable? because
multiple can be selected



Simple! else, flow editor

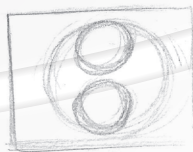
Open/close lock/unlock



Tap, maybe use
Pincode to enter



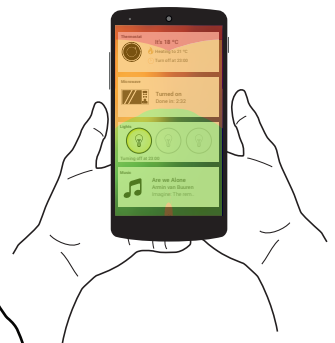
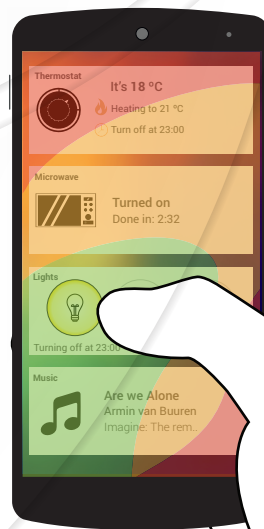
Main card



Extended view

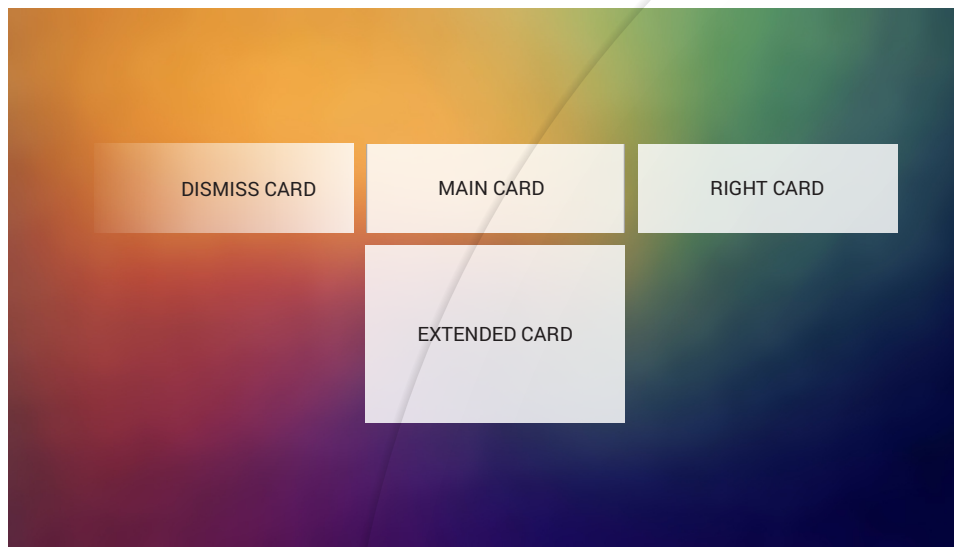
Twice the card size
extend functions?
advanced functions?
Bigger widgets?

ERS.

