

VaryFlex

Designed to assist organisations in the transition towards flexible working places.



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1. Introduction

Actual design of products is often more social than the intended design. Remote controls are designed for one user. However, all people present in the room are affected by it. Shared spaces like these call for social interactions, whether these are intended or unintended. This poses the design challenge for this project, where the focus lies on interaction design of smart connected systems. Within this, multiple users share an user experience that can be improved.

In the traditional shared space of offices, every employee came into the office at 9, went to his desk until 5 and left for home. However, a trend is occurring in which companies shift from this traditional working environment towards a flexible working environment. Employees can come in at any time they want and leave when they want. They don't even have to come in at all; they just have to make sure they meet the set requirements, like hours worked or meeting the targets the team has approved upon. It boosts the independency of employees and the productivity increases (Cooke, 2012) (van der Voordt, 2004).

Even though research has shown the benefits of flexible working spaces, this shift requires a lot of support. Support comes both from senior and direct management towards the team, but also from the team towards management. Support is often lacking from management throughout this transition, hampering the change. Additionally, it is also often met with skepticism amongst the employees (Cooke, 2012).

This report describes the design process of proposing a solution that helps organisations transition to flexible working spaces easier. This report has two main sections: the design process, and the final concept VaryFlex. The design process consists of starting off the project, defining, and redefining the scope. Additionally, user insights are gathered and processed to create a final design. Finally, the final direction is established during the second iteration. Design decisions of the final concept, VaryFlex, are highlighted and explained, showing the pros and cons of all the steps that are gone through.

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2. Design process

Literature

In the current developing technological age, more and more products and services tend to use some form of multi-user interaction. The term social translucence was introduced by Thomas Erickson and Wendy Kellogg and was meant as an attempt to design for “systems that support communication and collaboration among large groups of people over computer networks” (T. Erickson & W.A. Kellogg, March 2000). They argue in their paper that digital interactions abstracted from physical human interactions can improve the interaction experience and collaboration among users. Socially translucent systems must consist of the following three properties:

- Visibility: what actions of users must be visible in the system?
- Awareness: of what need users to be aware and how should that be presented?
- Accountability: can users be held accountable if they perform an act which counteracts with other users?

By designing for these properties, users will act upon the

social experience and expertises they have already acquired in their life to structure their interactions among each other. Examples can be found in the popular social media platforms such as Facebook and WhatsApp, where visibility, awareness and accountability are all woven into the structure of interacting with other users. For instance in WhatsApp, the check marks after sending a message tell if the message has been sent, received or read. This provides the sender of information about the receiver.

This theory is meant for online, digital interactions. However, the field of tangible interaction design is taking over more and more of the proposed social translucence framework to help designing tangible and embodied multi-user interaction products. The research “Designing for multi-user interaction in the home environment” (Niemantsverdriet et al, 2016) demonstrates this.

As the project revolves around the topic of shared systems and multi-user interaction, the theories and proposed properties for design offered by Erickson and Kellogg will be continuously be taken into consideration during the design process. Some key design questions abstracted from the

lectures about the social translucence theory that will be a central part of the process are:

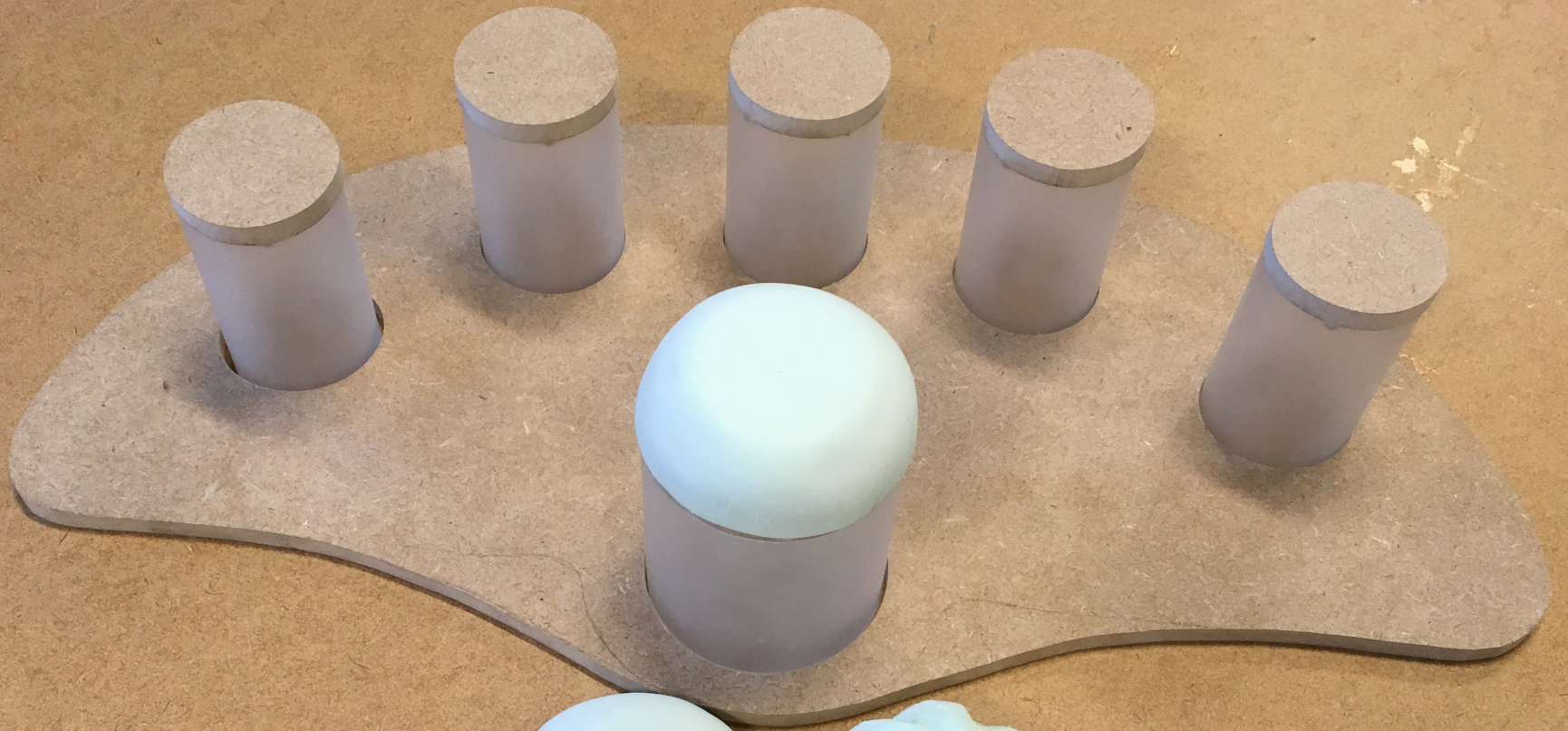
- What do people need to be aware off?
- What information is needed for awareness?
- How is the information gathered and presented?
- How can the information be used?

Early in the project the design team agreed that the final deliverable should incorporate several design ideas and methods about tangible interaction. Making use of several studies about interaction, interface design and tangibility, a starting point for the project was created. Making use of the Interaction Frogger framework (Wensveen, Djajadiningrat, & Overbeeke, 2004), several ideas about interaction, feedback and feedforward were taken and tried to put into practice during this project. Furthermore, theory about menu structures and ‘the optimal number’ of choices in an interface were researched from ‘The Essential Guide to User Interface Design: An Introduction to GUI Design’ (Galitz, 2007). The field of rich interaction also played a role within the first literature study, as tangibility and rich interaction often go hand in hand, both in design and in design research (van den

Hoven et al., 2007). Combining the methods of this literature study, several design preferences were created. The design should be a tangible interface, where rich- and tangible interaction would become key aspects. Also the interface should incorporate the properties of social translucence, providing users social information and creating some kind of awareness and responsibility.

Approach Q1

During the first quartile of the semester, an approach was made to grasp the core of shared systems and why it is important to design for them. The project started with a pressure cooker, where shared systems got analysed and evaluated in different design teams (see Appendix A1). After two weeks the pressure cooker ended, and the design project was started. Working towards the midterm demoday, the design team focused on exploring different approaches towards interface design for shared systems. In this chapter the first quartile will be briefly summarized. A more elaborate description on the context definition, preferences direction



and concept development and definition can be found in Appendix A2.

The team started with defining a context, and timely made the decision in line with the literature study to aim for an interface design where tangibility, rich interaction and social translucence would play a central role. In the initial phase, combined with these design properties, the following points were identified as important design preferences to consider in this project:

- The interface should stimulate compromising behaviour
- Setting a mood should be part of the interface
- The interface should be able to enlighten a space through spatial lighting
- To display social information on the interface
- It should have a decorative and aesthetically pleasing look and feel

The progress made in identifying the context and design preferences led to a first prototype exploration, given the working title 'Sociallight'. Sociallight will mediate a users' color preference with the existing light setting and provide an

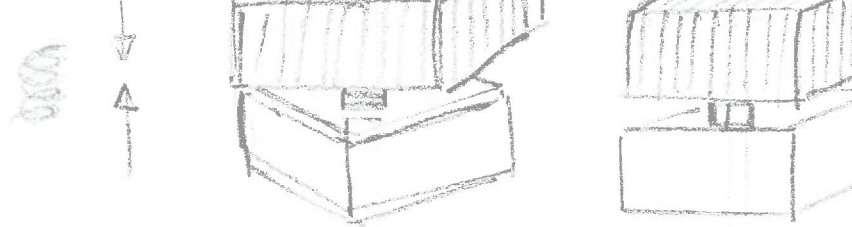
array of coherent options. The user can then decide which variation to use and, dependant on how radical the change is to the current setting, the haptic feedback also increases. The Sociallight provokes thought on where to work, and what the user's impact is on the working environment. All the properties and requirements according to the theories of interaction and social translucence were tried to fit into these explorations, leading to a very broad exploratory prototype which was still situated in a wide and open context. This also came back during the feedback sessions at the midterm demoday (see Appendix A3). Reflecting back to the first quartile, the design-team realized that some points should improve, both concept wise and process wise. The following points give a summarized overview on the feedback and reflection conducted after the midterm:

Project goals were not communicated right and clear enough
A better framing on the process and intention was needed
With a too broad project goal, too many parameters had been left open

The conclusion is that the direction, design goals and context should be reconsidered. In order to do so, it is needed to take

2. PROJECT SET (OWN)

PUSH

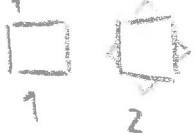


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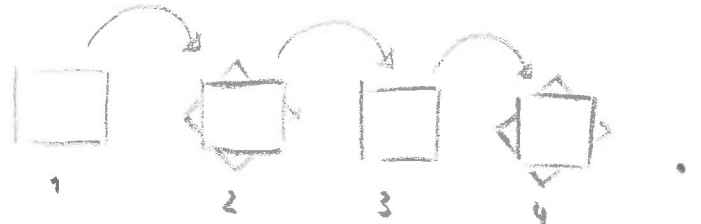
FLIP



