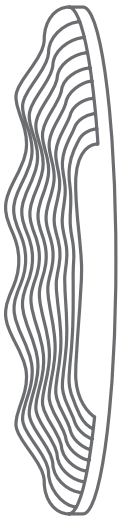
THE SOUND OF A SMART HOME

FINAL BACHELOR PROJECT

EVA VAN DER BORN



FINAL BACHELOR PROJECT
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EINDHOVEN UNIVERSITY OF TECHNOLOGY

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This is the report of my Final Bachelor Project ‘The Sound of A Smart Home’. The Final Bachelor Project is a project of 6 months to showcase what you have learned during the past three years.

My project is driven by the core question:

‘How can designers contribute to a meaningful and sustainable relationship with technology in everyday life?’.

In this report, I will describe my journey towards my final design: I will introduce myself as designer by means of my vision and identity. Then, I will elaborate on the most important project themes through literature research that has been done. These project themes include; The Internet of Things in home environment, Everyday Practices and Slow Technology and Unaware Objects. The middle section of the report reflects on the design process I went through by means of three pragmatic iterations and how that led to my final design that has been showcased on the Demo Day. Furthermore, I will describe the the first steps for future plans that have been made, and close off with a critical discussion on the insights gained and reflection on my design process and development.

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INTRODUCTION

VISION

During my studies I became interested in the relationship between people and and their objects, in particular technological devices. Technology has become such a obvious aspect of our everyday life, that indeed we are not actively thinking about anymore. Whilst these new emerging technologies make promises to solve complex problems we face in everyday life, they also introduce a considerable amount of unforseen complexity and issues. In the banal reality, these unforeseen issues and complexity often pass real user needs and desires, yet we tend to simply accept any possible output that is provided by technology.

To create a meaningful and more human relationship with technology, design can serve as medium between the two worlds. We can use design as a tool to speculate with different futures and how each will affect our everyday experience with technology. We should also actively promote a culture for designing computational objects in which reflection and engagement are key parts in the everyday experience in order to find out what truly meaningful is for us.

In my designs I play with elements of reflection and engagement, to realise a harmonized and sustainable experience with technology in everyday life. By combining conceptual thinking and high-fidelity prototyping, I attempt to create meaningful experiences that are aligned with this vision.

PROFESSIONAL IDENTITY

I have always been a creator and a thinker. Studying Industrial Design learnt me to build the bridge between those two. Design is way for me to turn my ideas into something realistic. My empathic and personality allow me to easlity understand people and the world around me. I have a curious mindset and a strong ability to deal with complex topics. Reflecting comes very natural to me. I proactively like to produce reflections on my goals and the things I value in design. The downside of this reflective quality is that it can sometimes cause self-doubt and often becomes visible in the early stage of the design process. Currently I am making a shift towards a more pragmatic approach in my creative process, in order to tackle these moment where I am stuck in the cycle of reflecting, ideating and validating.

I have always valued a certain level of depth in my concepts. Doing research on the topics that are part of my design space, makes me easily form a vision upon that, and allows me to position myself as designer. I will translate that vision into a set of ideas through short pragmatic iterations. When the sweet spot is found, I will test and deploy the concept in a realistic setting. The insights gained from this, will be translated in directions for further design iterations. This reflective, iterative process is the way I like the work best. My set of design skills can be described as all-round. These all round skills are valuable when exploring with different topics in a design process.

ABOUT MY FPB

After I finished my internship at Bureau Moeilijke Dingen in January 2017, I took a semester off to gain some perspective and rest. Previous semester I have experimented with different topics suchs as AI, critical design and sound design. These explorations were a starting point for my current vision and interest in how people form relationships and experience computational objects. Mathias Funk seemed a good fit for these topics and so I joined the CRIGS squad, with Mathias as my coach. When the project scope finally had been established, I decided to stay closely connected to the activities and students of the squad, in order to test my design in a realistic setting and get inspired by others.

CONTEXT

THE INTERNET OF THINGS IN DOMESTIC SPACES: SMART HOME

THE INTERNET OF THINGS

The term the 'Internet of Things' was used for the first time in 1999 by the MIT Auto-ID centre as a catchphrase for a RFID supply chain [1]. Over the past twenty years, the vision of Internet of Things evolved from machines that were able to perform certain tasks, to machines that learned to sense and respond. Nowadays, the term Internet of Things covers multiple technologies, protocols and desires in which a networked infrastructure is used to gather, compute and communicate data that is embedded in our environment in order to raise awareness of some everyday circumstance [2] [3]. Things refer to physical and virtual identities or even related events, that are able to be identified [4].

To make the story more coherent, we can distinguish the 'Internet of Things' in three primary scales: that of the body, the room and the city. The first and most intimate scale is a manifestation of what is called 'the quantified self' in which biometric data from various wearable sensors is measured to provide users with self-knowledge through numbers [5]. The second scale covers the connected everyday objects that are part of our domestic spaces and together go under term 'the Smart Home'. With the third scale, the network capabilities are extended to public environment and is also called 'the Smart City' [3]. This report will focus on the second scale of the Internet of Things: The Smart Home.

CONNECTED EVERYDAY OBJECTS

The ambitions within the field of smart homes differentiate from making banal everyday objects more surprising and delightful to more functional and pragmatic ends [6]. But what all covers these ambitions is the desire to provide users and business with effortless convenience. Lately, a technology push towards IoT made clearly visible that a considerable amount of IoT objects use 'connectivity' as an add-on feature or as an asset for the third parties it serves, instead to embellish the everydayness it is part of [7]. As a result, a few of these companies shut down because they were not able to meet the real needs of the user. A few these 'failed examples' are clearly demonstrated on the ironic Tumblr page We put a chip in it: 'it was just a dumb thing. Then we put a chip in it. Now it is a smart thing.' [8]. Take Juicero, a very expensive smart juicer that is able to connect to Wi-Fi but cannot actually produce juice from fresh vegetables and fruits. Instead, it needs to be accompanied by pre-packaged produce, only provided by the company itself [9].

What is often overlooked in the field of Smart Homes by technologist, researchers and entrepreneurs is how to blend these connected objects into our everyday life in a way it is actual meaningful for the end-users. Many connected everyday devices fail because they do not build upon the rich complexity and meaningful relations that already exist in the everyday. They instead only introduce new complexity into an already rich and complex system [7]. Borgmann's philosophical inquiry on technology in the everyday, describes how our devices take away the richness of everyday experience. This tension, called the device paradigm, becomes more and more visible nowadays. In addition to this, Weiser claimed that computational procceses have become almost invisible. For people, reasoning about computational processes is not based on a plausible links or cautions anymore. This magical thinking makes us easily accept the output any technological device and therefore amplifies the direction towards a device paradigm[10][11].

EXPERIENCING THE SMART HOME AS A WHOLE

In this report, a special interest is taken in how end-users experience the smart home as a whole. Nowadays, the most convenient option to check the current state your smart home is by simply opening your IoT dashboard. There is a considerable amount of 'plug and play' UI options, as well as DIY options for creating and personalizing your own IoT dashboard. The new complexity that is being introduced in the system through our connected everyday objects, is now visualized. By communicating through visually quantified information, the complexity that is introduced in a system through connected devices that not build upon the existing complexity, goes accompanied by an additional complexity. The usage of bars, graphs and numbers often goes beyonds the limits of our human capabilities in order to relate that data to our felt experiences and make sense out of it.

The IoT philosophy assumes that it is actually meaningful for end-users to see exactly how all individual connected everyday objects are doing. We should question ourselves if it is actually meaningful for us to consistently know the state of your smart. For example: Has this meaning for us when we are not at home or when we are on a holiday? Recently, there is a raising awareness in the HCI community on how to design for a data-driven world that provides us with a better experience in the world, instead of having a one-dimensional relationship with data where the focus lies on performance, convenience, and efficiency. Taking into account social life, we should explore alternative ways to represent and experience data in order to engage with it on a deeper, emotional level, for example by considering certain human qualities in this representation suchs as ambiguity and suprise [12].

PICTURE TOP RIGHT: JUICERO FROM https://www.thedrum.com/news/2017/09/05/the-failure-awards-defunct-branding-4-juicero
PICTURE MIDDLE: AEGIS IOT DASHBOARD FROM https://medium.com/getaegis/aegis-announces-beta-platform-to-lead-home-automation-revolution-d2f9e9389809
PICTURE BOTTOM RIGHT: DIY IOT DASHBOARD FROM https://dribbble.com/shots/3335070-Automation-App-for-Home-Monitoring-Dashboard-Smart-Home

EVERYDAY PRACTICES

THE EVERYDAY

Its important to get a graps on the everyday, when designing for meaningful experiences with IoT in everyday life. The everyday is the invisible reality in which we live. It is about sleeping, waking up, making breakfast, going to work, etcetera. What all these thing have in common, is that they do not stand out nor we actively think about. The everyday is a continuous flow of the making our everyday actions habitual in order to live a quiet and happy life [13][14].

PRACTICE THEORY

However, the main design challenge lies in questioning the everyday. Because how should be question things that are so invisible for us? A method to get a a better understanding of everyday life is Practice Theory. Practice Theory describes practises as a reconfiguration of elements. Hereby, elements are grouped into 3 types: materials, competences and meaning.

Materials describe the artifacts in use. For making coffee you will need a cup, the coffee (roasted or beans) and something to make the coffee with (percolator or coffee machine). Competences describe what kind of knowledge and skills are required to perform the practice. For making coffee this requires a knowledge about the quantity of coffee in comparison with the water, but also a developing a sensibility for different favours.

Finally, meanings are the rationals for engaging with the practice. Making coffee during a deadline period will have a different meaning, compared to making coffee have a different meaning, compared to making coffee for family members [15].

EMBRACING EVERYDAY COMPLEXITY TO MAKE MEANINGFUL CONNECTIONS

The coffee example clearly shows how Practice Theory provides a way to map out the richness of the everyday. The MECOPEL approach (MEaningful COnnected Products in Everyday Life) clearly describes how to embrace everyday complexity in order to realize meaningful connected everyday objects. This approach uses Practice Theory as an analytical tool to map out the existing complexity and find implicit connections between everyday practices.