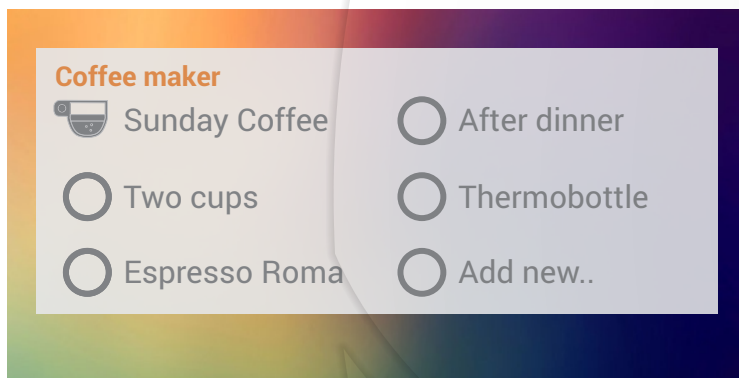


IIX CONCEPT PHASE: ENLARGEMENT

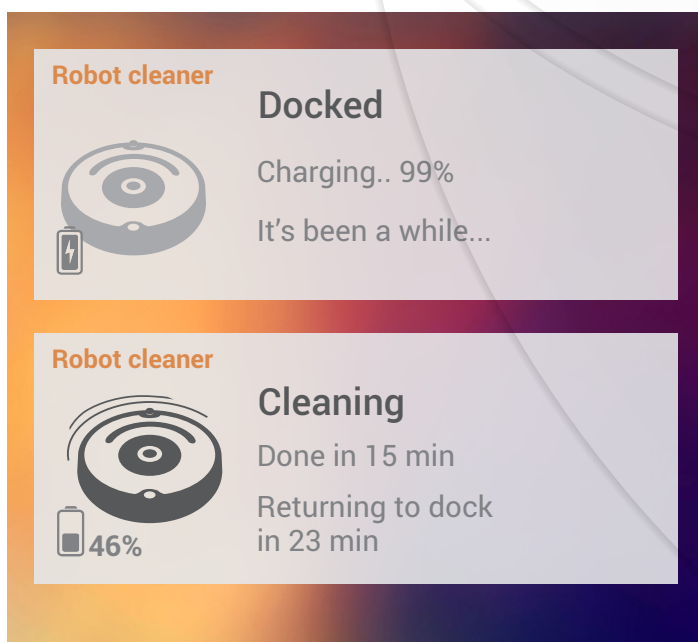
Enlargement of concept images



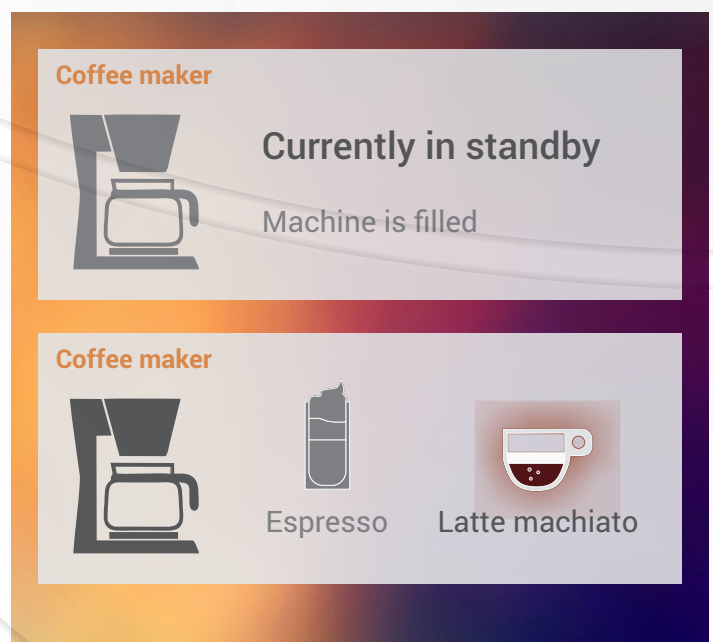
Structure of the cards



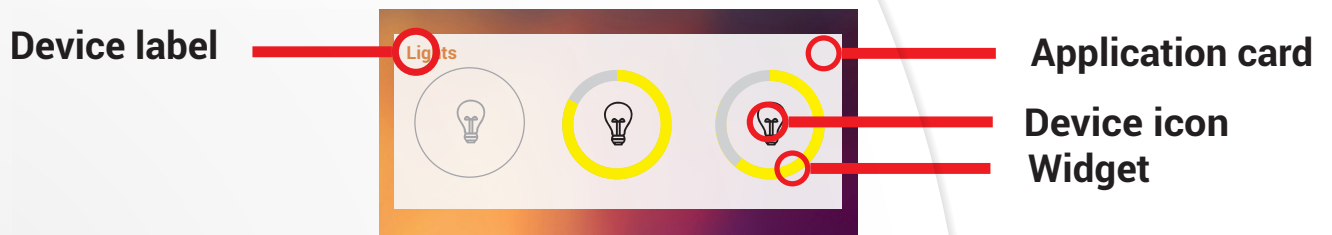
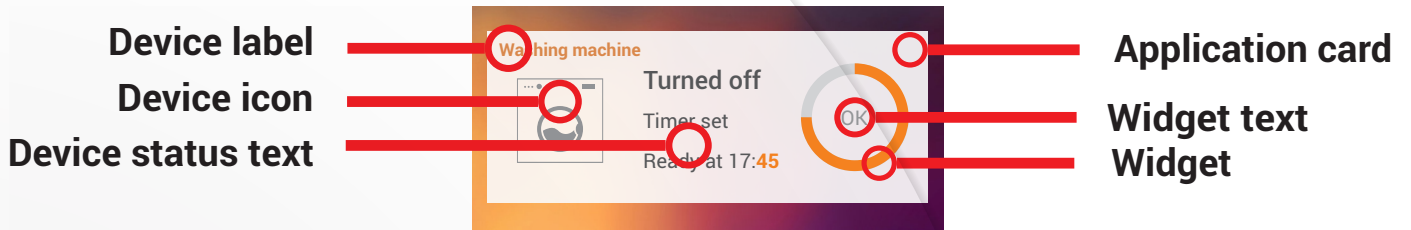
Shortcut buttons, default circles, or a custom one