TURN



TURN

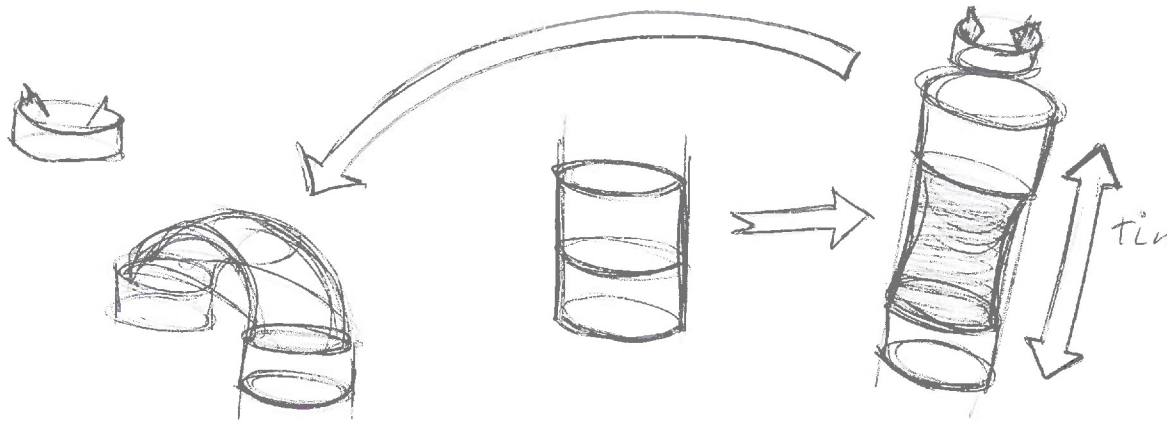
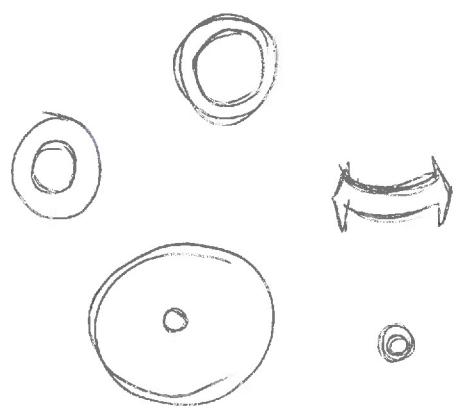
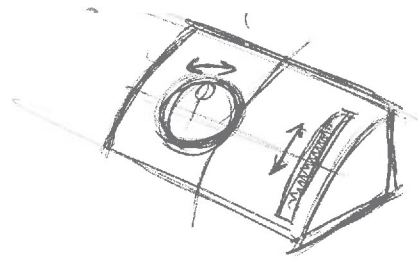


4. ABSENT BUT NEEDED

PUSH



PUSH



a step back and reflect on what the core of the concept has actually been in the last weeks. This so-called pivot-point in the project is described in the evaluation.

Evaluation

Taking the feedback from the midterm demoday into account, a reconsideration should be made on the context and concept thus far. Whilst reshaping the direction, the concept has been split up in various components. With this, different contexts and applications have been considered. Flexible working places were kept in mind throughout the project. However, the context was initially kept in the background and ill-defined. As the LaPlace building is a flexible working place, this would have been a fitting location to validate assumptions. Concretising the context would make it easier to further develop the context. Doing so led to show a potential design opportunity: the transition of traditional working places towards flexible working places. Further on in this report, the context will be more specifically defined. The concept Socialight that was presented at the midterm

demoday fits the new context as well. However, a proper fit is missing. The interaction design of the concept rests on too many assumptions that are in total too risky to continue with, and too many functions were included. Contrary, the context was too undefined. Background research needs to be done on the context, which can then be used to define what aspects of the concepts must stay, and which need to go. Factors of ownership and social translucence are of interest to the team, but an objective view needs to be held when going further. Going further, it is important to realize that the previous work should not be dismissed, but that it should be used as a foundation for the next iteration.

Flexible working places

Flexible working consists of employees having autonomy over their working activities. This means the time of execution of work, but also the location. It is an increasingly more popular form of work, as it has many benefits for both the employer and the employee. Employees have the opportunity to schedule their working hours in line with their personal planning, but

also to work one day from home in order to beat traffic and have a more effective work day.

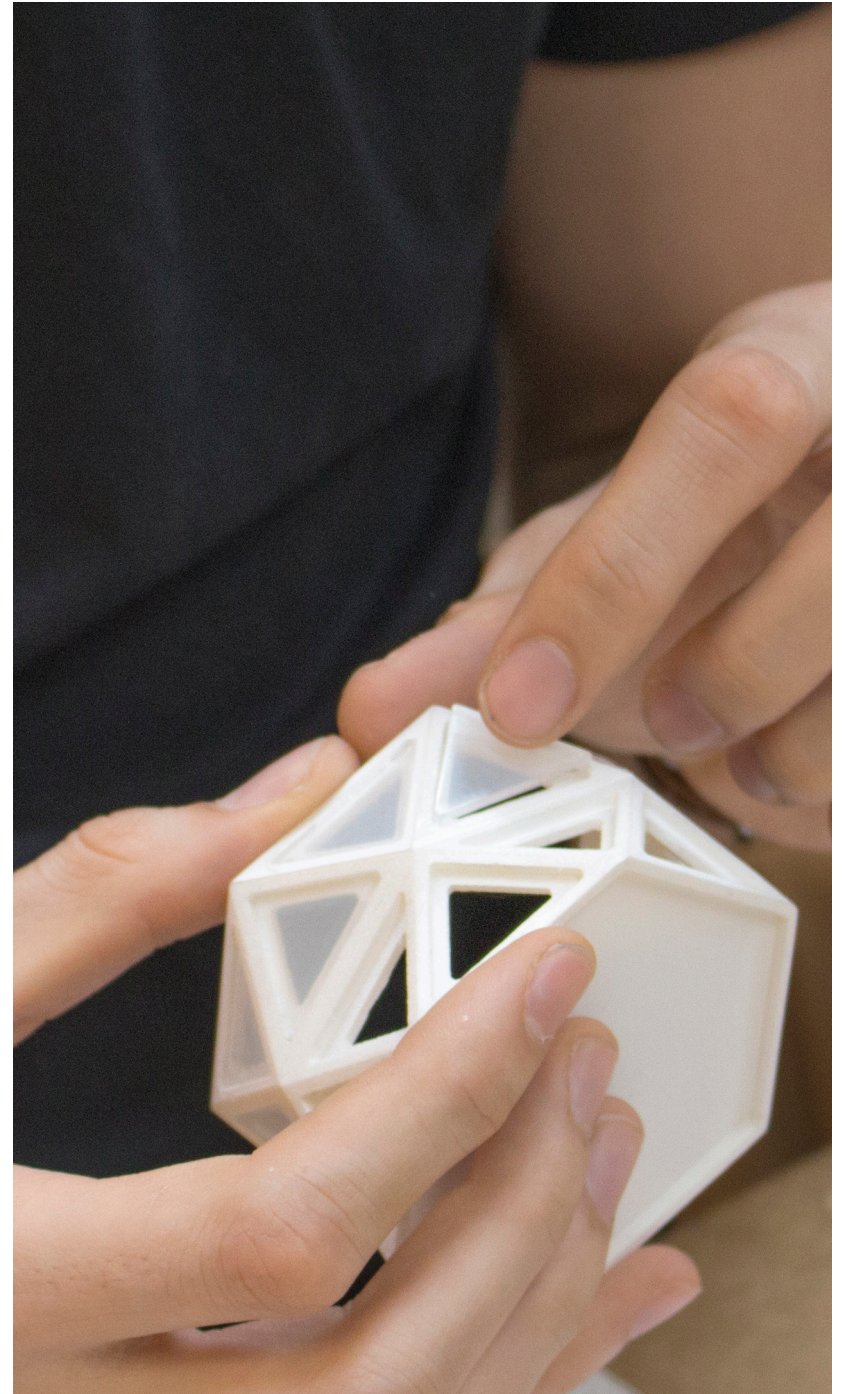
Many variations of flexible working consist, all in varying degrees of freedom (“flexiworkforce,” n.d.). For the scope of this project, three main distinctions have been made on the scale of traditional ways of working to fully flexible ways of working:

Full-time (Part-time) work

This is the more traditional way of working, where a worker is present at the work environment for all the hours the worker gets paid. There is little play in terms of worker flexibility, as even the desks are pre-determined.

Flexible desks and flexitime

Within this stage of flexible working, a compromise is made between traditional work and home working jobs. Workers have the flexibility to determine at what desk they sit, and whether they work partially from home. Support from management and their subordinates becomes increasingly important, as there is a potential conflict. Management wants to secure the goals they have set for their activities and tend to want reassurance of that. On the flip-side, workers are now



able to determine more freely where and when they want to spend their time on a project and are generally less visible to their supervisor.

Home/Remote working jobs

This is the most versatile and free way of flexible working. Employees get to plan their own moments at which they want to work. Next to that, they have the option to determine where they want to work; even in different countries. This requires support between management and employees. Both parties are expected to finish their work as agreed upon, but they are likely to be in contact less.

Benefits and drawbacks

Benefits

Contrary to the instincts of organisations, flexible working actually boosts employee productivity (Cooke, 2012) (van der Voordt, 2004) because of better worker communication, transfer of information, and increased availability. Next to that, there is less need for workspaces as less people will be present at the office. This results in a lower rent, and lower energy costs. Furthermore, a non-monetary benefit of

changing to flexible working spaces is the positive image a company creates. Enabling flexible working shows a modern, and professional appearance.

Drawbacks

Flexible working isn't all sunshine; before the change is fully made, other costs come to the surface. For example, often a better ICT infrastructure is required, as workers depend more heavily on them working well. Next to that, there is a potential renovation costs as the office may not be suitable for the type of work yet. Some workers may not like the change and resist it. This can be either due to loss of status, image, or losing the own workspace. (van der Voordt, 2004).

Research needs to be completed on an individual organisational level whether or not the benefits outweigh the drawbacks. When the benefits do outweigh the cost, the question arises: what's holding flexible working back?

What's holding flexible working back?

As stated by Cooke (Cooke, 2012), flexibility is essential to the future of organisations; both small and large. However, despite all the prospective benefits, companies are reluctant to take the leap into flexible working places. From the research conducted by Cooke, 32% of the organisations were afraid doing so would negatively impact productivity. Next to that, 38% of the respondents were afraid that the change would increase labour costs. From this, it can be said that the benefits of flexible working places are not clear enough for the people involved before the implementation.

Furthermore, Cooke states that a lack of senior sponsorship is one of the barriers holding flexible working back. Companies state that transforming into a flexible working space, means the risk of becoming less able to provide leadership to certain departments. This risk aversion results in a lack of sponsorship embracing flexible working places. One of the enablers for this case as stated in the research paper, is to create a business case in which the benefits get highlighted.

Moreover, direct management can also prohibit the transition to flexible working. Often, these managers hold a more traditional way of work (Cooke, 2012). Within this mindset, it is important for management to see their workers in order to believe they are working. In order to overcome this barrier, a culture of support between management and their subordinates is of importance. As stated by (Thoms, Dose, & Scott, 2002) “the more accountable the participant felt towards co workers, the higher his or her job satisfaction and trust in management”. Even though there is no research conducted on the reciprocity of this effect, it is a good start to overcome barriers when transitioning to flexible working places.

Additionally, support of both management and workers is important once the transition to flexible working places has been made. Once the benefits of flexible working are made clear to the employee, it is often still difficult to adjust to the new way of working. Ways to overcome this, is by offering clear guidance and support when the transition is gone through. Online training courses, guides, or an online platform

is deemed to be options in providing support for this (Cooke, 2012).

Finally, a risk-averse culture can prohibit the change to a fully flexible working environment. As the transition to this working environment can be large and impactful, companies may be hesitant to not go through with this. Additionally, as the change lacks urgency, there could be little motivation to make the transition. In order to overcome this barrier, low risk experimentation is implemented.

As mentioned before, flexible working places yield more productive employees. The main constraint that holds back the transition is the costs of transforming the building and the necessary infrastructure, and the mindsets of management and their subordinates. Changing the physical space is out of the scope for our project. Yet, what happens inside the space, between the people working, is something that can be manipulated and offer a smoother transition to a more productive working space. Looking at how other organisations face this transition is key in understanding how to facilitate it. No other organisation offers a technological product to assist it. However, consultancies are hired to work together

with organisations to accommodate the transition, as seen in appendix B.

User interviews

The literature around flexible workspaces is clearly explained from a generic and academic perspective. The benefits and drawback are stated pragmatically and give great input for the understanding of the context of this project. For a more personal influence and perspective, interviews are done with people with a working occupation. The working environment of the interviewees are clustered in two groups, a traditional office with fixed workspaces, and an office with flexible working places respectively. The interview is focused on the personal experiences around the working environment. To gain the most personal and real reactions, the questions were asked in a very informal setting. All interviewees were employed by different, unmentioned, companies. Without this background information and knowledge about the environment the people were talking about, they were encouraged to answer

freely. The insights gained with this interview are applicable for a better definition of the context where the concept will be based on.