These implicit connections can be physicalised by means IoT technology. By building on existing complexity in order to realize connected everyday objects, it is likely that they become actually meaningful for us and are more likely to blend into everyday life [7].

SLOW TECHNOLOGY

Slow Technology has the potential to function as a bridge between (emerging) technologies and the everyday, in order to realise a harmonised and sustainable relationship between us and our connected everyday objects. Instead of focussing on efficiency and convenience (fast technology) in order to take away time, the philosophy behind Slow Technology aims at "*creating technology that surrounds us and therefore is part of our lives over a longer period of time" [16].* Hallnass and Rodstorm, authors of the manifesto Slow Technology - Design for Reflection, advocate technologies that support moments of self-reflection as well as reflection on the technology itself. Slow Technology will give us more time for reflective activities instead of taking away time. In order to make a transformation to a more reflective environment, designers can use slowness in various ways. For example, a technology can be slow in a way that it takes more time to learn or understand how it works, or a design can be slow in its presence.

Important is that the term slow is relative and that technology can be slow in various degrees depent how one experiences time. As stated in the manifesto:

"Slow Technology calls for amplifying and stretching time presence, and reveal a presence of time that is slower" [16].

A good example of Slow Technology is Slow Games. Slow Games consist of multiple little wooden blocks

with LEDs that are based upon the game ‘Snake’ and are spread through a home environment. The element of slowness can be seen in the presence of the artifact: it can perform only perform one move per day. In comparison with a traditional video game that requires a fast demand and response relationship with the technology involved, this approach is contradictory. It does not aim at performance but makes us challenge our memory capability and leds us develop an engagement with the objects over a longer period of time [17].

UNAWARE OBJECTS

Temporality - the state of existing in time - proved to be a valuable concept when designing for a reflective environment. When attending to temporality, the relation with an object will change and become more nuanced over time . One of the key concepts when attending to temporality is unawareness. As stated by Ron Wakkary and Will Odom:

“Unaware Objects are intentionally designed to enact their respective behaviors without requiring nor demanding the attention of their owners. They execute preset computational processes and, in this sense, operate entirely unaware of their owner’s presence or actions. These objects have no explicit output functions based on interaction with them and they lack any kind of traditional ‘interface’ or control mechanisms.” [18 p.3].

PICTURE TOP RIGHT: SLOW GAME FROM http://willodom.com/portfolio/portfolio/slow-game/
PICTURE BOTTOM RIGHT: OLLY FROM http://www.pepijnverburg.nl/work

Unaware objects are rather contradictory compared with interactive objects. Instead of having direct interaction, unaware objects are manifested by intersections. Intersections refer to the encounters end-users have with the unaware object. This ranges from being mindful about the object to subtle using or repositioning the object. Ultimately, an accumulation of intersections has the potential to result in an ensemble. An ensemble is an dynamically changing arrangement of our everyday experiences around the artefact that becomes unique and nuanced over a longer period of time [18][19].

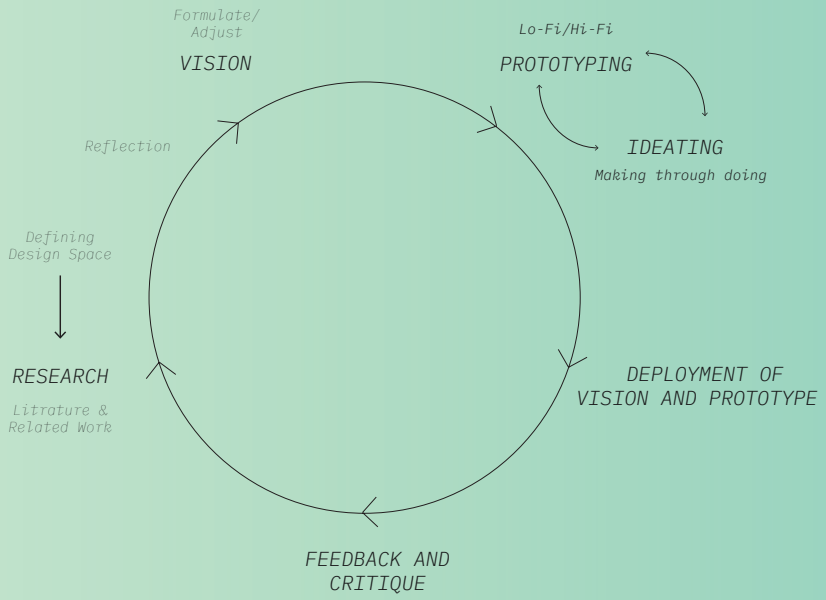
In conclusion, Slow Technology and Unaware Objects both demonstrated to be fundamentally valuable concepts when designing for a sustainable and meaningful experience technology in everyday life.

APPROACH

During the design process, an iterative approach was taken. This approach can be divided in 3 milestones : Midterm, Deployment and Demo Day, which can be found in the following chapter.

Over the past years, I have experimented with multiple approaches in the design process that were driven by different design methodologies and interests.

Through reflecting upon each, these experiences all came together and consolidated into my current design process. By now, visualizing my design process was key in order to go through the design process fairly smooth, and to have ground to base my steps and actions on.



DESIGN PROCESS

MILESTONE 1: MIDTERM

LITRATURE RESEARCH & FORMING A VISION

The project started out with a lot of research. I had chosen to do a project on my own with Mathias Funk as my coach, but I had not really developed a proposal for the project. Thus, I decided to explore with different project themes that were closely related to CRIGS. This process was focussed on the core question: How can designers contribute to a more meaningful and sustainable relationship with technologies? It is a very fundamental question, but not one that is easily answered or understood. Through excessive literature research (see chapter 4) and discussing my questions and findings with experts and other students, a vision was formed focussing on data and IoT in a home environment.

TRANSLATING DATA INTO SOUND

One of the first concepts was focussed on transforming data streams between different IoT devices into musical soundscapes for in the living room. The gathered data coming from everyday IoT devices was transformed into MIDI and mapped to different sounds in Ableton (music production software) in real-time. This concept aimed at creating an intimate experience with data. It allowed end- users to make more sense of their data: it told a story, revealed their hidden patterns and connections and above all, showed that sound provides an alternative way to experience your data.

EXPLORATION

Often, I can get easily stuck in the ideation phase when I go in depth with my conceptual thinking process. So, my goal for this semester was to tackle these moments by taking a more pragmatic approach. Hence, everyday scenarios were created. Based upon that, the practices were analysed in search for meaningful implicit connections, and created 8 individual channels in Ableton for each practice. To test the concept described above, the scenarios with their corresponding sounds were played to 5 participants that took part in a small explorative user study. The aim of the study was to gain insights on how people experienced the soundscape as a whole and have a deeper discussion about the qualities of the different sounds. As seen in appendix 1, this small test resulted in interesting findings. The main concern related to the concept was that most participants described the soundscape as disturbing and unstructured when it was played real-time.

SLOWNESS AND TEMPORALITY

With the findings, another round of literature research was done. I found out about the design philosophy Slow Technology. This had the potential in forming the bridge between my interest in IoT and everyday life. The philosophy described the presence and stretching of time as important factors for creating a longer-lasting relationship with your everyday computational objects. What could improve the current concept was a element of slowness. Instead of focussing on real time soundscapes, creating a summary of every hour in a form of a 20 seconds long soundscape, was aligned with this philosophy and vision. Hereby, the design is slow because one have to wait for a full-hour to experience and the data.

Next to slowness, an element of temporality was also present in this current concept. Soundscapes offered to be a potentially rich design material because sound exists in time and is is good in representing multiple events that are happening in a certain timeframe [20]. By playing the soundscape everytime exactly on the whole hour, the metaphor with a (traditional) clock was easily made. A clock plays exactly every hour a piece of information: time. Through the metaphor, anchoring time became a valuable part of the concept.

SOUNDSCAPES AS INFORMATION REPRESENTATIONS

Soundscapes also offer a medium for representing information in a way that is beautiful and has the ability to make the transition between foreground and background. Just as unaware objects, informative soundscapes are often open to engage with. Informative soundscapes can be categorized under the term ‘Calm Technology’, which has a lot of common ground with Slow Technology. Yet, Calm Technology emphasizes the periphery as the centre of interaction while Slow Technology focuses on the slowing down effect of an interaction [20].

MIDTERM DELIVERABLES

For the midterm, a slow and unaware prototype was created in order to support the storytelling element in my presentation. Because there was no interaction required with the design, the only purpose of having a physical element in the design was to hide the electronics. The simplicity in material and subtle complexity in form, makes focussing on time as basic element and reflecting more easier[16]. Thus, a simple box was made with an LED ring that represented 12 hours in a day. Inside the box, there was an Arduino Yun connected to a laptop and an external speaker in order to activate the right channel in Ableton through a virtual MIDI bridge, and in order to turn the right LEDS on (see appendix 2). During the midterm, 5 scenarios were presented, each with their corresponding soundscape. The discussions that followed proved to be very useful. Not only did it validate the qualities of the project, but it validated the strength of the story behind the project. For example; adding interactions and functions merely as features, would not be beneficial for the concept because it took away the value of slowness and temporality. This steered the focus of the project more towards the story the design was telling rather than the question that I was trying to solve. As a result from this, the concept was ready to be consolidated.

PICTURES OF MY MIDTERM PROTOTYPE CONNECTED TO AN EXTERNAL SPEAKER. A PICTURE OF THE SETUP OF THE SMALL USER STUDY: ABLETON AND A LAUNCHPAD.