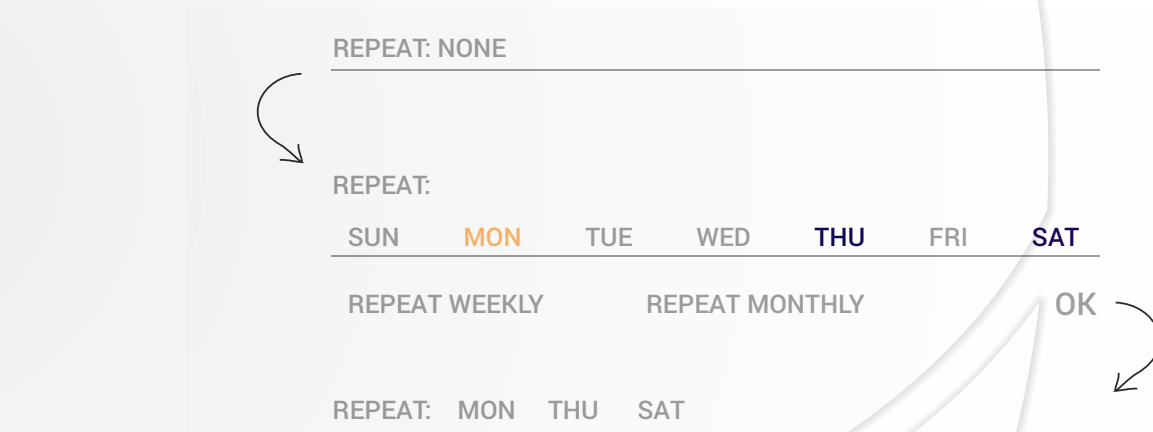
Device icon as an on/off button



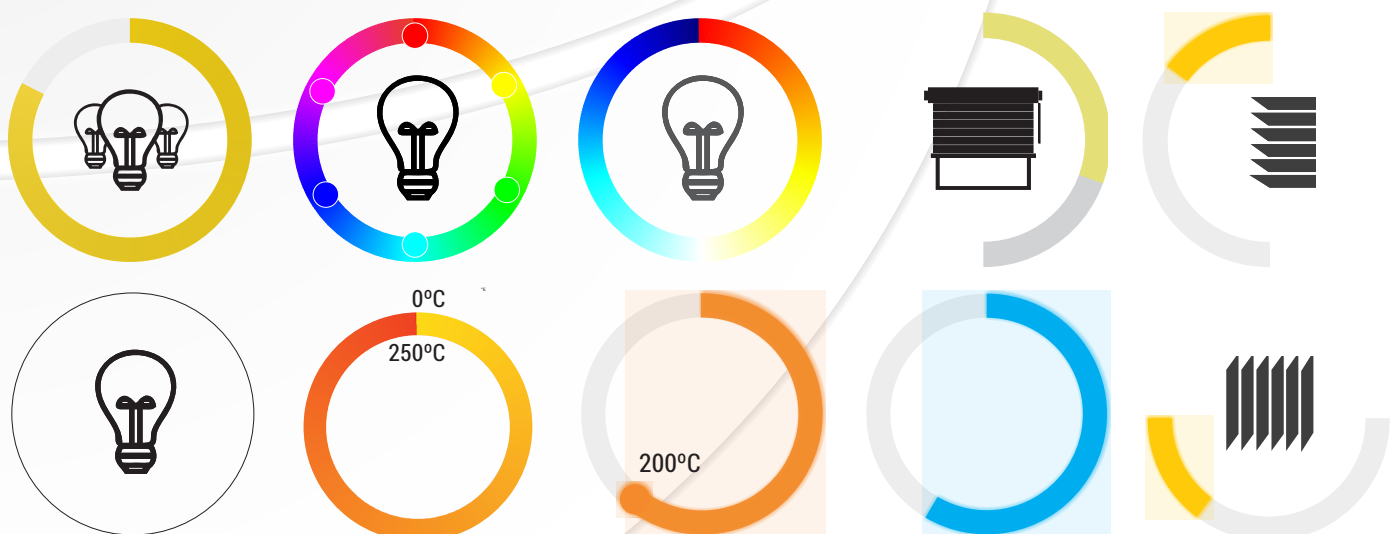
Custom on/off buttons with animation and color



Enlargement of elements and placement on the card,



A date picker



A lot of examples of circular widgets.

IX USER TEST (LINK TO FULL AT BOTTOM PAGE)

SETUP

Target

Since there is an initial idea for a prototype, an A-B test is test with two different concepts, which share a common base. These situation give possibilities for comparing dependent variables. The goal is to find out the preferences of the end users, and to translate these preferences to a conclusion regarding the user experience of the prototypes and their variations.

What is going to be tested?

- Ease of use of the widgets.
- Intuitive design.
- Menu and ergonomics.
- Efficiency
- Swiping of cards and navigating to advanced functions.
- Desired input size for a widget.
- Learnability.

Via a prototype which contains various cards and different menu interfaces.