In appendix C the interview questions for each cluster and the results are shown.

The interesting reactions are concerning the difference of each environment. Although some companies stated to have flexible workspaces, the employees do not act on it. For instance, one interviewee worked in a company in which every employee has a “fixed flexible” desk.

One reaction of the first cluster which is mentioned by every interviewee is that no one wants flexible desks with the argument that they do not know what to do with their stuff. Not everyone is used to carry everything they need in one bag. One general conclusion is that people are creatures of habit as they want to mark the territory of their working environment. They do not feel in control when this is flexible and uncertain.

Another aspect mentioned is that the employees that work more hours than others feel that they have more to say about their workspace. There is an hierarchy on who gets the

preferred desk.

Every company has its own set of rules formed by the employees themselves. Everyone knows about them and with that system the environment is set. When they are limited by the management, they are less in control and feel uncertain which can result in resistance. This is one aspect that should be taken into account while stating the scope of the project.

Personas

The following personas are based on the input of the user interviews mentioned before. The conflicts and preferences they mentioned are altogether combined and processed in the personas Jonathan, Gwen and Bob. These will be used to create scenarios in the future to evaluate the fit of the concept. The personas are seen in figure 2.1.



Jonathan Litney

Young professional

Age 24 years old

Work Junior developer

Home life Single

Flexness 50%

Bio

Jonathan is 24 years old and currently working as junior developer within the company. He is an ambitious and curious young man who always want to know everything about anything. He believes in learning from others and thinks that the best way to gain knowledge and expertise is by doing. He lives in a studio in the city center but he is really never home. Whenever he has some free time left he plays games by his friend's house or he is going to his favorite bar. His career is an important factor in his life right now. He will easily give up a free evening for work when a colleague asks him. He hopes that he gets a permanent contract before the end of the year.



Gwen Darley

Young professional

Age 32 years old

Work Logistics

Home life Wife (33)

Flexness 50%

Bio

With her ability to organize and oversee complexity in a big environment she is the best person for the planning of the logistics. Gwen is already with the company since her graduation internship 8 years ago. She is not fond of change and likes to stick to her own way of working. She sat on a desk next to the window when she was doing her internship, and has remained there for the years to come. However, due to the transition in the way of working for the company, that place will not be reserved for her anymore. Next to that, she is someone who has no issues rambling on and on. Whenever she is on her coffee break, it's a 30 minute trip. Every Sunday morning, she has a brunch with her girlfriend, siblings and nieces. This social activity is a real tradition where she is not thinking about work and the struggle it brings.



Bob Evans

Senior

Age 48 years old

Work Project manager

Home life Wife (47)

Sons (16, 19)

Flexness 50%

Bio

The first time Bob came to the company he had a lot of complaints. He is an individual who prefers his way of doing things. After some adjusting time, Bob is not indispensable. He is the steady factor with a strict scheme and planning with the most direct voice. He is a hands-on type of worker and tries before he affirms an item. Although he seems firm and strict, he enjoys helping junior employees to fit within the company. With his direct approach he has an authority the juniors look up to and Bob is happy to teach his skills to others. Bob has a the same planning the whole week and everyone knows it. He works from 8.15h until 17.30h and then he goes home to his family. He has a good division between private and work life and he believes that a clear schedule is the way to live your life.

Context

Company

The concept is used and located in a design company. Due to an increase of employees but the same amount of office space the company is transitioning from traditional working places towards flexible working places. At the moment the company uses flexible desks and flexitime, whereby the working place varies and where the employees are more freely in their time management. The design firm has around hundred employees.

Needs

Junior employees

“We are not afraid of change, and are open to new working environments.”

Senior employees

“There is nothing wrong with our way of working, and we would rather not change our office.”

Target group

The context that is designed for, are offices that are transforming;

Support flexible desk seatings;

Will eventually allow employees to work from home;

Working at a company from a different country, e.g. China, is out of the scope of this context.

Employees

The employees vary in age, between twenty two and fifty years old.



Bob Evans 48

Senior Project Manager



Gwen Darley 32

Planning & Logistics



Jonathan Lithney 24

Junior Developer

Building

The company has five rooms in which people mainly work, in addition to a set of meeting rooms. Each room is evenly split, meaning about twenty people work in a room (figure 2.2, 2.3).



figure 2.2: example of office within the context image from www.monroeistanbul.com Youth Republic



figure 2.3: example of office within the context image from Sónia Arrepiá, www.jhk.nl

Final concept

Our concept

The goal of VaryFlex is to smoothen the transition from working places that allow partial flexible working, to fully flexible working places. VaryFlex is a physical product system that utilizes tokens on an individual basis. However, the tokens are not linked to individuals personally. As stated before, a culture of support is important for this transition. With the concept, we want to create and reinforce mutual support in employee and management. By using VaryFlex, all layers of employees show they are capable of the flexible working places and are included in the process of transitioning. This is accomplished by providing more autonomy and ownership to the employees, whilst in the meanwhile helping management give that autonomy by making the workforce more transparent.

Autonomy and ownership are met through the environment; the VaryFlex tokens offer the employees the opportunity to shape the workplace to their liking. To start off, setting the lights in a shared space to an individual's preference

presumably helps in making it one's own space. Autonomy is expressed by setting an individual light preference in a shared space, taking others into account. Furthermore, the token's color is adjusted to the user's liking. This aspect of the concept will be further elaborated in the next part.

User journey

The first moment an employee comes in touch with the VaryFlex system, is through the tokenboard. The tokenboard is situated near the entrance of a room and coincides with the amount of spots available in the room. This helps the user in quickly seeing whether there are free spots left. As the user enters the room, a token is picked from the board and brought along to the desk that the user wants to take a seat at.

As the user is seated, the token is used to set the light intensity. This feature is part of the greater image that the VaryFlex system helps the user in creating their own environment. Next to that, a project is selected on the device, indicated by a color.

When the user wants to take a break, an estimated time of absence is set on the VaryFlex token. As the user leaves its

desk, the token remains at the desk. Next to that, the light is dimmed as the user leaves, indicating to other people that seat is unavailable even though the desk appears available. The VaryFlex token shows the time remaining until the user returns.

As the user is away but someone could use its help, a notification can be left on the token. Upon return of the user, the social environment helps in deducting what the request is, who it is from, and the urgency. The user is responsible for choosing what to do with the information he got from his environment.

Derived from the user interviews and the created persona's, scenarios within the context were created. The visual representations on the following pages describe these scenarios (figure 2.4 - 2.7). The scenarios can also be found in a written version in appendix D.