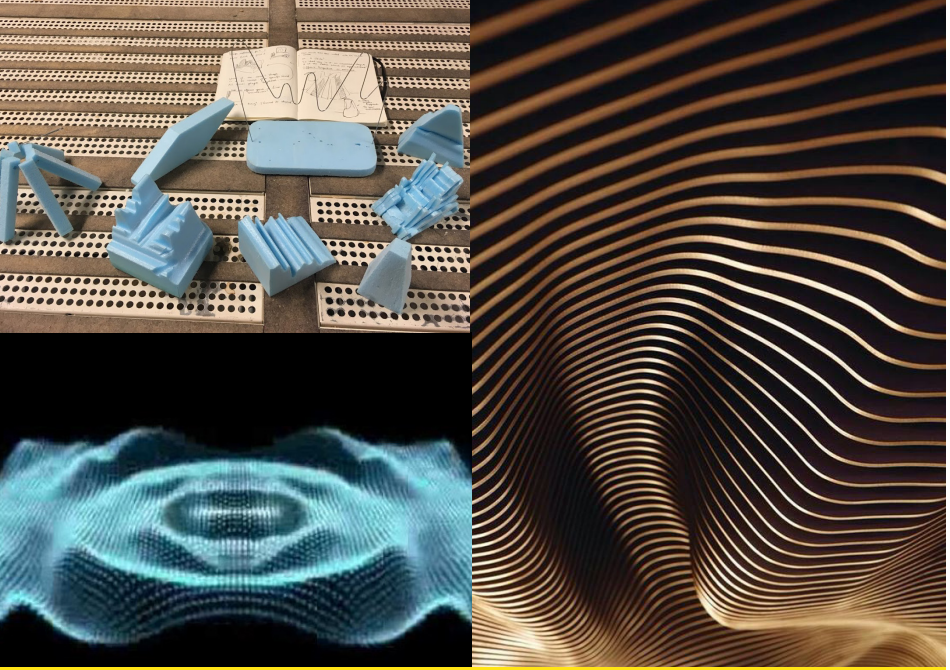
CONCEPT CONSOLIDATION

This is the abstract written about Sound of A Smart Home for the Video Showcase Submissions for CHI 2019. See Appendix 7 for the 1-page submission.

Sound of a Smart Home is a design exploration to reflect on how we currently use and experience connected products in our home environments. While the Internet of Things, as a global mesh of data gathered, computed, and communicated by smart objects, has brought us convenience, the way of communicating the state of the smart home now heavily leans on quantified information displays. An immediate demand and delivery relationship with smart objects exists, but touches us only in very utilitarian ways. Yet, the question remains: how to create sustainable and harmonized experiences with everyday smart objects?

The Sound of a Smart Home is a **slow** and **unaware** object that provides a summary of the activity of all connected products within a smart home in the form of a unique 20-second soundscape played every hour. This design collects data that is exchanged between connected things for an hour and then transforms it into a soundscape of ambient sounds that are mapped to specific data streams in the house and subtle changes that happen to them over time. By using sound as a medium instead of visually quantified information, it proposes an alternative, more intuitive way to experience your smart home as a whole and as an evolving ecosystem.

Ultimately, the project explores how slowing down the experience of smart home data through intersections might support reflections on the technology itself and on the everyday practices it is part of. This experience aims at supporting a longer-lasting relationship and engagement with everyday connected objects.



PICTURE LEFT, TOP: OF MY FOAM MODELS, PICTURE LEFT MIDDLE: A 3D SOUNDWAVE, PICTURE BOTTOM: A RENDER FOR THE DEPLOYMENT, PICTURE RIGHT: PARAMETRIC INTERIOR DESIGN

MILESTONE 2: DEPLOYMENT

After the Midterm presentation and concept consolidation, new goals for the deployment deadline were formulated in order to elaborate and substantiate the concept and integrate multiple competency areas. The four main goals discussed with my project coach, aimed at creating depth in terms of aesthetics, physicality, mapping, and sound design.

AESTHETICS

Although the simple, wooden box was an appropriate choice for the midterm, the boundaries could be pushed further in terms of form giving. I began exploring with different shapes by creating multiple foam models that were inspired by everyday objects and were related to time. A moodboard consisting various clocks, metronomes and music players was designed as inspiration for this. Also, I began to explore how sound could be visualized in 3-dimensional objects. Inspired from parametric wooden sculptures in interior design, I learned to create multiple 3-dimensional sound waves in Rhinoceros. These 3D models were imported into a slicing plug-in for CAD models and then translated to MDF prototypes. The slices in the design made sure that there was space for the speakers sound to come through the objects, and to create an illusion of a shape changing surface. After experimenting with various shapes and thicknesses of the MDF, a final model was made for the deployment. Initially, the object was meant to hang on a wall, just like a clock). However, the prototype

was very heavy and fragile at the same time, because all its weight was put on one slice. For practical reasons, the prototype was placed on a flat surface.

HARDWARE AND SOFTWARE

A loudspeaker inside the object was added. Having an extra connected component such as an external speaker, made it more challenging for the design to blend in everyday life. For the deployment, it was important to have a prototype that could function entirely on its own for approximately more than a week and could store a considerable amount of GB. Therefore a Raspberry Pi 3B+ was chosen. This was my first time working with a PI, and therefore a few things needed to be done to let it function properly. The PI was connected to a amplifier, which was connected to the loudspeaker. Also, a RTC (real-time clock) board was mounted on board in order to tell the Raspberry PI what the exact time is without use of the internet. These electronics were put away in secure MDF boxes.

The PI ran a Python script that played a random soundscape (out of 25 different soundscapes), every hour. This script can be viewed in appendix 4. Unfortunately, the PI stopped playing these soundscapes when it lost its connectivity with Putty or when it was removed from the current. PM2 was integrated in order to let the script run automatically at startup and to log the activity of the PI. Now I was also able to see which random sounds were played at specific times.

SOUND MAPPING IN PYTHON & ABLETON

Inspiration for the initial concept was drawn from a GitHub page called: Machine Music, that transformed weather data in Python into soundscapes for Ableton. The small collection of scripts used in this demonstration functioned as a good base for my final script which can be found in appendix 3. One of my main goals this semester was to learn the basics in Python, because I think it is a very versatile programming language. Therefore, Python was used as programming language to work with, over other options such as MAX/MSP.

A first step in this process was a conceptual data flow chart. I elaborated this in reverse direction, in order to stay close to the sounds I had in mind. By now, I was able to transform any random API values into sounds in Ableton. However, I created a data simulator as a result of the limitation of the data availability in the IoT Sandbox. Every hour exactly, the Python script would generate (partly) random values for different practices and put this in a temporary JSON file. Next, the script would import the JSON object (and immediately clean it) and assign the elements to different channels in Ableton. These elements were based upon the practices from the data canvas of the IoT SandBox. Yet, the question remained: How to get a nice sounding soundscape that preferably builds up in terms of sounds and fades out again?

The amount of elements present in an hour were divided in 4 parts in which every part represents 5 seconds soundscape. The amount of elements present in a soundscape slowly build up towards the end of 20 seconds and then fades out. Ultimately, the script has not been a part of the final design because it needs further optimization for real implementation. Nevertheless, programming this script and working with Python for the first time, contributed in a great extent to my development in the competency area MD&C.

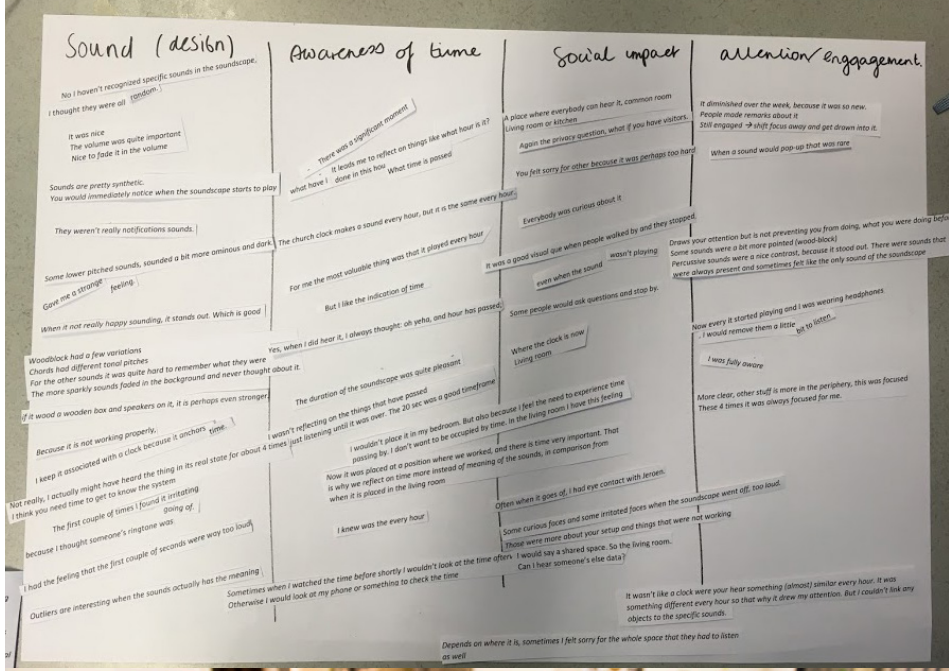
DEPLOYMENT AND SOUND DESIGN

Usually the timeframe for deploying slow and unaware objects is around a year. In the given timeframe of this project, it was difficult to do an actual deployment that lasted that long. Also, having all the connected everyday objects in the same house was almost impossible. So instead of having a deployment, the sound qualities of the design would be tested. For one week, a group of 4 students lived with the prototype. It was located in the the Graduation Space at the faculty of Industrial Design (TU/e), next to their working tables. The goal of the deployment was to find new insights for a refinement of the experience of the sound qualities of the design through exploratory questions about the experience of sound over a period of time. The participants were told that they could just do whatever they were normally doing. Afterwards, a interview was held with each participant. These questions can be found in appendix 6. This got followed by a small test in which the participants had to describe the different sounds in terms of everyday objects and events. Both approaches resulted in refreshing insights that were sorted in 4 groups: sound design, awareness