Cards made for the test are:

- Lights
- Oven
- Music player
- Blinding with 2 functions

Dependent variables

What are the variables which will be tested

- Time input
- Menu navigation
- Shortcuts
- Efficiency of input (time and movement)
- Find ability (intuitive & placement)
- Usability (ergonomics)
- Logics and intuition
- Preferences

Evaluation methods

The measurement of the variables is mixed. In the first place there is a between subjects measurement. The difference between inexperienced and experienced participants is determined by a question in the questionnaire. In the experiment, a result based on these differences can be concluded.

Secondly there is a within subjects measurement in the experiment. All participants test the first concept and then they get to try concept two or three. This might lead to a carryover effect for the second try. The test sequence is varied, so the starting concept is varied, to minimize the influence of the carry over effect. The time between the tests is used to interact with the participants and offer them a drink. This ensures there is space between the tests, to minimize the spacing effect for carry over effect with the concepts.

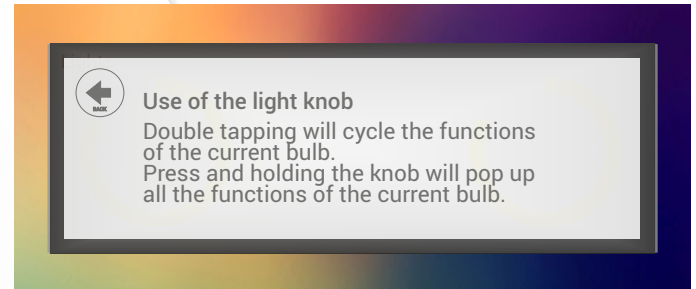
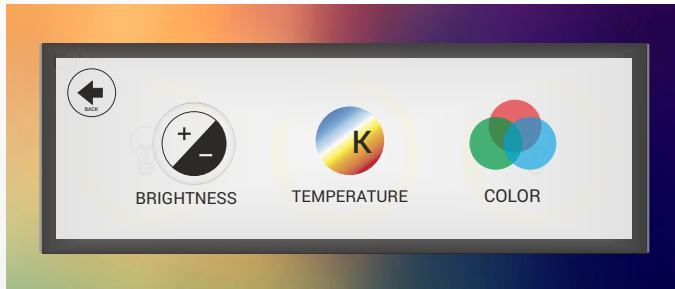
Also testing of expanded input controls is tested. The preference for these input widgets will be questioned via the questionnaire, but also will be observed.

FULL USER TEST and RESULTS are FOUND following LINK BELOW

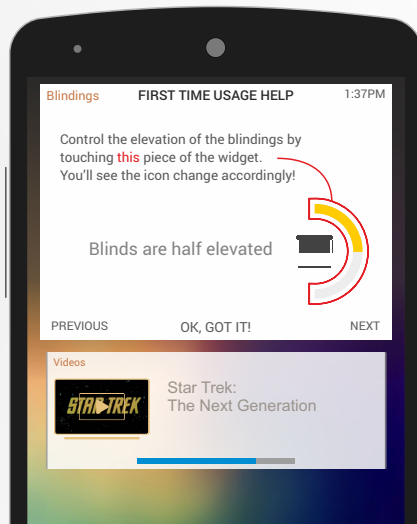
http://portfolio.io.utwente.nl/student/derkseni/bo/hosted_files/user_test_full.pdf

X REDESIGNED ELEMENTS

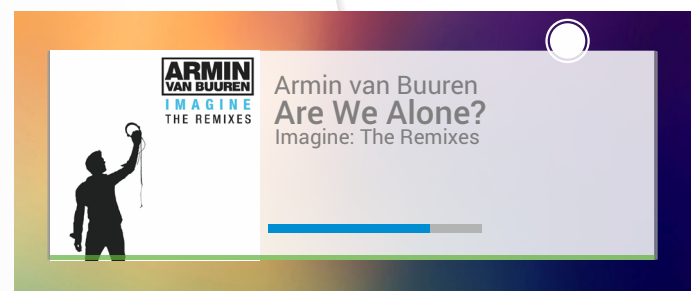
Enlargement of minimized images.



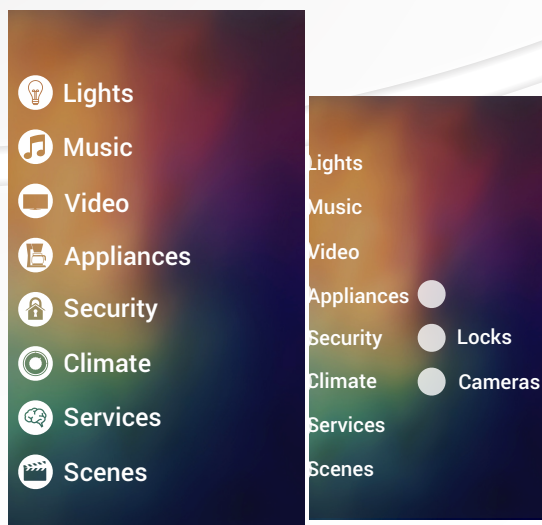
Popup used for selecting an underlying function, or used to give information to the user, with a back button to allow navigation.