SCENARIO 1

Looking for co-worker

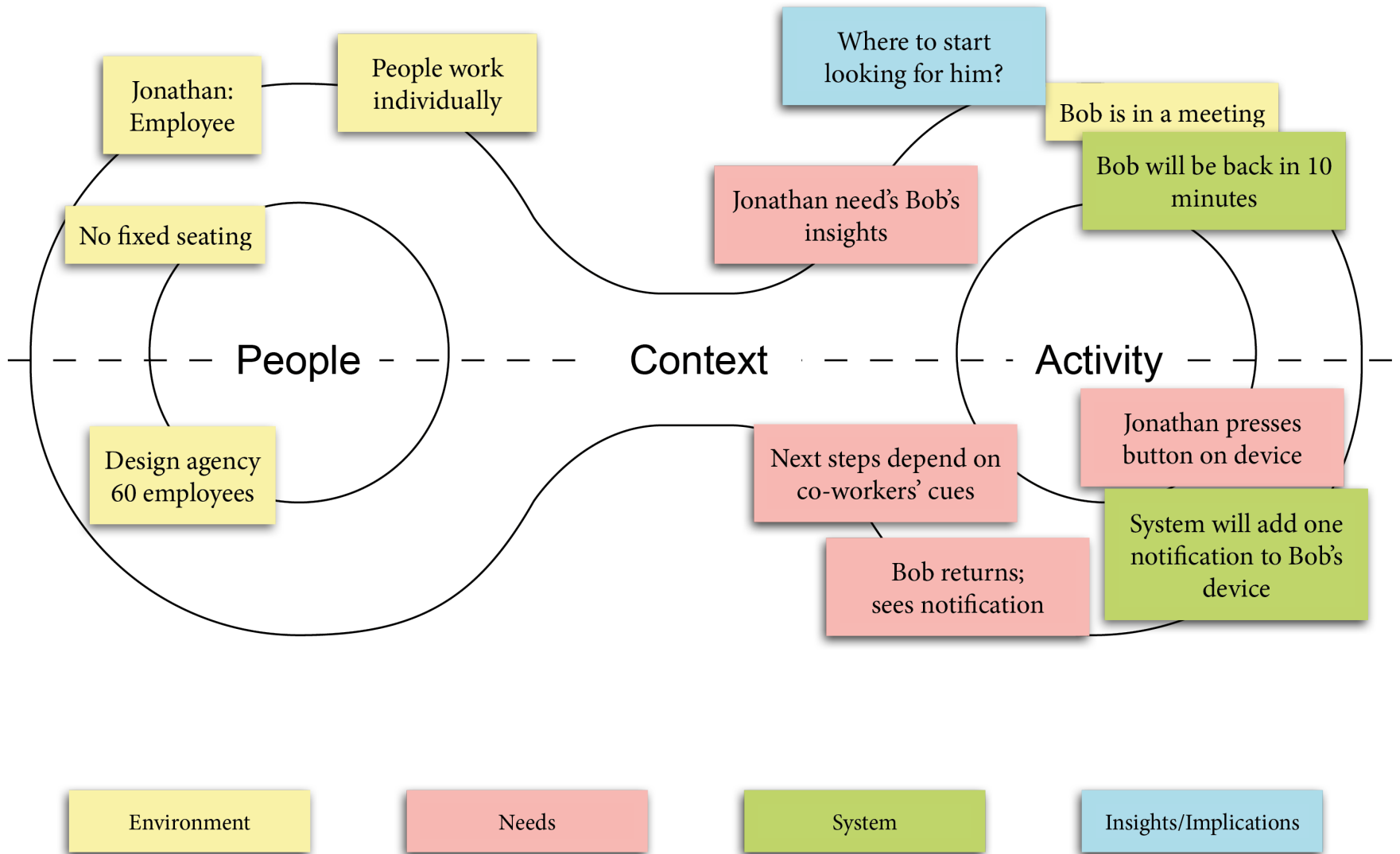


figure 2.4: scenario 1

SCENARIO 2

Need people working on project
Toolbox

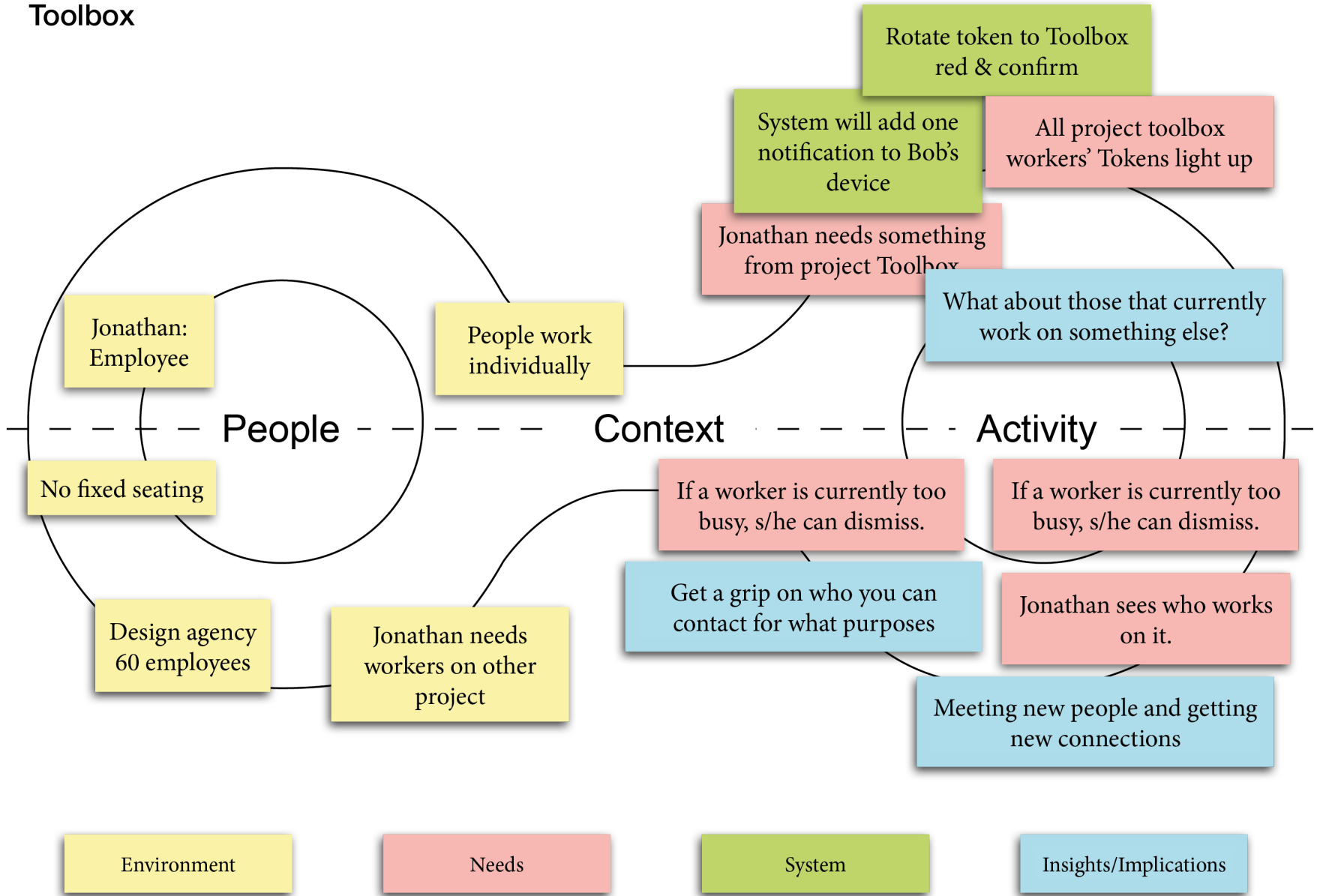


figure 2.5: scenario 2

SCENARIO 3

Leaving for a meeting

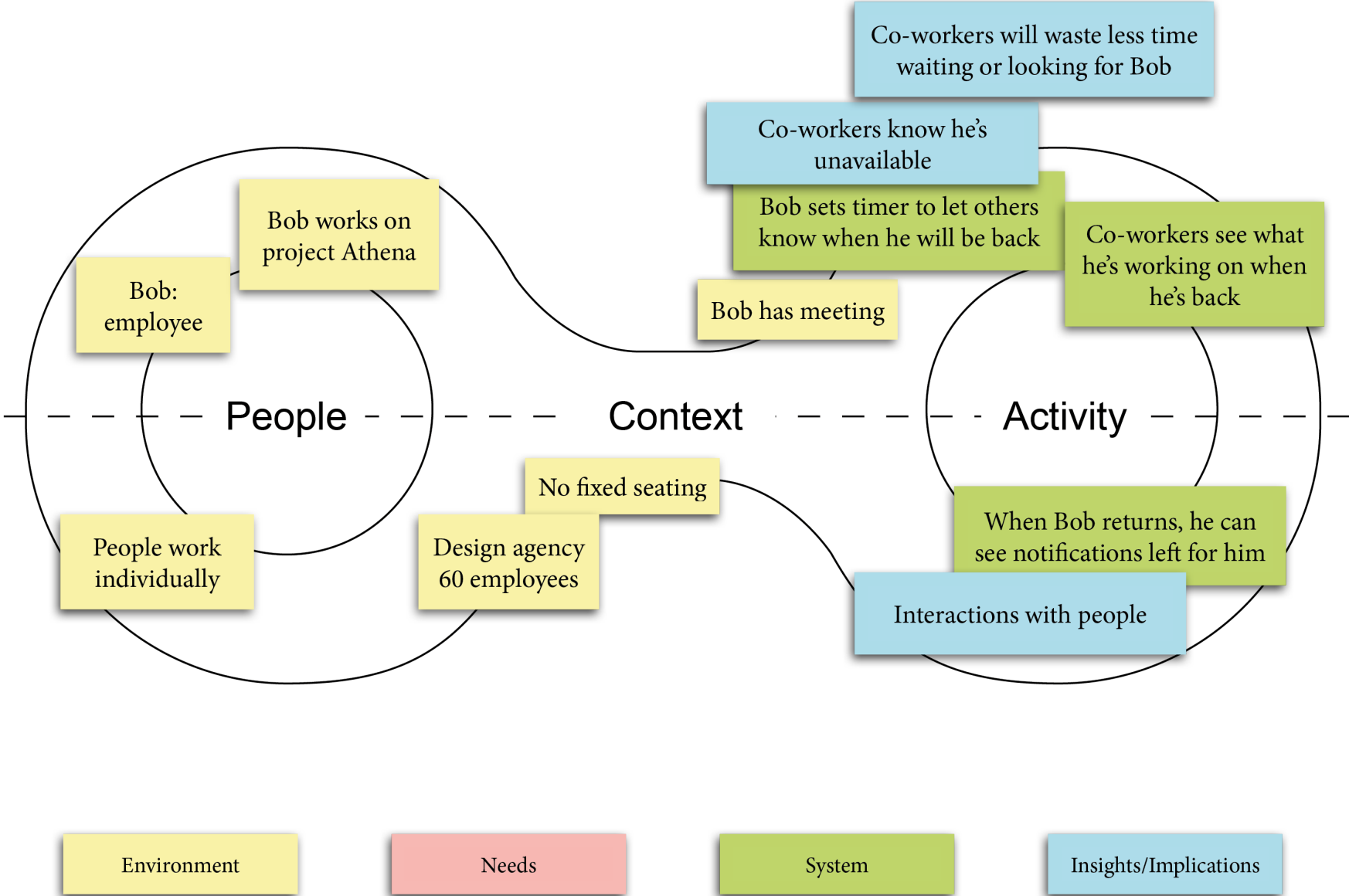


figure 2.6: scenario 3

SCENARIO 4

People don't place the token on their table

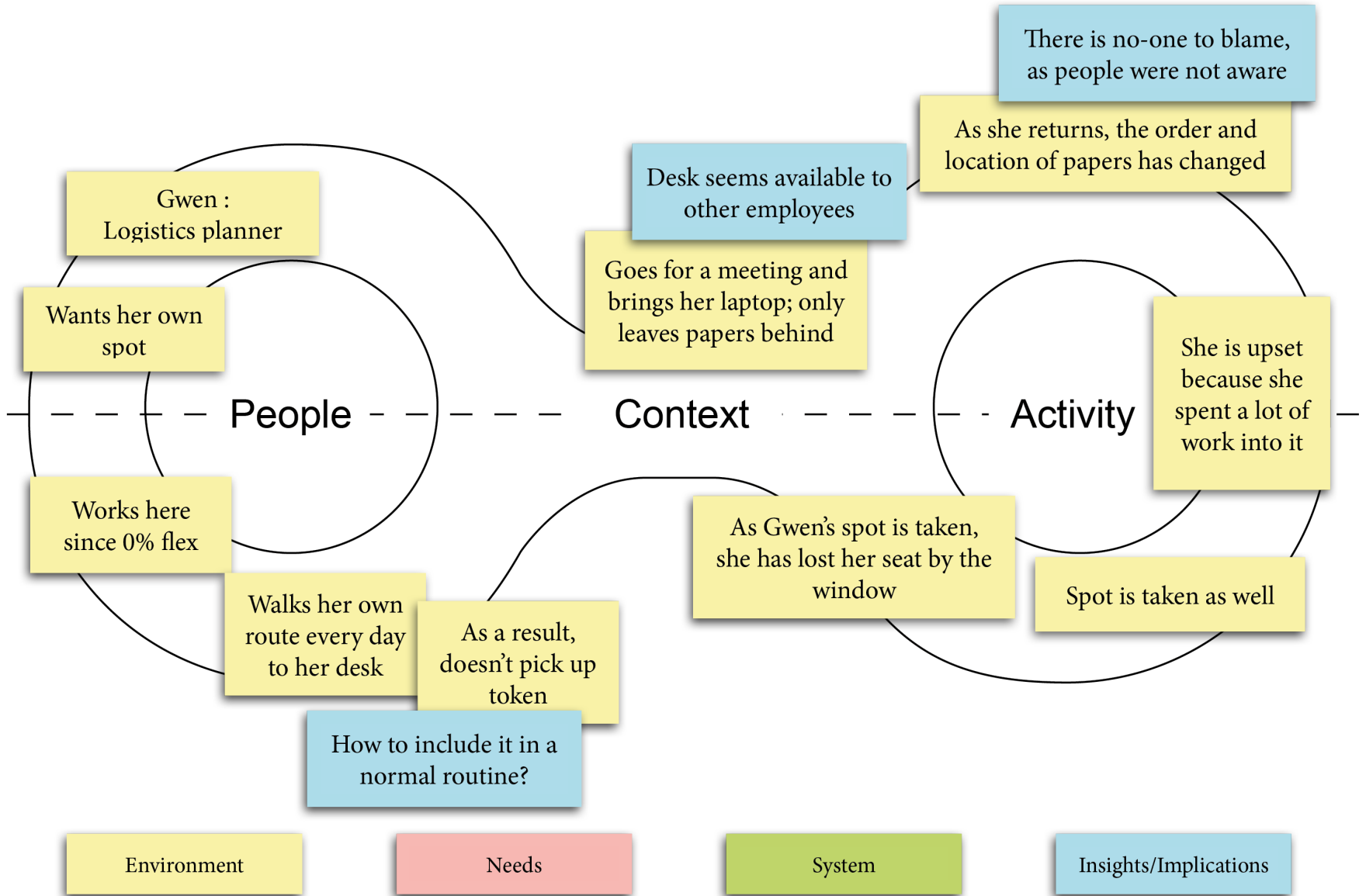


figure 2:7: scenario 4

Interaction mapping

VaryFlex has a set number of functions, yet our goal was to keep the product looking simple. We did not want any interface through a screen, as we feel the interactions should come intuitively and fit in a work flow, whereas a screen could make the product take longer to use. Making the interactions more fluent is done through the use of metaphors, enabling users to know the coupling, instead of learning it. If the user performs an action incorrectly, they are easily undone (Wensveen et al., 2004). There are two interaction modes in the product: presence and absence. The split of modes helps the user with learning the interactions. The set of interactions coupled to presence are only performed to a user's own token, whereas the set of interactions coupled to absence are only performed to someone else's token. Within this chapter of the report, the validity and potential pitfalls of the mappings are also disclosed. Due to time constraints, the final interaction mapping could not be tested. The proposed test set-up can be found in appendix E2.

As mentioned before, the expected user journey is for the

user to take the VaryFlex token from the token-board, either (1) search for other people working on a specific project, or (2) get seated at an empty desk. After the user is seated, he/she is expected to set the light intensity, and then tell the system what project he/she will be working on. When the user expects to be temporarily absent from his desk but wishes to stay seated after his absence, he must be able to inform his co-workers using VaryFlex. A timer for expected absence-time can be set and will be displayed using a counting-down LED ring. When other colleagues need the person that is provisionally away, they should be able to leave a message to inform that someone is looking for him

Presence

When the user of the VaryFlex token is present at his desk, the interactions of (1) setting the light, (2) setting the color, (3) searching for others, and (4) taking a break are present. The token is oriented with the wooden side up. See figure X for a schematic of the interaction.