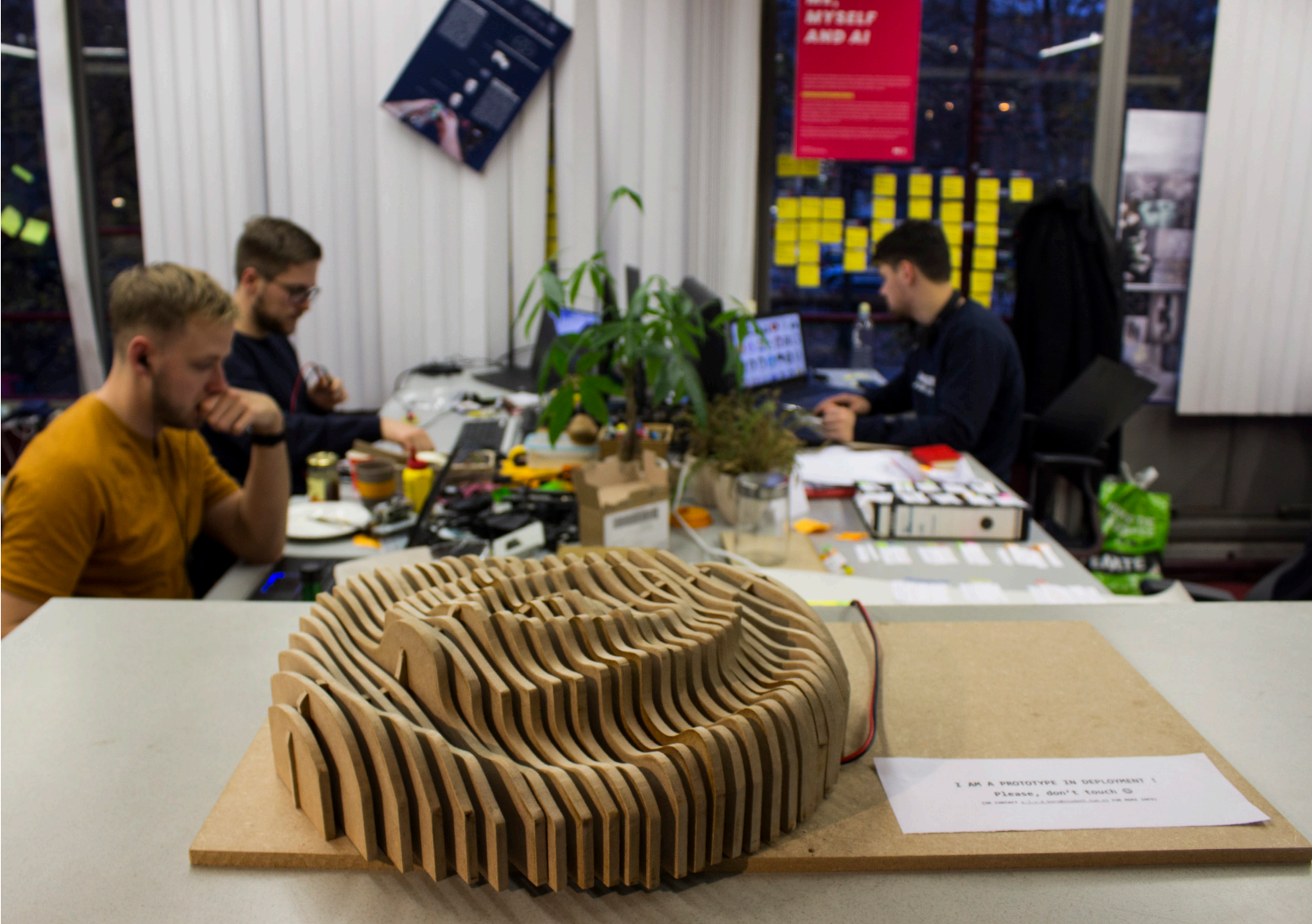
social impact and engagement. The most important findings were related to the sound design and awareness of time. All the participants argued that the soundscape should swell in more, to be more inviting to listen to. Also, 4 specific sounds in the soundscape were too similar and therefore the participants experienced difficulties with recognizing them back.

What was also interesting was that participants started to write on post-its specific moments in the day when experienced intersections with the artifacts. These intersections ranged from being mindful of the prototype, to subtle uses of the prototype such as changing the volume. Also they kept track of other other peoples comments and behaviour around the prototype that were actually not part of the deployment. Instead of leaving loose post its around the prototype, I provided them with a little booklet for keeping track of their thoughts and actions.

With a functional working prototype and insights from the deployment , it was time to focus on high-fidelity prototyping, work on next sound design iterations and provide ways to tell my story.



PICTURE TOP RIGHT: QUOTES AND FINDINGS SORTED IN CATEGORIES
PICTURE BOTTOM RIGHT: PROTOTYPE FOR DEPLOYMENT


MYSELF
AND AI
I AM A PROTOTYPE IN DEPLOYMENT !
Please, don't touch

Data Flow

Your everyday IoT objects

Subscribe to data channels

filtering & normalizing

Data preprocessing

Store data in local JSON/CSV file

for 60 min long

Transforming into MIDI in Python

select tonal scale & put values in range of midi notes

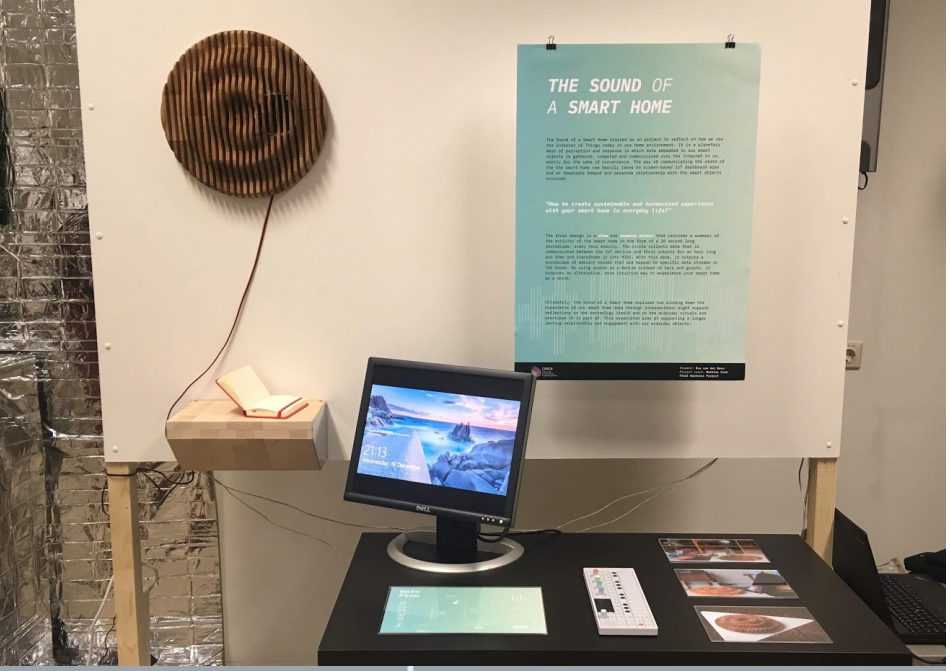
Send data via Virtual MIDI Bus

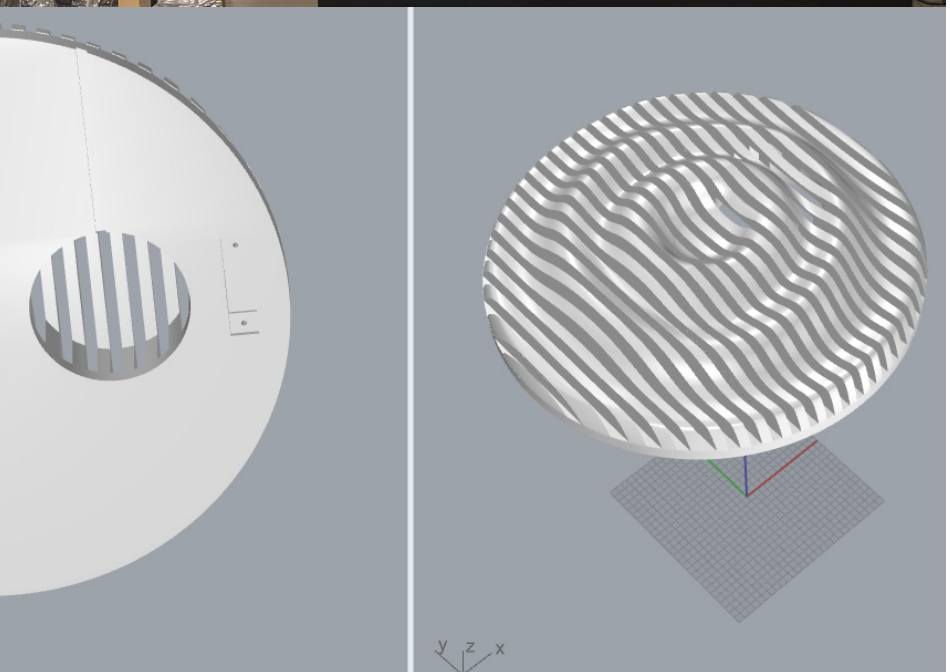
Converting MIDI data to 20 sec soundscape

Create Ableton channels

Map IoT ojects to channels & randomly assign order of activation

Amplified by the circle





PICTURE LEFT TOP: FINAL DEMO DAY STAND
PICTURE BOTTOM: FINAL PROTOTYPE HANGING ON THE WALL

MILESTONE 3:DEMODAY

For the Demo Day, the aim was on giving visitors an experience of what living with the design could be. Therefore, the focus was on the actuality, rather than the functionality. Storytelling techniques could be a valuable addition in order to convey the concept and create a coherent experience. The Demo Day was also the right moment to have deeper discussions with people from different backgrounds in design.

A high fidelity prototype was designed for the Demo Day, together with little bookshelf that functioned as a casing for the electronics. For the storytelling element in my presentation, a fictional video was created that showed two scenarios of people living with the design. The prototype was synched with the video, so that the soundscapes were played at the exact right moment. Also, the soundscapes were re-designed according to the findings that came out of the deployment.