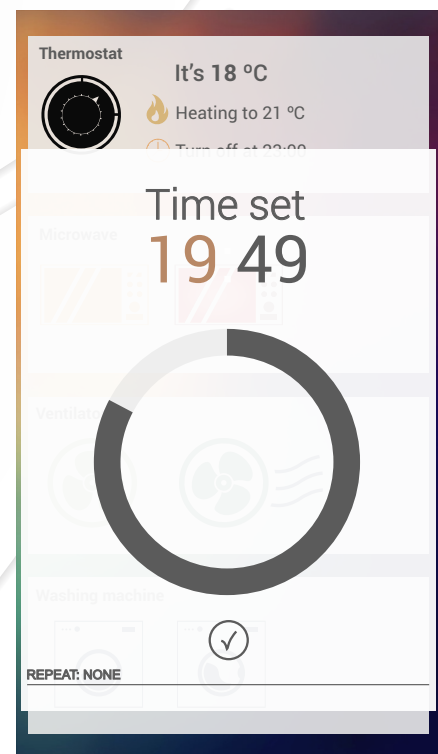
First time usage pop up. A bigger pop up allows for more information and a small guide with navigation.



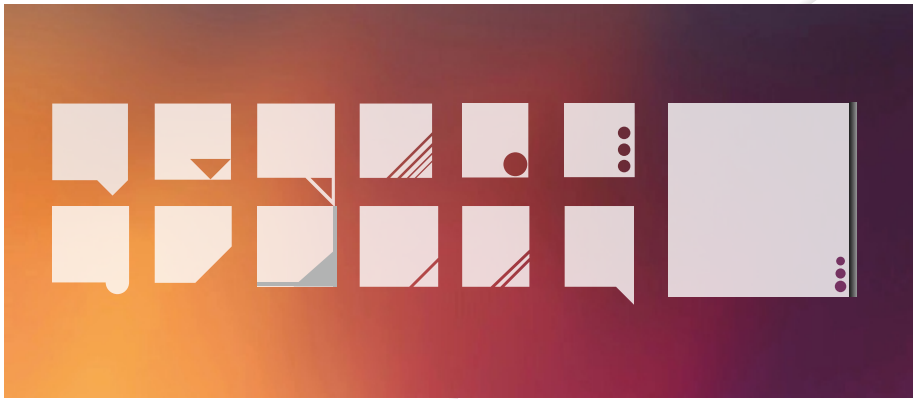
Music card with source and duration added, via a card with sized bar and a duration/progress bar.



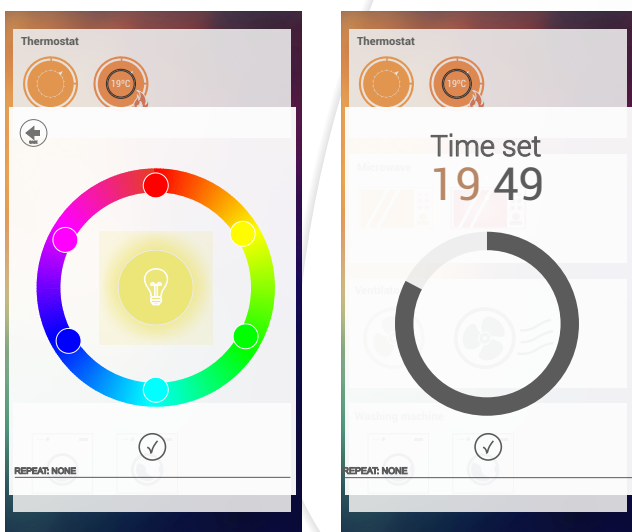
Vertical menu, with swipe interaction visible. The menu moves left when the fingers move more to the right.



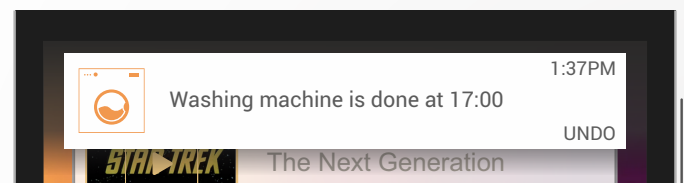
Time selection widget, with big feedback and the option to repeat on other days.