1. Setting the light

Setting the light requires the user to rotate the top part of the

device in a clockwise or counter-clockwise motion. This will respectively increase or decrease the light intensity. As user feedback, people tend to want to confirm the light setting. This has likely to do with the delayed feedback from the ceiling lights, as the device itself previews these settings. Currently, there is simply a delay which will automatically confirm the light settings after X seconds of inactivity. A more elaborate study in regards to the interaction mapping must point out whether or not a confirmation button is more logical.

When a user presses the device after setting the light intensity, the project is changed. This can be undone through cycling through the projects again.

2. Setting the color

Color selection is meant to show other employees what project the user will work on, or whether he/she would like to be disturbed or not. This is an agreement that can be made amongst employees. Setting the color is expected to occur after the user has set the light intensity. By pressing the device, the user toggles through the color available which is shown by the lights on the device. If the desired color is selected, the user does not need to confirm the action.

3. Searching for others

A search for people with a specific color is done by pressing and holding the two halves together. As the selection of the color is done by a pressing motion, searching for others should be in the same fashion. This in order to stay consistent across the device. As the two halves are held, the device slowly toggles through each color. When the desired color is visible, the device has to be let go. When the device is let go, all surrounding devices with the same color light up.

When someone's token lights up, there are 2 possible interactions: (1) deny search, and (2) cancel all searches. Denying a search is performed by pressing the token - this only influences the pressed token. Cancelling all searches is performed by press- and holding the token. This will remove the light from all lit up tokens. This is done when the user who initiated the search has found what was looked for. This can be done on every token that is lit up by the initiator.

4. Taking a break

When the user will be absent from its desk, for example due to a meeting, the device should be flipped upside down. When the device is upside down, the timer function

is activated. Upon flipping it upside down, a clock is symbolized on the bottom of the device - which is now the new top. Looking from above, a hexagon is visible on the face. Each edge is one-sixth of the face, symbolizing one-sixth of an hour which equals to ten minutes. Rotating the device activates the LED ring which runs along the edges of the hexagon. When the desired time of absence is set, the ceiling light dims, showing other people the seat is taken but the worker is currently absent.

The origin of the interaction for flipping the device upside down comes from mobile phones. When a phone rings and the user wants to inconspicuously decline the call, it is done through flipping the phone face-down onto the table.

Upon return, the user can flip its token back. The ceiling light will return to the setting as it was before the user left.

Absence

When a worker is absent, its token is placed with the acrylic side facing up. As a user reaches the desk of another worker who is absent, there are 3 interactions available, namely (1) leaving a notification, (2) adjusting the timer, and (3) flipping the token to its normal position. However, interaction 2 and 3 are only meant to be executed by the

Presence

1. Setting the light



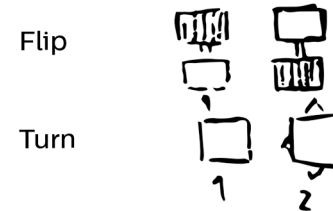
2. Setting the color / deny search



3. Searching for others / cancell all searches



4. Taking a break



Absence

1. Leaving a notification



figure 2:8: interaction mapping schematic

Value proposition

In the transition, there are various stakeholders involved. When organisation A wants to transition to flexible working places, they often hire a consultancy to aid them in this. Together, they set up and execute a tailored plan for the specific organisation. Additionally, the various layers within the organisation are all affected by this. Simplified, these include senior management, direct management and functional employee. Everyone in this transition has a different role. As seen in appendix F, management should be targeted within companies as buyers and serve as one main group to create a value proposition for. Next to that, consultancies that are hired by organisations to help with the transition serve as a second main group of interest. Finally, the employees that are the end-users must also be kept in mind as they are the ones who use the products, together with management.

Value proposition for organisations

Looking at the buying process roles, management has the role of influencers. When looking at smaller companies,

management can also take the roles of influencers, deciders, and buyers. Management's interest is the improved employee productivity that can be achieved through transitioning to flexible working places.

VaryFlex helps them in this transition by having employees "show" their management they are ready to be more autonomous, and the system visualizes that. This presumably helps decreasing the costs of the transition as the organisation can firstly make the company ready themselves, before hiring external parties.

Value proposition for consultancies

Consultancies are hired when organisations that want to transition to flexible working spaces need help. With VaryFlex, these consultancies can create a tailored program in less time. The concept can be used to get a feel of the company culture and needs of various functional departments of the organisation. Additionally, offering a technological solution on top of the current offer helps differentiating a consultancy from others.

Value proposition for employees

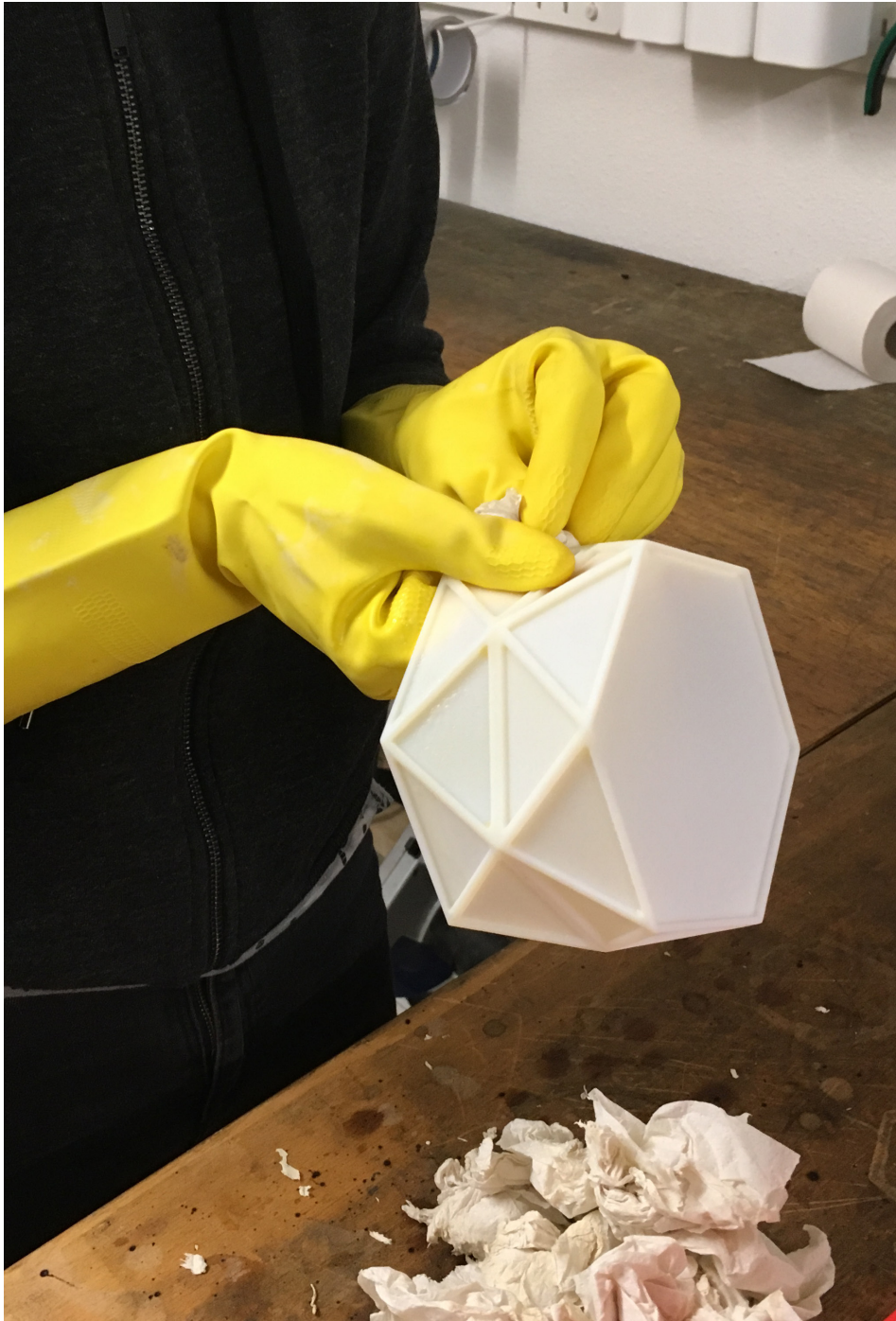
Through using VaryFlex, employees are included in the transition. This will help them shape the workplace, as the system helps them in wording their needs. Moreover, they are able to work together in a seamless way with their co-workers. When seatings change, this will help in keeping a constant factor.

Realisation

Physical demonstrators

To demonstrate the concept of VaryFlex, two prototypes were made. One prototype was used to demonstrate the true proportions of the desired token, the other prototype was a larger scale model with electronics fitted inside in order to demonstrate the interactions of the VaryFlex tokens. Both prototypes were built using a combination of different production techniques. The outside frame was created using a 3D printer, the acrylic triangular tiles that are fitted inside the printed frame were laser-cut and the balsa-wooden triangles are handmade. The prototype shape, chosen





after a small exploration (appendix G1), originates from an origami technique named Yoshimura Buckling. This beauty of this technique is that the deformation in both axial and circumferential direction is described using goniometric functions. With only two connectors on both sides and force directions toward each other, a deformation occurs gradually and orderly. (de Vries, 2005) The triangles also represent this deformation or change as the Latin capital letter for 'delta' is triangular and represents change in mathematics. The antiprism structure gives grip to the form that stimulates the turning movement. The hexagonal shape is chosen because it can represent the clock as ten minutes represent each side of the hexagon. After a material exploration (appendix G1), the materials are chosen to give the form contrast and clearly distinguish the two states of the prototype. In the first state the bottom part is where the light is showing through the form. This has a transparent look where clear and synthetic materials are used. The upper part is the natural counterpart where the 3D printed frame runs through both parts and where the balsa wood with its handmade look, creates the contrast between the functionalities and the different feeling.





Electronic prototype

Also the interactions as specified earlier in this report were recreated in the interface using custom made electronics and software. Using a Lithne, the bridge to the connected ceiling lights in the LaPlace building at the University of Technology in Eindhoven was made. “Lithne is an open-source hardware electronics development platform inspired by the popular Arduino framework. The board is the result of the Ph.D. research of Serge Offermans and Remco Magielse for the Intelligent Lighting Institute. They created it for the design and development of wireless lighting applications and installations.” (“Introduction - Lithne,” n.d.)

With the use of this device, real-time control over the ceiling lights can be prototyped and so the concept can be completely visualized in context. The Lithne is inspired by the Arduino platform, and it works quite alike. The only difference is that it has an integrated ZigBee-module, which can directly communicate to a host computer. Also a battery pack could be added to the Lithne, so the prototype could be displayed wirelessly.

While the Lithne replaced the Arduino in this project, the rest of the electronics are rather usual. One of the main components is a tilt-switch, which indicates the physical state of the prototype (up-right or upside-down). Another frequently used component is a 24-steps rotary encoder with integrated push-button, which functions as turning knob and tactile indicator. The last main component used is a NeoPixel led-string, which is easily controllable using a standard library. With this simple set-up the desired interactions could be visualized, a process that took quite some time and had to be executed right in every detail in order to be a good representation of the concept’s interactions. The software program can be found in appendix G2.

3. Discussion

VaryFlex proposes a design solution towards the adaptation of traditional working environments towards flexible working environments. Due to the scope and duration of the project, not every aspect of this design can be validated. Several questions remain that require more extensive research to validate and show the potential of the concept.

First of all, office culture is an important factor in the adoption rate of the concept. The implementation of VaryFlex rests on the assumption that both management and employees are on board with the idea. However, it should be kept in mind that there are potential groups that do not want to go through with either the transition or system usage.

Secondly, controlling the light could be an interesting option to create ownership in the environment, but this also raises questions. Firstly, to what extent does this create ownership? Next to that, to what extent does it influence the working behavior of surrounding workers? From the user study, a desk light is seemingly harmless, but the ceiling lights have not been tested with. Additionally, is there a way that creates ownership in the environment that does not require controllable ceiling lights? These are all potential pitfalls that

should be properly tested in order to take the next step in developing this concept.