HIGH-FIDELITY PROTOTYPING

The prototype that was used for the deployment was not very flattering. After experimenting with different materials, wood seemed to be the appropriate option for the final prototype because it gave a sense of warmth and endurance. Wood resonates with long lasting effects because it inherently expresses time through its natural fibers. The form and material qualities of the prototype should be easy configurable in and around everyday settings, in order to invite for intersections and ensembles over time [19]. By not fixating on a

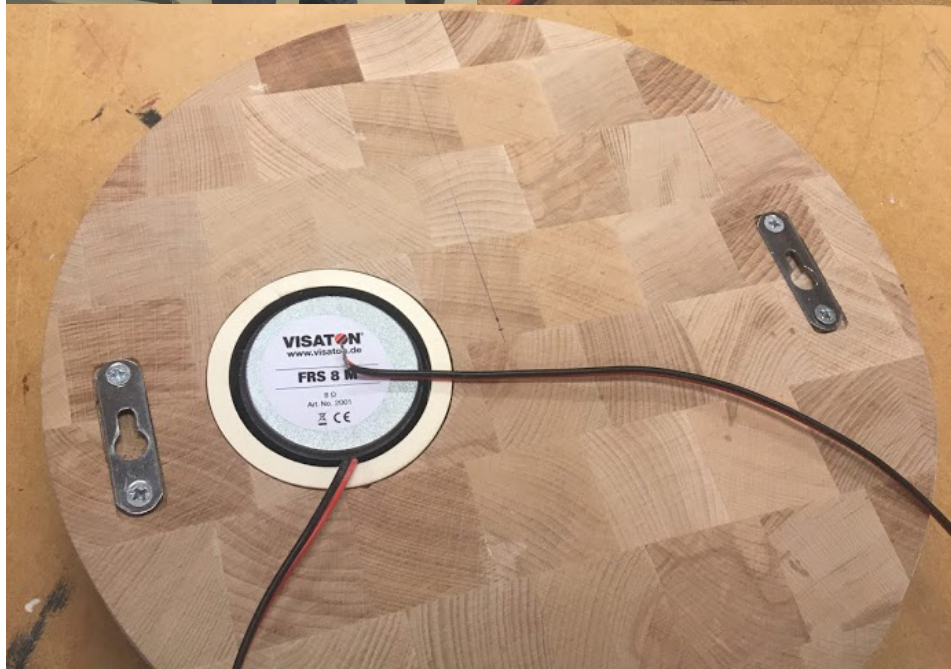
PICTURE TOP RIGHT: CHET PROUD OF THE CNC RESULT
PICTURE TOP LEFT: UNFINISHED WOOD AND NEW SPEAKER
PICTURE BOTTOM: BACK OF THE PROTOTYPE

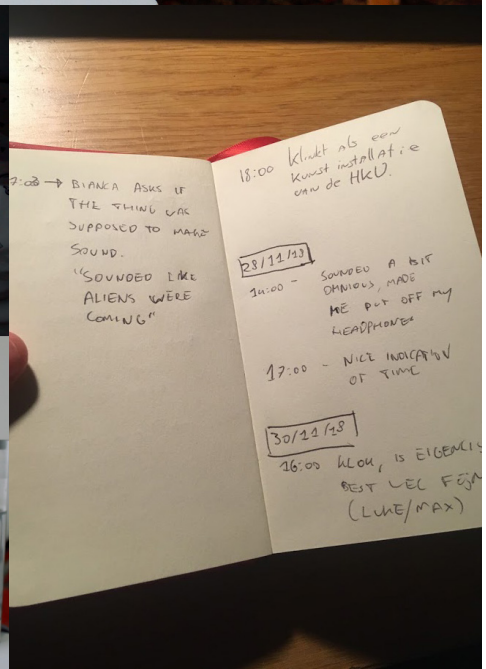
a specific way to place design one's home, there was room left for the users to decide whether they would hang it on the wall or place it somewhere on a flat surface. From this, they could think about what to configure around the prototype.

Instead of having multiple slices of MDF that had a high risk of breaking, this prototype was made out of one solid part of wood. To create a more sophisticated appearance, a new 3D model was made in Rhinoceros and a smaller speaker with less Watt was selected to work with. With a new 3D model, a solid chopping block made from beechwood was fabricated with the CNC mill. After treating it with sandpaper and linseed oil, it dried for a couple of days. Suddenly, all the fibers were more expressive and visible. A small wooden cabinet with pieces of foam inside was made and attached to the speaker.

ELECTRONICS

Almost all the electronics of the prototype were kept the same after the deployment. A more fancy casing was made out of maple wood. At the same time it functioned as a little shelf for the booklet that was added to the design experience. Instead of having a script that played every hour a random soundscape, a demo version was programmed. Two push buttons were wired to the Raspberry and could be controlled with a single push. One button started the Python script that was in sync with the video while the other button started the script for directly playing a soundscape at random base.





PICTURE LEFT TOP: OTIS LISTENING TO SMART HOME
PICTURES LEFT BOTTOM: DIFFERENT PRACTICES FROM THE VIDEO
PICTURE RIGHT: THE DIARY FROM THE DEPLOYMENT

STORYTELLING

Initially I thought it was hard to show Demo Day visitors how the concepts slowness and temporality played a role in my concept, because often pitching your project does not last very long. Pepijn Verburg, co-creator of Olly advised me on how to present such a slow and unaware object in a way that is very interesting. To show people how their relationship with the object might change, I speculated with two scenarios to show the contrast: The first scenario described how people just received the design and are still learning to understand how it actually works, and finding out the consequences of using it. In contrast, the second scenario describes how the participants live with the object 8 months later, and how they have developed a sensibility towards the object that allows them to experience the data in a more natural and intuitive way. Both videos demonstrated quick shots of interactions with everyday connected products, followed by a unique soundscape that was coming from the design.
The video was shot in a friend's apartment and therefore the smart object involved (and thus the soundscapes), were dependent upon the objects that were availible in the appartement.

Inspired and based on what the participants wrote down during the deployment, I wrote a part of a fictional diary. It consisted of little notes, comments and reflections. This diary can also be seen in use in the video. For the Demo Day, the aim of this diary was to have a visual representation of reflections and intersections people might have when living with the design.

PICTURE TOP RIGHT: THE RASPBERRY CONNECTED TO THE PUSH BUTTON WIRES
PICTURES: ALL THE HARDWARE READY TO BE MOUNTED TO THE CASING

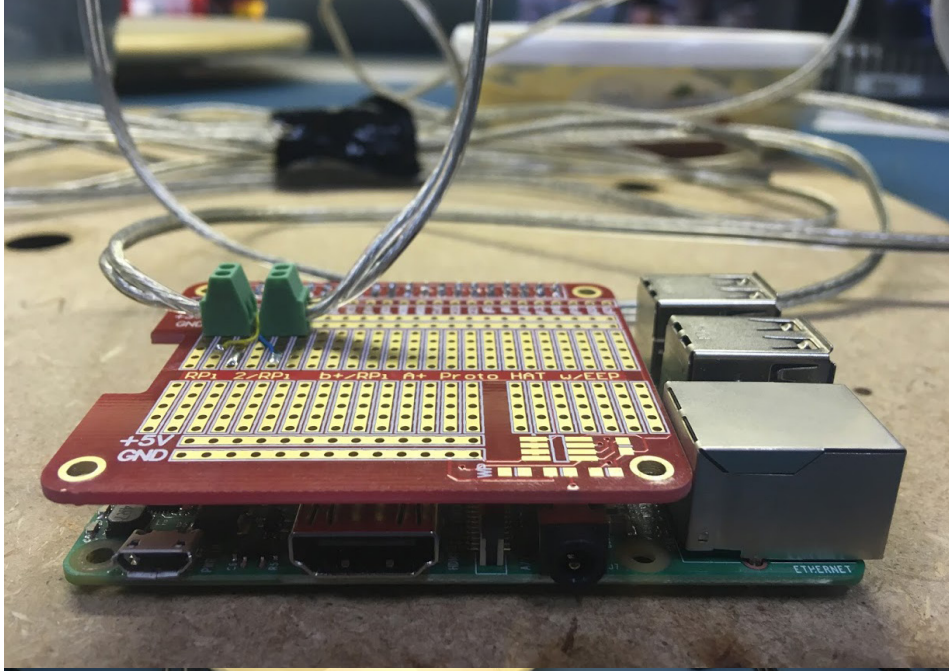
PROGRAMMING

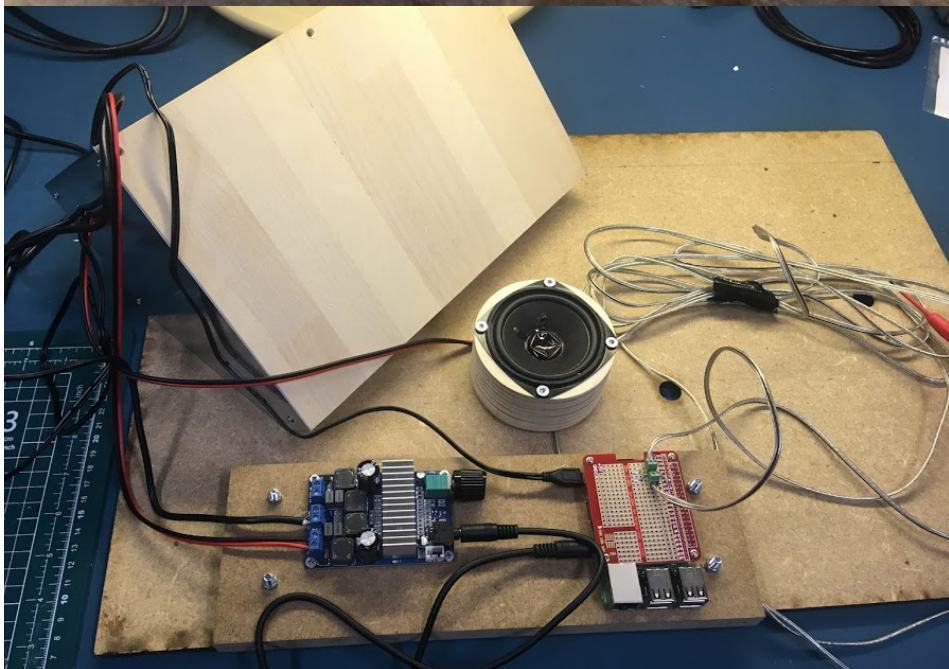
As seen in appendix 5, the script for the Demo Day only had to play specific soundscapes at a push button command. Through the use of various delays that were synched with the time intervals of the soundscapes of the video, the video and the soundscape were perfectly aligned.
An own IP address was created to let the code run fluently during the Demo Day. Due to an overload of the network, the connection was often lost and therefore the Raspberry PI was rebooted multiple times.