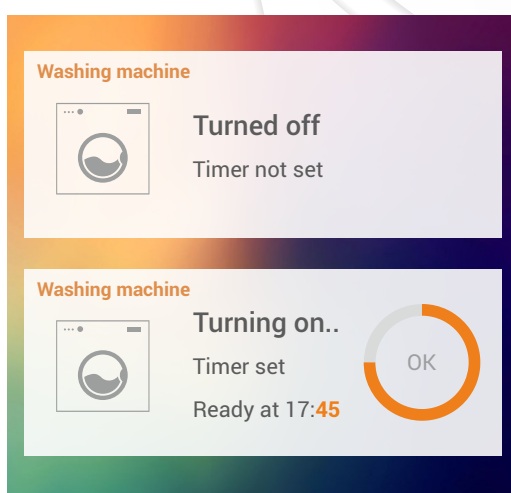
Card hints for extending a card. Hinting a downwards movement, but also upwards when expanded. The result is a group of three vertically placed bullets, with different sizes, sinuating an direction for the finger to swipe or drag.



Using the enlarged circular widget for setting the color of the RGB lights.



Notification with a button for undoing the just entered action, preventing errors. The notification can be swiped away when accepted, or it will dissapear by itself. Tapping the notification leads to the applications card of which the action was set just now.



Only after first interaction a widget shows, this prevents faulty behavior by accidental touches of the screen. Protecting the devices and your valuables.

XI RANK TO THE DESIGN BRIEF

Demands of end -users

Total Realized

Create a uniform look of the application			
Allow casual users to control the devices			
Do not allow casual users to adjust expert settings without prompts		They can	
Allow expert users to control many aspects of their devices.			
Make controlling Homey (your home) be as easy as touching one button. (AI, sug		Not yet possible, AI maybe	
Create an overview of all upcoming events		Not yet possible, AI maybe	
Show important device information:			6 3
• On or off			
• Events			
• Status			3 3
Control all lights in a zone at once.			
Make grouping on a card possible in the case of many similar devices e.g. lights.		Not possible directly, in extended card maybe add a tab	
Provide sharing data outside the application (share groceries or timeline)		Not possible directly, in extended card maybe add a share bu	
Make navigating to a specific devices fast		using gestures	
Make possible to turn scene on or off		Not yet defined where they are	
Use interactions equal to the expectations of interactions.		Used double tap for new function	
Provide feedback 'before' (display status), during and after and interaction.			
Provide textual feedback		status/feedback	
Provide visual feedback		icon/widget	
Provide physical feedback in the form of audio and/or LED ring animation.		can be linked	
Provide a help option for the users		First usage help, must be easy callable	
Inform the user of the input		During widget and feedback, afterwards notification	
Warn the user of abnormal input		Not yet built, AI?	
Warn the user in case of dangerous variables.		Not yet built, AI?	
Warn the user in case of a priority event.		The card shows up, notifications will be	15 10

Demands of developers

Provide appearance details of elements			
Provide parameters and variables of the elements			
Provide interaction behavior of the elements			
Create scalable elements			
Provide behavior of elements in different environments (flow editor, developer's s		Not yet tested, but could be interchangal	5 4

Demands by analysis and heuristic evaluation

As a result of the analysis and the heuristic evaluation, more demands for a great user interface and usability can be derived.

Make sure a lot of cards and controls are centered around the comfortable area			
Create visual LED feedback according to expectations (green for success etc.)		Yes	
Allow elements to be controlled by the finger as displayed in figure 15&16			
Provide widget control inside the ergonomic responsible area		yes mostly possible, or a bit in the orange spot if desired.	
Do not use interfering interactions, e.g. swipe up for more then scrolling		Swipe up/down is also used for the extended card	
Provide interaction feedback using haptic feedback.		Not built, but can be added by development team	
The application must provide child and abuse protection		No, can be integrated, but not looked at	7 4

Based on the heuristic evaluation

Strive for consisted interaction within the application			
• Equal looking widgets must have the same interactions		Yes	
• Same behaving devices must have the same looking cards.		Yes	1 1
Create a dialog containing information about the action entered.		Notification	
Show where the user is located inside the app.		good to think about	
Allow consistent interaction within a card		Yes	
Provide shortcuts for multiple settings		Shortcut card	
Allow undo of the action entered		Notification	
Make error prevention possible		Can be AI, but now not available	
Actions which contain one or multiple errors are not directly performed		good to think about	
Mnemonic support for navigating and displaying options		icons	8 5

45 30

XII - HEURISTIC EVALUATION OF THE FUNCTIONAL CONCEPT:

By Ivo Derksen

1) Strive for consistency.

Consistent sequences of actions should be required in similar situations; identical terminology should be used in prompts, menus, and help screens; and consistent commands should be employed throughout. While not directly said, usability and interaction also should be consistent. Deviation of this rule must be minimized.

Mostly the interface elements are consistent, some interactions are not always the same: double tap on an icon for example.

8,5/10

[Screenshots of concept interface seen on pages 64 and 65 and concepts on pages 48 - 57]

2) Enable frequent users to use shortcuts.