From a viability point of view, research should point out whether the implementation of this system is worth the costs. Organisations purchasing the system in its entirety buy an amount of tokens, token boards, and controllable ceiling lights if they are not yet implemented in the office space.

However, the concept of VaryFlex should not be seen as the ultimate solution for organisations transitioning to flexible working. Since this subject is rather new and not yet explored thoroughly within the interaction design field, this design tries to make an approach to tangible and physical product design for this transition. Making use of sources found in the design community, such as the social translucence theory, interaction frogger and other frameworks and methodologies, designing for social, multi-user environments is tried to fit into the corporate environment in a time of change. The opportunity is there, and designers should try to see how they can use their expertise to support organisations during these transitional times.

4. Conclusion

VaryFlex proposes a design solution for transitioning from traditional working environments towards flexible working environments that many organisations face. For the organisations that have trouble with this, VaryFlex poses a potential solution. Users have been included throughout the design process to create a design that fits their work flow and needs. Afterwards, value propositions for different types of companies have been created. Finally, a fully functional prototype has been realized through the use of 3D printing, and laser cutting.

With VaryFlex, employees are meant obtain responsibility of their own environment. Building up support is difficult and takes a lot of time. When you're not always around the same people, it can even more difficult. VaryFlex is the constant

factor in these changing times and includes all layers of an organisation in the process, making it easier to adapt to a flexible working environment. By providing tangibility in this process, VaryFlex aids workers by giving them ownership of their environment. By deciding what they want to do with their token, they influence their physical and social environment. This consists of aspects like showing a co-worker the user will be back after your meeting in 15 minutes, or notifying the manager that the user could use his help when he returns to its desk. Next to that, VaryFlex enables the user to take control of the lighting in the direct environment of the desk, taking others into account.

5. References

Aanpak | Flexibel werken. (n.d.). Retrieved January 9, 2018, from <http://www.flexibelwerken.nl/nl/aanpak>

Cooke, J. G. (2012). The Benefits of Flexible Working Arrangements: A Future of Work Report. Hot Spots Movement. Retrieved from <https://www.bc.edu/content/dam/files/centers/cwf/individuals/pdf/benefitsCEOFlex.pdf>

de Vos, T. (2016, October 25). Veranderstrategie en Veranderaanpak | HNW | Veldhoen + Company. Retrieved January 9, 2018, from <https://www.veldhoencompany.com/nl/dienst/veranderstrategie-veranderaanpak/>

de Vries, J. (2005). Research on the Yoshimura buckling pattern of small cylindrical thin walled shells. Proceedings Of The European Conference On Spacecraft Structures, Materials And Mechanical Testing 2005 (ESA SP-581). 10-12 May 2005, Noordwijk, The Netherlands. Edited By Karen Fletcher. Published On CD-Rom, Id.#21.1.

de Wildt, M. (2012). Implementatiewijzer Flexibel Werken. Qidos . Retrieved from <https://www.qidos.nl/wp-content/uploads/2016/02/Qidos-ImplementatiewijzerFlexibelWerken.pdf>

ijzerFlexibelWerken.pdf

flexiworkforce. (n.d.). Retrieved November 14, 2017, from <https://www.flexiworkforce.com/what-is-flexible-working>

Galitz, W. O. (2007). The Essential Guide to User Interface Design: An Introduction to GUI Design Principles and Techniques. John Wiley & Sons.

Het nieuwe werken. (n.d.). Retrieved January 9, 2018, from <https://www.gispen.com/nl/ontwerp-en-realisatie/het-nieuwe-werken>

Introduction - Lithne. (n.d.). Retrieved January 11, 2018, from http://lithne.id.tue.nl/index.php?option=com_content&view=featured&Itemid=435

Niemantsverdriet, Karin; Broekhuijsen, M.J.; van Essen, H.A.; Eggen, J.H. (2016), Designing for multi-user interaction in the home environment.

Onze aanpak. (n.d.). Retrieved January 9, 2018, from <https://www.ynno.com/onze-aanpak/>

Preece, J., Rogers, Y., Sharp, H. (2002), Interaction Design: Beyond Human-Computer Interaction, New York: Wiley

Thomas Erickson and Wendy A. Kellogg (2000), *Social Translucence: An Approach to Designing Systems that Support Social Processes*.

Thoms, P., Dose, J. J., & Scott, K. S. (2002). Relationships between accountability, job satisfaction, and trust. *Human Resource Development Quarterly*, 13(3), 307–323.

van den Hoven, E., Frens, J., Aliakseyeu, D., Martens, J.-B., Overbeeke, K., & Peters, P. (2007). Design research & tangible interaction. In *Proceedings of the 1st international conference on Tangible and embedded interaction - TEI '07*. <https://doi.org/10.1145/1226969.1226993>

van der Voordt, T. J. M. (2004). Costs and benefits of flexible workspaces: work in progress in The Netherlands. *Facilities*, 22(9/10), 240–246.

Webster, F. E., & Wind, Y. (1972). *Organizational Buying Behavior*. Prentice-Hall.

Wensveen, S. A. G., Djajadiningrat, J. P., & Overbeeke, C. J. (2004). Interaction frogger. In *Proceedings of the 2004 conference on Designing interactive systems processes, practices, methods, and techniques - DIS '04*. <https://doi.org/10.1145/1013115.1013140>

6. Appendix

Appendix A1: Pressure Cooker

Starting off the project, an introduction to social interactions with shared systems was gotten through a two-week pressure cooker. This was done in groups which is not the same group as we ended up doing the project with. During the first week, various shared systems were analysed in terms of social interactions. In the second week, systems and interactions were zoomed in upon and a new design so.

Caro

During the first phase of the project knowledge about what a shared system really is was gained. All found shared systems were divided into six clusters. Five systems were more analyzed on the basis of six subjects; what does the system do?, what are the different roles of users?, what is the goal of the system?, what is the target group?, who are the stakeholders?, and how is the system used?. The purpose of these questions is to analyze when a system can be seen as a shared one, and what aspects distinguish this.

Storage

Shared systems in this cluster are lockers, system or key cabinets, mailboxes, and a pin-up board. Public lockers are spaces used for storage which come in different sizes, yet are usually small. With several different types of lockers, come different types of shared usage and ownership. It can vary in time, control and choosing. The main goal for lockers is that personal belongings are save for a time in the middle of an experienced unsafe environment. Most questions in this cluster are formed around time. Is a locker shared when the user gets to own it for a year? Is borrowed ownership part of a shared system? Is a storage unit only shared when multiple people are able to use it or when ownership can change over time? When is locker system a shared one?

Public Transport

The second cluster formed is regarding public transportation. In the Netherlands, NS can be seen as a shared system or service. NS provides a service whereby they use a train to take multiple people from one place or another. Green Wheels and Swapfiets is another kind of system. The companies also

provide a shared system but they share product ownership. The shared system lays hereby with the company and its service, not with the product itself.

Equipment and facilities

Although the categories equipment are facilities are divided in different clusters, the way of using is the same. Equipment contains products as a coffee machine, a fridge in a shared kitchen and a printer. These are products which are needed and used often but one person does not use it enough to have a private one. Facilities contain central heating, public toilets, trash bins and light buttons. These can all be found in a public place. A light button controls the light, but one is enough and anyone in that public space can control from that central position. The same as a toilet or a trash bin. The capacity for these clusters can be too high and shared usage is the most effective and efficient way whereby individual property is irrelevant.

Information provision and public sharing

Systems in this cluster are focused on information provided

on a central place, such as a roadmap, road signage and escape signs. The signage on the road or in a building are information points which help the user to find the way where to go. It acts as a guidance system that is visual and enables the user to determine his route. Its usage is shared but with a personal goal. This is the same as in the public sharing cluster. This cluster is about the road network, an elevator, a revolving door. The road network is a system of interconnected roads designed for multiple users; (un)motorized vehicles and pedestrian. It is an infrastructure designed for the people. Ownership is not really of great importance and it is mostly publicly located. These systems are based on individual used but without and individual ownership.

The analysis of all these systems in the different clusters brought two main terms; shared ownership and shared usage. What kind of sharing is applicable for the system and what kind of information is needed to make this clear for the (new) user? These questions are of great importance for the first iteration and has to be in focus when creating the project environment to design for.

Marco

Analysed systems

Central heating system

Sitting in a space - the space being either public or private - is influenced by your comfort. One aspect of your comfort, is the temperature. But how does everyone's preferred temperature differ from each other? Changing the temperature in a room with many people becomes more difficult as more people are present in the room. How can you find a sweet spot in adjusting the temperature? Concepts that have been played around with are the transparency as one user adjusts the room temperature, but also how important everyone's impact should be. Social communication should be the central point in this discussion.

Traffic

Traffic is a complex network of cars passing each other in high speeds in various directions, with bikes, motorcyclists, and trucks sharing the same road. Every action of every vehicle impacts others around them, and its scale can be difficult to

interpret. When another vehicle merges unexpectedly, it all becomes personal. How can inter-vehicle social interaction influence the atmosphere within traffic?

Sound system

Even though only one person in a shared space could want to listen to a song, it is likely other people around that person will hear the music as well. Discussing what song to put on is also difficult, as atmospheres music create are intangible and potentially tough to describe. How can design play a role in mediating or discussing music in a shared space?

Shared bank accounts

When two people share a bank account, there is only one screen that connects their interactions: the screen of online banking applications. Both users have a bank card which they can use to their liking. When a purchase is made, the information on this transaction is limited on the bank application, and it is done post-payment. Can social interactions within a shared bank account play a role pre-purchase?

Smartphone usage

The dynamics of a group are heavily influenced if a person uses his or her cellphone during a conversation. From personal experience, this often results in a domino effect of knowing it's okay to use your phone. When using a phone in a group setting, it can come across as looking indifferent or uninterested in the group. Can design play a role in the message that phone usage in a group brings across?

Autonomous vehicles

As autonomous vehicles become the norm in the future, there is more time spent in vehicles together. People no longer have to navigate and watch the road, but social interactions become more important. Will there eventually be a “main responsible” driver? Or do all passengers with a driver's license have equal say in what the car will do?

Tobi

During the pressure cooker for the M1.1 Industrial Design-project in the squad ‘Social Interaction with Shared Systems’ an analysis of shared system found on the campus of the TU/e was made. First an exploratory iteration was made, where all

potential shared systems were photographed and clustered in different topics. Afterwards the five generated topics got analysed on their properties and possible opportunities for design.

Shared systems with one user at the time

These systems can occur in two settings. They can be placed within an undefined shared space, such as vending- or coffee machines. These machines can be placed in any shared space, but the interaction is rather basic and only allows for one user at the time. A cash-register or self-checkout is usually only found in stores, making it a shared system in a defined space. Interesting design opportunities arose, like trying to find ways in which these machines can be used simultaneously by two users or more. How would you be able to provoke interaction with these kind of shared systems? Would users prefer this change of interaction?

Shared public spaces & systems that influence a shared space
Within this topic a distinction between professional shared space and leisure shared space was made. In these spaces

different senses that influence each other are central. Visual, scented, audio, temperature senses all describe the experienced atmosphere of such an environment. A key factor is who has control over these senses: are they controlled by one central controller, or is the control shared amongst the users of the space? As often users don't have direct influence on (some of) the actuators in a shared space, opportunities for design arise in the interaction of multiple users in order to control a space's environment. What interfaces can be used, how would this interface be presented towards the user. Another interesting aspect within this subject is how the communication of senses, or preferences for them, can enhance decision-making or collaboration among the users of the interface.

Shared public systems with unwritten social rules

Within this category several public systems where vague, subjective social rules apply were observed. Systems such as elevators in buildings or revolving doors or escalators. The use of these systems can strongly depend on cultural aspects or habitual use. For instance in London, it is very usual to stand

on the right-hand side on the escalator, and walk on the left-hand side. If a tourist does not obey these social rules, Londoners get angry. The thing with these systems is that the use is mostly self-evident and acted out naturally. In design, rewarding the users for correct use in the cultural context of these systems can be an interesting perspective to look at. On the other hand, playing around with the interactions and social rules can create a fun and meaningful discussion among users.