SOUND DESIGN

Based upon the findings of the deployment and the objects present in the video, new sounds were created for the two soundscapes. Important was that the sounds formed a coherent, ambient sound palette, but also were different enough so they would not fade away in the background. Texture, attack and decay, envelope and scale were important parameters for the mapping and modifying sounds. I tried to capture the texture of the original sound of the object. Attack and decay was used to play with the continuity of the data flow. An envelope was an interesting method to make sounds fade in and out of the background and add a softer touch to the sounds.

The sounds are made with build-in synthesizer (plug-ins) in Ableton. Each individual sounds behaves differently according to its input. Thus subtle changes will be heard in the individual





sounds when the interaction deviates. These subtle changes are a fundamental part of the learning process and contribute to the slowness aspect of the design. The order in which each individual sound is played is 1:1 related to the order of the actual events that happened during that hour.

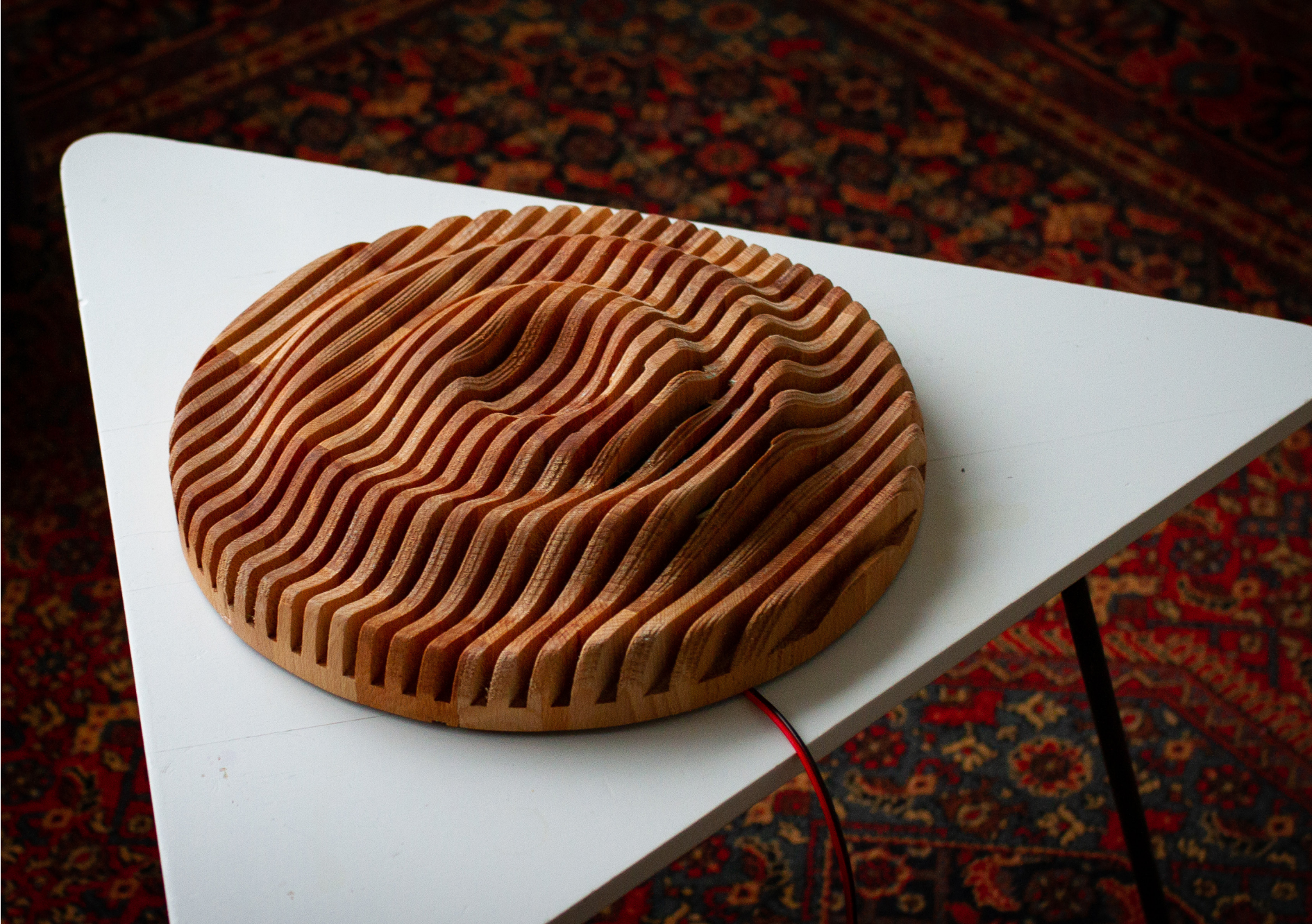
An OP-1 was used in order to quickly explore with different parameters. After the sounds were selected, mapped to their object, and individually modified, it was time to create the soundscapes. Because the focus of the presentation was on the experience, the quality of the soundscape had to be really high. Thus, the soundscapes were made by hand through use of a launchpad and timer, instead by means of the Python script. Hereby, the same technique was used for building up the soundscape. The 2 soundscapes were saved as WAV files and moved to the PI. The complete Ableton Set, provides a good baseline for enabling a possible connectivity with Python in the future.

FEEDBACK DEMO DAY

The Demo Day was the first moment the design was shown to the outside world. Insightful discussions were held with experts in field of IoT as well as other professors from the faculty of Industrial Design. These discussions raised some interesting questions such as: How would the first stage of living with the design be? What kind of actions will people take to understand the mapping and the workings of the system? Also, there were a few questions on how I positioned myself as a designer in this project. Is this part of a research through design or is this a critical design statement? During the Demo Day it became clear that the visual appearance of the design had a considerable effect on people. Some comments include: *'I don't know how this works exactly but I would love to have this in my interior',* and *'I would love to see the surface change shape'.*

PICTURE: FINAL SOUND DESIGN SET-UP: ABLETON LIVE, A LAUNCH PAD AND AN OPI-1.

PICTURE OF FINAL DESIGN
TAKEN BY TWYCER/ FOTOGRAFIE VOOR BEDRIJVEN



EXPERT FEEDBACK

Unfortunately, doing research through design by means of a deployment for assessing the strengths and weaknesses of my concept related to Slow Technology and Unaware Objects that expired over more a year, was not possible. However, as Gaver stated in his article What Makes a Good CHI Design Paper, many other forms of assessment are also potentially valuable in order to critically address design related work [20]. This might include expert critiques from other practitioners and therefore I reached out to two important researches with a background in Slow Technology and Unaware Objects. The next chapter will discuss the feedback from the experts and Demo Day more in-depth.

WILL ODOM

Will Odom is an Assistant Professor in the School of Interactive Arts + Technology at Simon Fraser University in Vancouver, British Columbia. He is a human-computer interaction design researcher interested in designing and studying technology that positively shapes the human condition.

In his recent works, he explores with the qualities of Unaware Objects to realise this vision. Will provided me with very insightful feedback.

"I like that you're aiming to get away from screen based notifications / information and explore an alternative way of making more real and present data from connected artifacts in the home. A second thing I like is that this approach falls in line with a small but important and growing set of works in design and HCI that are exploring how we can design for and support support experiences like reflection, interpretation, curiosity, and so on.

*In terms of the framing of your concept, I think it misses out on that you are *revealing* data that is often unseen, unknown, and largely invisible. One thing I would push you on is to try to be a little more precise kind of change, experience, or action that you'd hope to facilitate or trigger from this design concept if people lived with it in their everyday lives? Is it simple about being more aware of changing amount of data being communicated by and among their devices in everyday life? Or, is it about trying to trigger a more formal action in the person living with it? I think the video starts to allude to a possibility at the end with the woman making a diary entry but it was a little unclear.*

Also, what are the tradeoffs of having an aggregate amount of data across devices being projected back into one's environment every hour as a soundscape, as opposed to having different tonal qualities associated with specific devices so one can become aware of how individual practices/rituals shape the transfer of data by specific IoT devices?"

LARS HALLNÄS

Lars Hallnäs is Professor in Interaction Design in the University of Böras, with a research background in experimental interaction design, design theory, mathematical logic, computing science, philosophy and music composition. He is co-author of manifest Slow Technology - Design for Reflection.

Lars speculated about what might happen with the home environment.

"What I think will happen is not the introduction of a calm and reflective home environment. More like a mysterious environment that turns data into riddles. This is interesting and clearly in line with the idea of slow technology as an antidote to efficient time "consuming" technology. But there are certain things I think you should do and that is to make the series of soundscape presentations more random, the length of each, when and where they occur and so on. The specific design of the soundscape "outlet" is another issue. It looks very beautiful on the images you sent me and could be things that have the same "function" in the environment as ventilation stuff, that is a nice metaphor I think. There should of course be lots of them here and there. Slow technology is not just "slow", it is technology that is obstinate and should disrupt your comfort zone. "

FUTURE STEPS

SUBMISSTION FOR THE VIDEO SHOWCASES CHI 2019

On the 6th of January, Mathias and I have delivered our submission for the Video Showcases Submissions for CHI 2019. Our submission covers a re-edited version of the video that was shown during the Demo Day. This edit now includes additional text and graphics, and a one-page abstract about the project. The Video Showcases is a place where designers can demonstrate their work related to HCI through a video. For the selection process, the videos will be juried by a small group of judges and the selected to be screened on CHI 2019. The videos will be seen by a great community of HCI experts and therefore I am really enthusiastic about what might come from this.