As the frequency of use increases, so do the user's desires to reduce the number of interactions and to increase the pace of interaction. Abbreviations, function keys, hidden commands, and macro facilities are very helpful to an expert user.

Using a shortcut card, the users can quickly create and summon their shortcuts. Double tap to cycle through the light widgets is also a shortcut for interaction.

(9,5/10)

3) Offer informative feedback.

For every operator action, there should be some system feedback. For frequent and minor actions, the response can be modest, while for infrequent and major actions, the response should be more substantial.

Feedback is currently given using textual and visual information. The thermostat is a good example, it changes colour when the user deviates of the standard input, and the new value is also represented above the widget. Added notifications after confirming an action and using first usage help card more informative feedback can be given in the help section.

(9/10)

[screenshot of thermostat card and cold input]

4) Design dialogs to yield closure.

Sequences of actions should be organized into groups with a beginning, middle, and end. The informative feedback at the completion of a group of actions gives the operators the satisfaction of accomplishment, a sense of relief, the signal to drop contingency plans and options from their minds, and an indication that the way is clear to prepare for the next group of actions. The notification confirms the action is registered, and allows for one last chance to change back the action with one touch. The icon and text could also animate a

change in state, yielding closure.
(8/10)

5) Offer error prevention and simple error handling.

As much as possible, design the system so the user cannot make a serious error. If an error is made, the system should be able to detect the error and offer simple, comprehensible mechanisms for handling the error.

Error prevention using an undo button on the card. Unfortunately the only thing I can recommend is looking for variables which are not right (both away oven on), and then send a notification or block the action till someone unblocks it intentionally.

(7/10)

6) Permit easy reversal of actions.

This feature relieves anxiety, since the user knows that errors can be undone; it thus encourages exploration of unfamiliar options. The units of reversibility may be a single action, a data entry, or a complete group of actions.

It is possible thanks to the notification and undo button, although this is not featured after every step. So more use of a back button could prove better usability maybe.

(7/10)

7) Support internal locus of control.

Experienced operators strongly desire the sense that they are in charge of the system and that the system responds to their actions. Design the system to make users the initiators of actions rather than the responders.

Using the extended card and pretty advanced functionality, the user feels powerful and in control. This means it is possible to set a lot of settings via the smartphone.

(8/10)

8) Reduce short-term memory load.

The limitation of human information processing in short-term memory requires that displays be kept simple, multiple page displays be consolidated, window-motion frequency be reduced, and sufficient training time be allotted for codes, mnemonics, and sequences of actions.

Using a lot of visual material, like icons, animations and the need for text is becoming unnecessary. This makes use of our recognition of images and associations.

(8/10)

By Athom

1) Strive for consistency.
Consistent sequences of actions should be required in similar situations; identical terminology should be used in prompts, menus, and help screens; and consistent commands should be employed throughout. While not directly said, usability and interaction also should be consistent. Deviation of this rule must be minimized.

Consistency is realized by creating an equally looking interface based off all materials they have created. This is ok, but the concept had some inconsistencies during usage.

The need to click text for displaying the clock was inconsistent of the blinding widget, where double tapping the icon showed the other feature, just as with the lights.

This also occurred with the oven and the temperature icon.
(7/10)

2) Enable frequent users to user shortcuts.
As the frequency of use increases, so do the user's desires to reduce the number of interactions and to increase the pace of interaction. Abbreviations, function keys, hidden commands, and macro facilities are very helpful to an expert user. Shortcuts are nicely found and probably useful, but how do they stack up against scenes? Shortcuts specifically for that (single) device. Personally to afraid that it is competing to much with scenens.
(6/10)

3) Offer informative feedback.
For every operator action, there should be some system feedback. For frequent and minor actions, the response can be modest, while for infrequent and major actions, the response should be more substantial. Feedback is currently given using textual and visual information. The textual feedback should increase in size. The visual feedback was very visible through color. Time setting feedback was harder to see with the smaller widget, since it is just text, changing a little. With the bigger time setting widget this was way better.
(8/10)

4) Design dialogs to yield closure.
Sequences of actions should be organized into groups with a beginning, middle, and end. The informative feedback at the completion of a group of actions gives the operators the satisfaction of accomplish-

ment, a sense of relief, the signal to drop contingency plans and options from their minds, and an indication that the way is clear to prepare for the next group of actions.

Notifications do handle this, not too much things to pop on the screen.
(8/10)

5) Offer error prevention and simple error handling.
As much as possible, design the system so the user cannot make a serious error. If an error is made, the system should be able to detect the error and offer simple, comprehensible mechanisms for handling the error. Error prevention through the undo button is good. This will be done via AI and warnings via notifications or Homey self.
(8/10)

6) Permit easy reversal of actions.
This feature relieves anxiety, since the user knows that errors can be undone; it thus encourages exploration of unfamiliar options. The units of reversibility may be a single action, a data entry, or a complete group of actions. Error prevention through the undo button is good. This though just limits to one complete action(group) being undone.