Shared information systems

When walking around the campus, a lot of information systems were observed. A lot of these systems broadcast functional information about a specific building or room, while others inform users about a lot of other news and activities. The main divisions that could be made within the shared information system were whether the information was exchangeable or editable by multiple users or if one administrator took care of the provided information. And if the freedom of use was limited by technical boundaries or was very broad because of a low-tech approach. A good example of this contradiction is

the information shown on TV's, the information shown on a message board. A message board can be edited by everyone, while a tv hanging from the ceiling has a 'hidden' editability. The main design goal that could be formulated in this challenge is to think of ways on how to convert low-fi communication methods to technological advanced interfaces without losing the freedom of use and editibility.

Multiple user systems which communicate its availability
These systems were mostly found on studyportals and meeting rooms that could be reserved in advance. Displays at the entry communicated if the rooms were available, and at what time they are reserved. At some rooms, you could make a booking on the interface, at others it should be done online. To improve these designs, more contextual feedback could be added before a user goes to the room. Also the personal or social information about why the room was booked was lacking, which could make interesting discussions about prioritising a room.

Appendix A2: Defining context, Preferences direction & Concept development

Defining context

The questions resulting from the social translucence theory stated in the paragraph above, are the starting points for our design proposal. But these questions apply for nearly every topic in the design practice. It is therefore important to define a context for which can be designed. In the first brainstorm session a lot of different ideas about contexts were generated. From classrooms and home situations to public spaces, waiting rooms, restaurants, bars and lots of other potential multi-user environments (see Figure 6.1). Since lighting is an available resource within the squad, the choice to incorporate lighting in the context definition was quickly made. However, lighting was not supposed to have the highest priority in the design proposal, but should act as a supportive factor within the concept. As the brainstorm sessions continued, the context closed towards some point

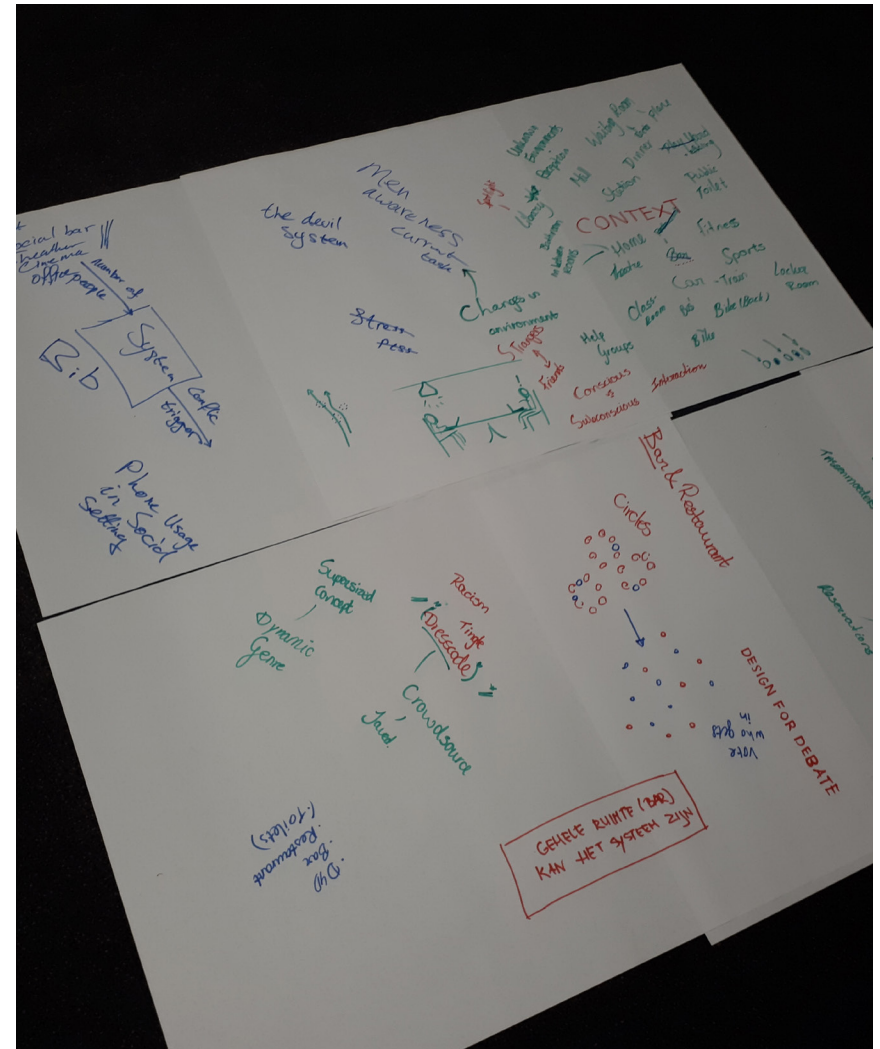


figure 6.1: multi-user environments

of interests for an interface design that were shared among the design team. The properties of a potential interface were described as followed:

The interface should stimulate compromising behaviour

Setting a mood must be part of the interface

The interface must be able to enlighten a space through spatial lighting

It is important to display social information on the interface

It must have a decorative and aesthetic look and feel

The start of the project was initially meant for defining a context, but instead a requirement set for an interface was created. A lot of functionalities were thought of to resemble social translucence and tangible-, embodied- and rich interaction in an interface. The chosen direction at this point in the project is to design an interface which mediates the lighting preferences of all users in a shared space, and displays this information through the interface to other users. Yet an important factor, the context of the proposed design, was still missing.

The ideas of what to design were there, but due to the lack of context a valid value proposition was still very hard to grasp.

Instead of defining a concrete context, the focus was more shifted towards exploration and interface properties. Parallel to each other, the design team focused on both physical prototype properties such as shape, form and interactions, as well as a first electronic prototype consisting of a mediation interface that was connected to several Philips Hue lights. The exploratory approach resulted in a lot of generated knowledge on interaction design, interaction mapping, formgiving and designing and prototyping connected products. As the midterm demoday was approaching, the design team realized that the context of their concept was still not clear, and that due to the amount of exploratory work the value proposition of the concept was still unclear. Although a lot of knowledge was gained, the concept needed to be wrapped up in a defined context in order to be presented properly. The direction of shared working spaces was picked as the preferred context to work on, and an attempt to fit the exploratory works into this context was made. The decision was made to present the several exploratory works during the midterm demoday, and choose a more specific direction according to the feedback gained from it.

Preferences direction

The project continued with placing the preferred exploratory prototypes and their corresponding interactions, properties and values into context and evaluating how each individual interface could contribute to a more optimized socially interactive shared space. The main preferred prototype was given the working title 'Socialight' (figure 6.2). With Socialight, exploring with lighting would be stimulated. With visual feedback this exploration could be first done on the interface itself. When the user finds a pleasant setting, they can enter it as their preferred light. The lighting preferences of all people present in the space would be taken into consideration and mediated through the interface. By making use of rich interaction and haptic feedback, interacting with the interface should be easy and inviting. The context was defined as a 'shared working space', where mainly creative professionals work. The space has smart lighting equipment installed and the users are interested in exploring with these lights. Once a user finds a group of desks to work at, a light setting is already given by other people that work there at



figure 6.2: concept Socialight

that time. As the user gives his own input into the device, the Socialight will mediate his color with the existing one and provide an array of options. The user can then decide which variation to use and, dependant on how radical the change is to the current setting, the haptic feedback also increases. The Socialight provokes thought on where to work, and what the user's impact is on the working environment.

Concept development and definition

After weeks of exploring and doubting on what topic to choose, finally the feeling of choosing a more concrete design direction was sensed. The decision for this direction was partly pushed by the midterm demoday, but also incorporated a lot of the values that were seen as important by the design team. The priority for now is to define the concept even more and find out how to develop the concept after receiving feedback during the midterm demoday. As the main direction now stands, the important aspects of what it is that makes the space 'shared' and 'social' are highlighted and deeper defined. As a first dissection, the concept is divided into three main categories: User, Interface and Space. (figure 6.3)

As can be seen in the picture above, a lot of additional properties of each category were defined during this brainstorm session. For each category the highlights will be shortly named:

User

An important factor for the user is the freedom of choice. Whatever interface you design, a user will eventually choose whether to use it or not. This means the interface should trigger curiosity. Also the goal of the activity was perceived as an important factor: why would a user actually use the interface? What are the advantages? What do they gain? And finally 'other users', how can they influence each other in their interacting? How does hierarchy play a role?

Interface

During this period of the process a lot of discussion revolved around the 'shares' of the users' input. How long is the input of a user seen as valid? Must the preference lose weight over time, or according to an amount of new user inputs? What happens to the light when the first to come in the room loses

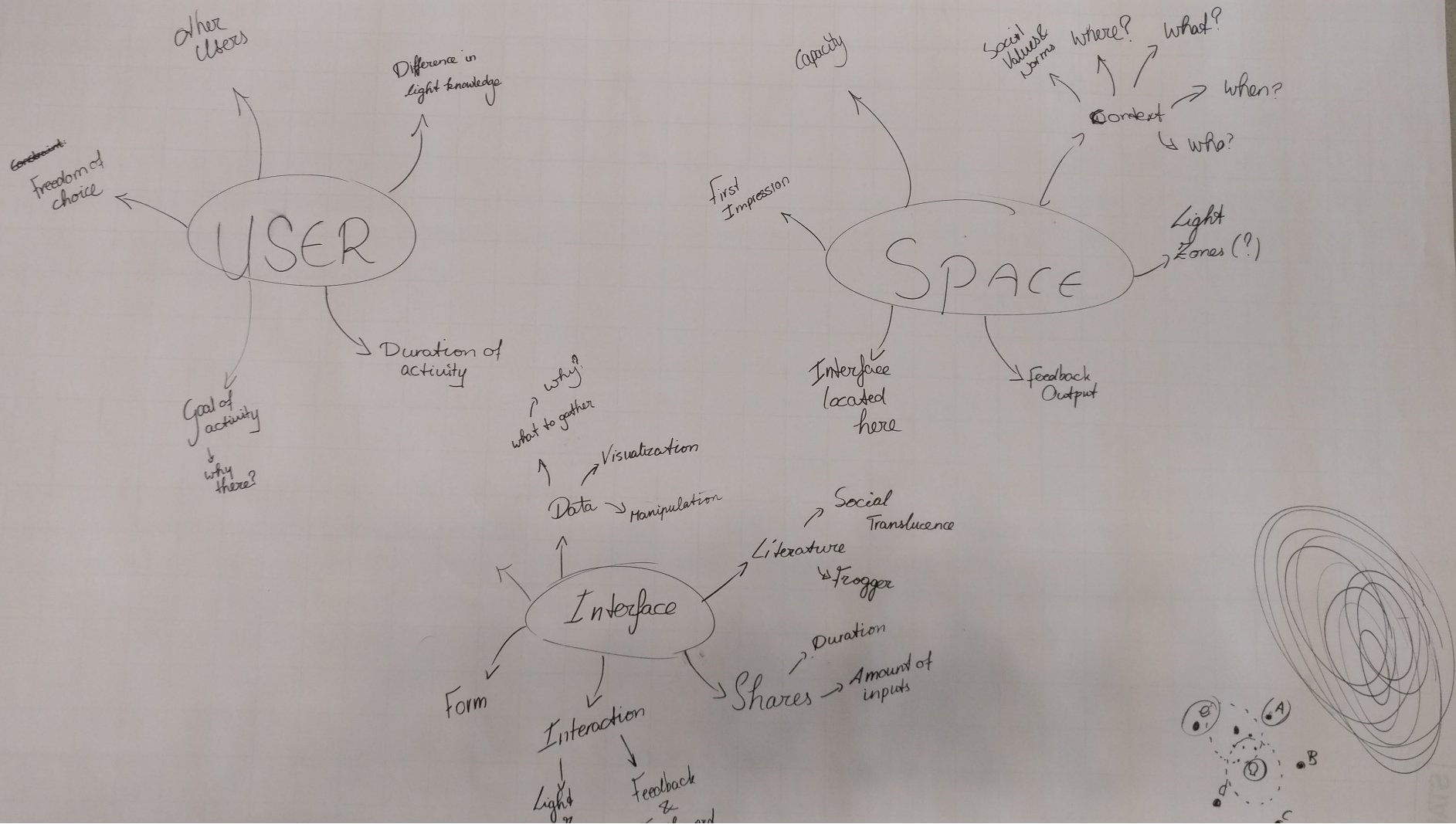


figure 6.3: user, interface, and space

his entire share in the lighting? Combined with this, the data acquired by the interface also was a great discussion point. Actually what data needs to be gathered and why? And how would you visualize this data, can it be manipulated?