DISCUSSION

ON FEEDBACK DEMO DAY

In this discussion, I am not aiming at solving the question that had been the motivation of the project (how to can designers contribute to a more harmonised and sustainable experience with connected everyday objects), but I will look at the different perspectives and insights that have been collected during the project in order to evaluate the vision, concept, and outcomes. Furthermore I will speculate about possible future directions of the project.

On the Demo Day it became clear almost everybody could resonate with the concept and vision, but had its own opinion on how they would exactly use the artefact in their home and how they would experience the soundscapes. Stephan Wensveen (Program Director of the faculty of Industrial Design, TU/e), clearly demonstrated how intersecting with the object would lead to an unique ensemble.

"I prefer to put it somewhere on a flat surface in my home, so I can put little cards or written notes between the wooden slices, instead of having a diary."

In this example, writing notes and putting them into the design are a set of ongoing encounters that he has with the design. In a more holistic perspective, the configuration of the artifact through use of the written notes, is a result an ensemble that will affect a larger context; that of the home environment and its inhabitants.

ON FEEDBACK WILL ODOM

Will Odom liked several aspects of the project. His feedback made clear that the concept could be stronger if I considered more deeply what will happen as a result of the largely unseen and unknown data patterns being revealed in the home on an hourly basis. This does not have to necessary be towards a pragmatic end, but even if it is stimulating people to be more mindful or understanding of their IoT devices as having more agency than we typically do. Therefore, I should consider what kind of change, actions, dreams, curiosities, or practices/rituals might this lead to this. He also addressed that I should consider what the tradeoffs are of having an ambient soundscape as a representation of the data, opposed to having specific tonal qualities for every individually object. An possible answer for his remark, addresses a topic, closely associated with data, that has not been debated in this report yet. Privacy is fundamentally import value to take into account when designing representations of data. In order to achieve a feeling privacy in the house, the soundscape provide an opportunity to put a layer of abstraction over the data, in which recognizing different IoT devices immediately, becomes very difficult. Compared with having specific tonal qualities for every object, now people have to learn the mapping and interrelations over a longer period of time.

ON FEEDBACK LARS HALLNÄS

Lars Hallnäs feedback made clear that the sound design aspect of the project is fundamentally important to design a calm and reflective environment, and that there are clearly opportunities left to reduce the mysteriousness of the soundscape. Yet, this mysteriousness in itself can be a very powerful tool in itself in order to make sense out of the data. For example it can tell that something might be wrong with the data or the object itself. His proposal of having multiple designs spread through the house opens up a possibility of new intersections and ensembles. Also he made clear that there is still room to experiment with different time frames in which the soundscape exist in order to keep an element of surprise and ambiguity to support everyday creativity [12].

CONCLUSION

The concept and the prototype as it is now, is not flawless and there is a lot of room of improvement in terms of sound design, connectivity and research through design. An actual deployment in which real IoT devices are connected to the system and lasts over a long period of time, could be the first step towards the realization of the ideas and insights discussed above.

REFLECTION

This project started of not as I wanted to go. During my time at Bureau Moeilijke Dingen I developed an ambitious attitude, but at the same time experienced a large drop in my confidence as designer as a result of being too much out of my own comfort zone. In my previous semester, this really became visible in every aspect of my design process. I had put the standard really high and in order to design something good, I had to validate every insight I had. This got me stuck in an process of ideation and validation which led me to finally quit the project halfway through. The current semester would be a new opportunity to prove my worth to others, but mainly to myself. After four weeks I felt I had fallen back into the same old habits of ideation and validating, with as a result excessive literature research and a lot of frustration. There was an acute need for a pivot in my creative process, in order to graduate.

I set myself the goal to have a more open and explorative attitude towards a design process, because naturally a design process always goes different then expected. Through pragmatic iterations, I explored with different methods such as a visualization of use cases, coding small scripts and creating and testing different sounds. By not immediately translating it back to literature or opinions from others, these explorations slowly formed the concept. The question 'How to design for a more sustainable and harmosided relationship with technology in everyday life', became the main focus of the project. By the time I was able to present the concept at the midterm, but also the insights I gained from my research, discussions and reflections. Enthusiastically, people reacted upon the focus of the project with their own opinions. What struck me was that question that drove the project was in itself perhaps more interesting than providing a solution for it. With this in mind, the expectation from designing something that satisfied all requirements for solving the question, shifted towards a more open and explorative approach that also seemed to fit my vision and identity as designer.

After the midterm, I decided to continue with the concept and focus on the story it expressed, instead of focussing on the connectivity. There were creative opportunities in doing so, in which the video became the most important one. I had by now developed a clear understanding of the things I had to validate, and things that needed to be left open for imagination. With more clear goal and a more structured iterative process, there was room to work on more specific goals as described in my PDP. I gained a considerable amount of experience in all competency areas, expect B&E. The biggest progression was made in the the comeptency area C&A. Multiple new techniques got integrated in my creative process. The story that the design expressed became the main focus in the second stage of the process. Creating different prototypes, from low to high fidelity, learnt me to work with tools suchs as Rhinoceros and Ableton. These two programs became very important for defining the creative output. Wood became my main material to work with. I have learnt multiple techniques to modify and embrace its material properties. Also, I explored with different storytelling techniques during the whole project. I learned to create realistic use cases by means of analysing practices through Practice Theory. I also learnt to convey my message to an audience through the video and demo day demonstration. I took a slightly different approach for developing myself in U&S. Instead of doing a user test towards a pragmatic end, I learnt to collect insights through explorative studys and talking to experts within the field. In this project I worked with a Raspberry PI and different communication protecols for the first time. It proved to be a very powerful tool despite all the connectivity issues. In terms of MD&C, I had set myself the goal to learn the basics of Python. I think it is a very nice, relatively simple programming language. Yet, the simplicity also sometimes bothered me because debugging was very difficult. It was a pity that I was not able to implement the script for transformed the data into sounds in my final design. The unfinished script can still can be futher developed for a possible next iteration. Furthermore, the core of the project was driven by a R&D approach: I learned that you do not neccesarily have to provide an answer, but that asking questions can also be very valuable. In this project my qualities conceptual thinking and high-fidelity prototyping really came to the foreground, which are qualities I am now really proud of to have.

This year was not what I had imagend of what graduating should look like, but the struggles and new discoveries made me only more proud of the end result.

Thanks to all my participants for participating in my user study and deployment. Your opinions and insights were very valuable for the project. A big thank you to Chet Bangaru. Thanks for taking care of my solid piece of wood and turning it into something beautiful. I also want to thank the rest of D.Search for all their help. Thanks to Astrid and Otis to play in the movie and have me over to film in your beautiful apartment. I want to thanks my fellow students, friends and family for supporting me during my Final Bachelor Project. Finally, a big thank you to Luke. Thanks for all your inspiration, motivation and always being supportive. I could not have done it without you.

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I want to thanks Pepijn for his diplomatic feedback, in depth analysis on my concept, and help with finding the right approach for presenting my work at the Demo Day.

LARS HALNÄSS & WILL ODOM
Thanks to Lars Hallnass and Will Odom for providing me with critical feedback while being on the other side of the earth. Your fresh insights are fundamentally important for future improvements and directions.

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All the pictures without a reference are taken by myself.

APPENDIX 1

GENERATIVE USER STUDY FOR MIDTERM

Goal of the research: Generate more insights for the final experience in order to nuance the concept and chosen sounds.

Materials and probes: CSV scenario file, Ableton Live + Timer + Ableton Launchpad

1.Explain concept + new idea + scenario
2.Let them hear the soundscape with timer = real time
3.Let them hear the soundscape without timer = new concept

5 Questions about the experience as a whole

How did you experience the soundscape as a whole? Try to describe it

Did the soundscape make you think of certain events happening in the house? How and why?

How disturbing did you experience the soundscape as a whole?

How do you think the soundscape fits with the other sounds in the house?

How would you experience the soundscape over time? (How challenging would you find recognizing different soundscapes)

What are your thoughts about this technology?

5 Questions about specific qualities of the design

Can you describe specific every sound in detail. What did you like about them and what not?

What were the sounds that stood out of the soundscape? Why and how?

What do you think was the purpose of the sound color?

What do you think were the purpose of sound FX's?

What do you think were the purpose of melody/ scales in the soundscape?

Recommendations and further thoughts about the experiment?

What are your thought about giving a summary instead of doing this in real time? What are for you the pro's and what are the cons?

SUMMARY OF RESULTS

- Experienced as disturbing in real time
- Description of sounds as mellow, ambient, noise
- Needs to shift between periphery and attention
- Need for silence now and then
- Recognizing practices fairly easy
- Volume is important
- The soundscape need more structure
- Attack and decay influence the type of event
- Engaged while listening

APPENDIX 2

ARDUINO CODE MIDTERM

```
// Sketch for midterm CRIGS
// (c) Eva van der Born

#include <Adafruit_NeoPixel.h>
#ifdef __AVR__
#include <avr/power.h>
#endif

#define PIN            13
#define NUMPIXELS      12
Adafruit_NeoPixel pixels = Adafruit_NeoPixel(NUMPIXELS, PIN,
NEO_RGB + NEO_KHZ800);

char inByte;  // initialize the character inByte

void setup() {
  Serial.begin(9600);
  pixels.begin(); // This initializes the NeoPixel library.
}

void loop() {

  // turn the leds on black before every new funcion
  for (int x = 0; x < NUMPIXELS; x++){
    pixels.setPixelColor(x, pixels.Color(0,0,0));
  }

  if (Serial.available() > 0) {
                // read the incoming byte:
                inByte = Serial.read();
                // say what you got:
                Serial.print("I received: ");
                Serial.println(inByte);
}

  // functions for keypressing
   pressingBytes1();
   pressingBytes2();
   pressingBytes3();
   pressingBytes4();
   pressingBytes5();

   // print the incoming byte
   Serial.println(inByte);
   pixels.show(); // This sends the updated pixel color to the
hardware.
}

void pressingBytes1() {

   if (inByte == '1'){
    for (int i=0;i<9;i++){

     // pixels.Color takes RGB values, from 0,0,0 up to
255,255,255
     pixels.setPixelColor(i, pixels.Color(0,255,255)); //
Moderately bright green color.
    }
    return;
   }
}

void pressingBytes2() {

   if (inByte == '2'){
    for (int i=0;i<11;i++){
    // pixels.Color takes RGB values, from 0,0,0 up to
```

```
    }
    return;
   }
}

void pressingBytes3() {

  if (inByte == '3'){
    for (int i=0;i<4;i++){
    // pixels.Color takes RGB values, from 0,0,0 up to
255,255,255
    pixels.setPixelColor(i, pixels.Color(0,255,255)); //
Moderately bright green color.
    }
    return;
   }

}

void pressingBytes4() {

    if (inByte == '4'){
    for (int i=0;i<7;i++){

    // pixels.Color takes RGB values, from 0,0,0 up to
255,255,255
    pixels.setPixelColor(i, pixels.Color(0,255,255)); //
Moderately bright green color.

    }
    return;
   }
}

void pressingBytes5() {
    for (int i=0;i<12;i++){

    // pixels.Color takes RGB values, from 0,0,0 up to
255,255,255
    pixels.setPixelColor(i, pixels.Color(0,255,255)); //
Moderately bright green color.

    }
    return;
   }
}
```