(7/10)

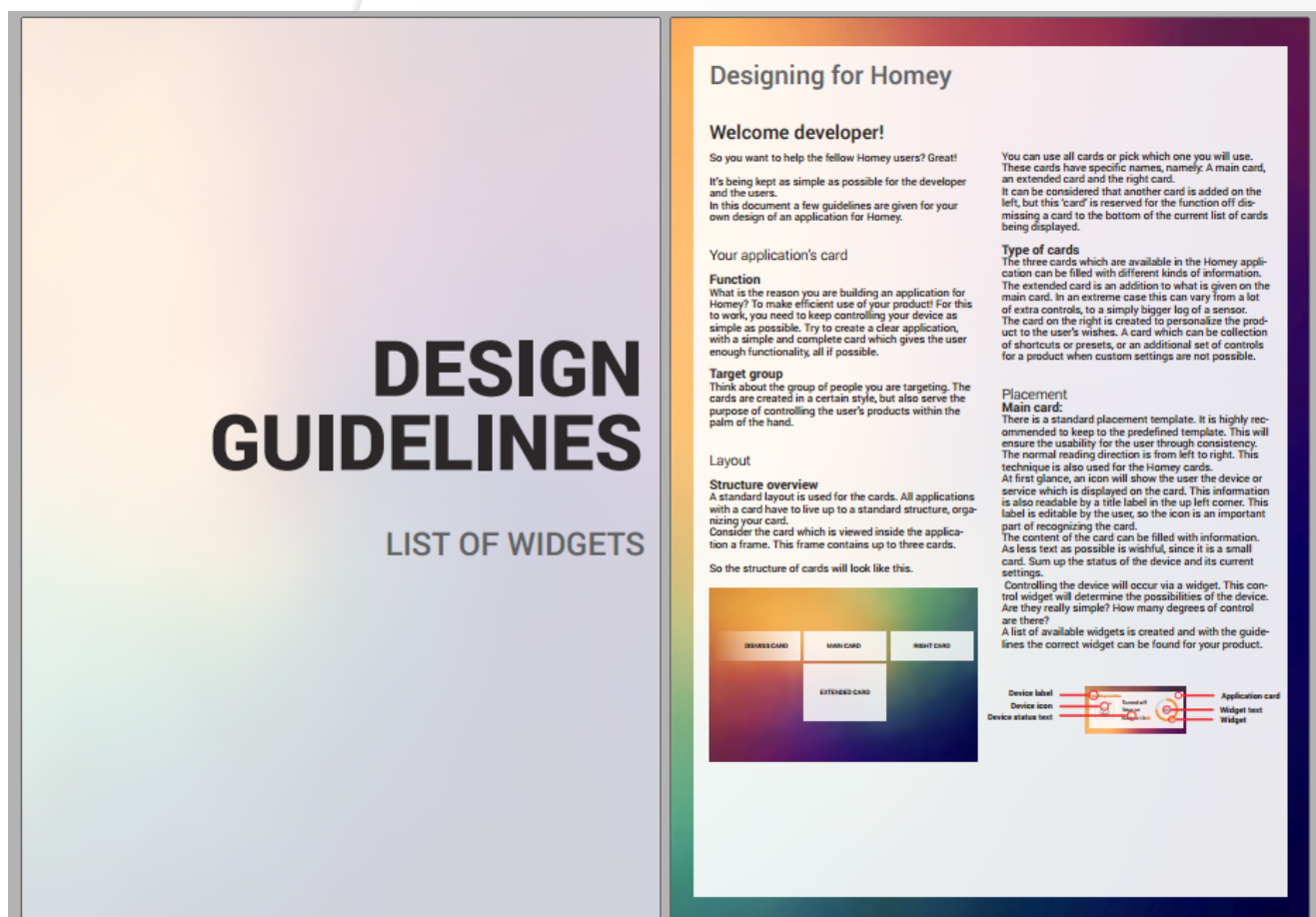
7) Support internal locus of control.
Experienced operators strongly desire the sense that they are in charge of the system and that the system responds to their actions. Design the system to make users the initiators of actions rather than the responders. Yes although the use of the extended cards was not yet satisfying , it does provide the advanced user sphere.
(8/10)

8) Reduce short-term memory load.
The limitation of human information processing in short-term memory requires that displays be kept simple, multiple page displays be consolidated, window-motion frequency be reduced, and sufficient training time be allotted for codes, mnemonics, and sequences of actions. Good use of icons, and text. Most items inside the application speak for themselves, or are accompanied by text.
(8/10)

XIII DESIGN GUIDELINES FOR DEVELOPERS

CAN BE FOUND ONLINE AT:

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