APPENDIX 3

TRANSFORMING DATA INTO MIDI [23]

```
(c) Gabriel Levine and Eva van der Born
# import dependencies
import mido
import time
import requests
from tonal import Tonal, mapping
import json
import random
from random import shuffle

# define output in loopMIDI. Type in Pyton the following:
# >>> mido.get_output_names() to get the active Midi Ports
output = mido.open_output('loopMIDI Port 2')
tonal = Tonal()
mid_range = tonal.create_sorted_midi("HarmonicMajor", "C")
start = time.time()
max_time = 100

# Creates a list of amount of channels that needs to be played.
# 0 - 5 sec: 1 channel active
# 5-10 sec: 2 channels active
# 10 - 15 sec: 3 channels active
# 15 -20 sec: 5 channels active
COUNT = [1,2,3,5]

# Creates a list of practices
PRACTICES = ["chores", "leaving house", "good sleep", "waking
up", "synchronizing activities"]

# Creates a dictionary of practises with their channel number
CHANNEL_SETTINGS = {
    "who_chores":0,
    "activity_chores":0,
    "who_leave":1,
    "activity_leave":1,
    "who_sleep":2,
    "time_sleep":2,
    "who_wake":3,
    "time_wake":3,
    "lights":4
}

SAMPLES = 5

# Setting up a JSON file...
SETTINGS = {
    "chores":{
        "who_chores": [40,80],
        "activity_chores": [40,80]
      },
    "leaving house":{
        "who_leave": [40,80],
        "activity_leave": [40,80]
      },
    "good sleep":{
        "who_sleep": [40,80],
        "time_sleep": [40,80]
      },
    "waking up":{
        "who_wake": [40,80],
        "time_wake": [40,80]
      },
    "synchronizing activities":{
        "lights": [40,80]
      }
}

# Create an empty dict
```

```
data = {}

for key, item in SETTINGS.iteritems():
    ritual = {}
    data[key] = ritual
    for task_key, task in item.iteritems():
        values = []
        ritual[task_key] = values
        for i in range(SAMPLES):
            value = random.randint(task[0], task[1])
            values.append(value)

# Save JSON file
with open('data_generated_V2.json', 'w') as outfile:
    json.dump(data, outfile)
# Open JSON file
def read_data():
    play_data = []
    with open("data_generated_V2.json", "r") as read_file:
        data_1 = json.load(read_file)

    random_order = [0,1,2,3,4]
    shuffle(random_order)
    for i in random_order:
        ritual_name = PRACTICES[i]
        ritual_data = []
        play_data.append(ritual_data)
        for key, value in data_1[ritual_name].iteritems():
            channel_number = CHANNEL_SETTINGS[key]
            ritual_data.append( (channel_number, value) )
    return play_data

def turn_music_on(data_list, count, current_note):
    for i in range(count):
        for note in data_list[i]:
            chan = note[0]
            value = mapping(note[1][current_note], mid_range)
            try:
                output.send(mido.Message(
                    'note_on',
                    note=mapping(value, mid_range),
                    velocity=50,
                    channel=chan))
            except Exception as e:
                print("Error: {}".format(e.message))


def turn_music_off(data_list, count, current_note):
    for i in range(count):
        for note in data_list[i]:
            chan = note[0]
            value = mapping(note[1][current_note], mid_range)
            try:
                output.send(mido.Message(
                    'note_off',
                    note=mapping(value, mid_range),
                    velocity=50,
                    channel=chan))
                print(value, "note on", chan)
            except Exception as e:
                print("Error: {}".format(e.message))

data = read_data()
for i in range(4):
    for current_note in range(5):
        turn_music_on(data, COUNT[i], current_note)
        time.sleep(1)
        turn_music_off(data, COUNT[i], current_note)
```

APPENDIX 4

RASPBERRY PI CODE DEPLOYMENT

```
import schedule
import time
import os
import random
import datetime

def rndwav ():
    print(datetime.datetime.now())
    randomfile = random.choice(os.listdir("Music"))
    file = ' Music/' + randomfile
    print(file)
    os.system ('omxplayer -o local' + file)

schedule.every().day.at("00:00").do(rndwav)
schedule.every().day.at("01:00").do(rndwav)
schedule.every().day.at("02:00").do(rndwav)
schedule.every().day.at("03:00").do(rndwav)
schedule.every().day.at("04:00").do(rndwav)
schedule.every().day.at("05:00").do(rndwav)
schedule.every().day.at("06:00").do(rndwav)
schedule.every().day.at("07:00").do(rndwav)
schedule.every().day.at("08:00").do(rndwav)
schedule.every().day.at("09:00").do(rndwav)
schedule.every().day.at("10:00").do(rndwav)
schedule.every().day.at("11:00").do(rndwav)
schedule.every().day.at("12:00").do(rndwav)
schedule.every().day.at("13:00").do(rndwav)
schedule.every().day.at("14:00").do(rndwav)
schedule.every().day.at("15:00").do(rndwav)
schedule.every().day.at("16:00").do(rndwav)
schedule.every().day.at("17:00").do(rndwav)
schedule.every().day.at("18:00").do(rndwav)
schedule.every().day.at("19:00").do(rndwav)
schedule.every().day.at("20:00").do(rndwav)
schedule.every().day.at("21:00").do(rndwav)
schedule.every().day.at("22:00").do(rndwav)
schedule.every().day.at("23:00").do(rndwav)

while True:
    schedule.run_pending()
```

APPENDIX 5

RASPBERRY PI CODE DEMO DAY

```
import RPi.GPIO as GPIO
import time
import os
import random

# to use Raspberry Pi board pin numbers
GPIO.setmode(GPIO.BCM)
GPIO.setup(18, GPIO.IN, pull_up_down = GPIO.PUD_UP)
GPIO.setup(22, GPIO.IN, pull_up_down = GPIO.PUD_UP)

#Left button press on the board --> play sounds in synch with
video
while 1:
    if (loop == True):
        print('waiting for button')
        loop = False

    if (GPIO.input(18) == False):
        print " case video"
        time.sleep(49)
        file_1 = ' Music/Demoday1.wav '
        print(file_1)
        os.system ('omxplayer -o local' + file_1)
        print "continues pending"
        time.sleep(20)
        file_2 = ' Music/Demoday2.wav '
        print(file_2)
        os.system ('omxplayer -o local' + file_2)
        loop = True

    elif (GPIO.input(22) == False):
        print " case random "
        time.sleep(5)
        randomfile = random.choice(os.listdir("Music"))
        file_3 = ' Music/' + randomfile
        os.system ('omxplayer -o local' + file_3)
        loop = True
```

APPENDIX 6

QUESTIONS DEPLOYMENT INTERVIEW

1. How would you describe the effect a soundscape had on you?
2. How aware were you of the presence of time during moments a soundscape was played?
3. How would you rate your level of engagement with the design during moments a soundscape was played?
4. Would you consider the soundscape disturbing in some times?
5. How did you perceive the relation between form giving and experience?
6. Did you start to recognize specific sounds day-by day? When and how easy was this?
7. To what extent challenged the soundscape your memory capabilities?
8. How would you compare the sound of the soundscape with the other sounds of your environment?
9. Which external factors influenced your experience of the soundscapes?
10. What did you think of the structured repetition of the soundscapes?
11. What did change in the environment when a soundscape was played?
12. Imagine you have a family home, where would you place the design?
13. Did the design evoke social interactions/ discussions about the design? What kind of things were said?

APPENDIX 7

ONE PAGE ABSTRACT SUBMISSION
VIDEO SHOWCASES CHI 2019

Sound of a Smart Home

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ABSTRACT

This design exploration is a reflection on how we currently use and experience connected products, things, in our home environments. While the Internet of Things, as a global mesh of data gathered, computed, and communicated by smart objects, has brought us convenience, the way of communicating the state of the smart home now heavily leans on quantified information displays. An immediate demand and delivery relationship with smart objects exists, but touches us only in very utilitarian ways. Yet, the question remains: how to create sustainable and harmonized experiences with everyday smart objects? The Sound of a Smart Home is a slow and unaware object that provides a summary of the activity of all connected products within a smart home in the form of a unique 20-second soundscape played every hour. This design collects data that is exchanged between things for an hour and then transforms it into a soundscape of ambient sounds that are mapped to specific data streams in the house and subtle changes that happen to them over time. By using sound as a medium instead of visually quantified information, we propose an alternative, more intuitive way to experience your smart home holistically as an evolving ecosystem. Ultimately, the project explores how slowing down the experience of smart home data through focused micro-summaries might support reflections on the technology itself and on our everyday practices. The designed experience aims at supporting longer-lasting relationships and engagements with everyday connected objects.

KEYWORDS

Design Exploration; Smart Home; Sound design; Internet of Things; Slow Technology; Unaware Object, Design for Reflection.

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