Space

The biggest point about the space is that this is where the entire context is about. From the amount of users to the first impression to the light distribution, everything depends on how the space is arranged. Since the interface is located in the space, it is important that the space is surveyable, so that information from the interface is legible to (most of) the users in the space.

The conclusion of this brainstorm session is that the direction chosen generates rather more questions than answers, and maybe a revision of the initial design goals must be considered. Yet the midterm demoday is coming up. The suggestions, feedback and new insights and perspectives gathered there may help with this re-consideration.

Appendix A3: Midterm Demoday

The focus of the first quartile was explorative and with a broad view on shared systems. With a rather open and unspecified context the demo day presentation consisted of an interface where light mediation played the biggest part, and whereby the interaction is intuitive and tactile. This interface, as mentioned above, was connected to several lamps united with the Philips Hue system on a presentation table. Since exploration was key to this quartile, the multiple forms were displayed to complete the story. Together with an oral presentation the work that had been done in the first quartile was explained. Light in a public workspace as shared system is a common subject where many projects already focussed on and the coaches and experts present during the session focussed on this. The received feedback of this day would be very useful for the next iteration of this project. Another feedback item input that was desired was the way of interacting with the interface. Intuitive and aesthetic interaction was a main topic which appeared as an important aspect that needed to be

included. The explorations presented acted as options where the best one could be selected.

Reflection moment between iterations

Looking back at the work done in the first weeks together with the feedback received on the midterm demo day the focus could be perceived unsure and unstable. Although the input of multiple ideas and the amount of exploratory work was excessive, the goals were not communicated the best way whereby the message was not stated clearly and where insecurities came to light. In addition, a better framing on the process and intention was needed.

With a too broad project goal, too many parameters had been left open. For the amount of time stated for this project, the mentioned topics were not feasible to design for and a better choice in direction was needed.

Although the under-defined goal definition gave too many options to design for, a base for multiple directions was already created. With new insights and a more critical view, a new focused and specified direction was selected. The goal at this stage was to create an inviting light interface that makes users experience new light settings through trial and

error in a social context. Still this goal needs to be specified with corresponding parameters which are discussed below. This selection was based upon personal motivation and interest. When a project can contribute more to personal development, intrinsic motivation will be encouraged and results in a satisfying end.

Parameters

Goal statement

The goal at this stage was to create an inviting light interface that makes users experience new light settings through trial and error in a social context.

with inviting a socially translucent lighting interface is meant as described in the literature of iteration 1

users will experience new light settings through trial and error were it enables them to take responsibility of the light satisfaction among others

the broad social context will be focused in a shared flexible workspace.

The goal can be specified as; to create a socially translucent lighting interface that enables users to take responsibility

of the light satisfaction among users through single-user input in a multi-user flexible workspace where people have professional relationships.

The lights will be divided in different light zones per a group of table. The space will be separate in multiple zones where the light is separate as well.

The lighting will be variate in the white spectrum [warmth/temperature] and brightness.

The literature that plays a big goal in this phase of the project is the social translucence theory as discussed in previous literature chapter. A term central for this theory is accountability. In order to create this accountability, within this project, is has been found importanted that the user has a responsibility. Accountability can contribute to responsibility.

Therefore the interface The interface has to enable users to take responsibility of the light satisfaction. As you contribute to the light settings, you work together to find a comfortable light environment. It should enable users to take control over the light environment.

Another term is social visibility where the information is clearly visible. Therefore should all actions be visible and

reversible. Actions are feed-forwarded and gives social information about the decision making process of the users before one. This information sharing will decrease insecurities about actions done and if a conflict arises it will increase and stimulates social interaction.

With a strict and communicated planning and a redefinition of the focus and goal, a new base was formed for the next iteration. But at which opportunity is this project targeting? What is the problem statement and in what context is that located? What is the added value? The foundation which was needed to fill in these gaps, was found in the flexible working places and the transition from a traditional office to this flexible place in particular.

Appendix B: Benchmarking

As of writing this report, January 2018, there are no physical devices on the market that assist organisations to transition towards a flexible working place. However, there are various companies that can be consulted by an organisation wanting to offer flexible working spaces. Examples of these companies in the Netherlands are YNNO (“Onze aanpak,” n.d.), Gispén (“Het nieuwe werken,” n.d.), Qidos (de Wildt, 2012), and Veldhoencompany (de Vos, 2016). These consulting companies generally offer information to employees and employers through information sessions and teach it through workshops, but can also be consulted for more personal issues or questions. The aforementioned companies serve as inspiration in how the transitions are currently handled, and how design can be implemented to play a role in this process. All of the aforementioned companies have a very similar approach that “Flexibel Werken” (flexible work) has provided (“Aanpak | Flexibel werken,” n.d.). Flexibel Werken is a Dutch, online platform that offers insights on how to transition to flexible working. Various news articles, opinions, research,

and tips are provided. Firstly, to transition to flexible working, the consulting company sits together with the organisation wanting to transition towards a flexible working environment. In this stage, the drivers of the change are mapped, the results of the company are defined, the needs and demands of employees and support from senior management is reassured. However, this contradicts the research previously mentioned, performed by Cooke. That study showed that management’s support is lacking, holding back the transition. Consistent in this is the importance of management.

Secondly, a tailor-made concept is created to suit the company’s way of working. The focus here lies in consistent usage, and effective usage. In terms of consistent usage, policy and procedures are of importance. Questions that need to be answered in this stage are “What is the vision of the company?”, “What is the eventual way the office works?”, and “What are everyone’s roles and responsibilities?”.

Thirdly is the step of implementation. This can be done through different ways, such as pilots, oil-stain method, or a simultaneous, organisation-wide implementation. During this stage, the vision is communicated to the whole company

and employees and managers are educated to deal with the new way of working. Finally, resources become available. Examples of these are adjustments in the ICT and physical environment.

Then, in the fourth step, measurements are made. These measurements are done in order to see whether the new way of working meets the goals the company has set. Examples of these goals are productivity, or employee satisfaction. At the end of this stage, successfactors and areas of improvement are determined

Finally is a step that never really ends. Improvements that are discovered are fed back to the third step: implementation. As the demands and way of working keeps evolving over time, this step remains necessary.

Appendix C: User interviews

The literature around flexible workspaces is clearly explained from a generic and academic perspective. The benefits and drawback are stated here pragmatically and give great input for the understanding of the context of this project. For a more personal influence and perspective, interviews are done with people with a working occupation. The working environment of the interviewees are clustered in two groups; a traditional office with fixed workspaces and an office with flexible working places. The interview is focused on the personal experiences around the working environment. To gain the most personal and real reactions, the questions were asked in a very informal setting. All interviewees were employed by another company but which companies was not known. Without this background information and knowledge about the environment the people were talking about, they were encouraged to answer freely.

The asked questions for each cluster and the results are shown below.

The interesting reactions are concerning the difference of

each environment. Although some companies stated to have flexible workspaces, the employees do not act on it. For instance, one worked in a company whereby every employee has a fixed flexible desk.

One reaction of the first cluster which is mentioned by every interviewee is that no one wants flexible desks with the argument that they do not know what to do with their stuff. Not everyone is used to carry everything they need in one bag. One general conclusion is that people are creatures of habit. They want to mark their territory, as with a working environment. They do not feel in control when this is flexible and uncertain.

Another aspect mentioned is that the employees feel that they have more to say about their workspace when they work more hours than someone else in the company. There is an hierarchy who gets the preferred desk.

Every company has its own set of rules formed by the employees themselves. Everyone knows about them and with that system the environment is set. When they are limited by the management, they are less in control and feel uncertain which can result in resistance. This is one aspect that should

be taken into account while stating the scope of the project. The insights gained with this interview are applicable for a better formation of the context where the concept will be based on.

The questions for this user interview are Dutch since the interviewees have Dutch nationalities. As mentioned above is the style very informal and focussed on the experience of the employees in their companies working environment.

The questions are divided in the separate cluster and asked as the following:

Cluster 1; 0% flexers

Wat vind je van de huidige manier van werken aan een vast bureau?

Weet je waar iedereen om je heen aan werkt?

Heeft het invloed op je manier van werken als je weet waar iedereen om je heen aan werkt?

Komt het ooit voor dat iemand op jouw plek zit?

Weet je welk bureau bij welke collega hoort?

Hoe kom je te weten waar een afwezige collega is?

Zou je graag willen wisselen van werkplek?

Wat zou je er van vinden als je bedrijf flexibel werken invoert? (100% flex)

Cluster 2; 50%-100% flexers

Wat vind je van de huidige manier van werken?

Weet je waar iedereen om je heen aan werkt?

Heeft het invloed op je manier van werken als je weet waar iedereen om je heen aan werkt?

Komt het ooit voor dat iemand op jouw plek zit? Ben je er bang voor?

Wanneer je de keuze hebt, heb je liever een eigen bureau?

Weet je welk bureau bij welke collega hoort?

Hoe kom je te weten waar een afwezige collega is?

Heb je wel eens moeite met het vinden van een werkplek?

The reactions are stated below. The total amount of interviewees is seven and they are all corresponding to a number.

Cluster 1;

P1:

Ideaal, het is mijn bureau en opgeruimd op mijn manier.

Ja

Nee het is niet nodig maar wel handig voor wanneer er vragen

zijn

Nee

Ja

Er is geen briefje ofzo, maar mond op mond communicatie waar iedereen is

Nee, functie en bureau horen bij elkaar

Gaat niet, operationeel werk dus er zijn te veel hulpmiddelen die vast bij een bureau horen en dus hoort bureau bij de functie

P2:

Fijn, mijn eigen papierwerk en zooi kan ik laten liggen

Ja

Kan ik sparren over problemen

Niet als ik er ben

Ja

Via via, het is een klein bedrijf dus achteraan wie er is

Nee

Werkt niet, het is een productiebedrijf en wanneer je niet weet waar iedereen zit kost het te veel moeite om iedereen kunnen bereiken.

P3:

Fijn, eigen plek en eigen vastigheid

Ja

Ligt aan de functie, leidinggevende functie weet het wel

Nee (zegt hij defensief)

Ja

Ik ben bedrijfsleider dus ik weet alles van iedereen

Nee, ik wil mijn spullen op het bureau

Het kan niet bij alle functies, de hogere functies niet

Cluster 2;

P4:

Ruk, ik heb RSI en elke dag moet ik alles opnieuw afstellen

Ja, we doen op de afdeling allemaal hetzelfde

Het is één afdeling, dus wel handig als je ergens vragen over hebt

Het is af en toe wel vechten voor een plekje maar er is geen angst.

Ja

Ik herken spullen

Er is een skype en een chat waar je afwezigheid kan zien

Ja, bij te volle dagen is er plek te kort

P5:

Het is een flex plek maar heb toch mijn eigen bureau. Als het bureau maar instelbaar is hoe ik het wil

Directe collega's wel

Ja, voor assisteren van problemen of vragen stellen

Ja, wanneer ik er niet ben. Ben er niet bang voor maar hij moet het wel netjes achterlaten.

Nee, niet per se

Ja want iedereen zit eigenlijk altijd op dezelfde plek

Er is een algemene outlook agenda en informatie over wanneer iemand afwezig maar extern werkt of gewoon afwezig of aanwezig

Nee want als ik er ben en iemand zit aan 'mijn' bureau staan ze op en gaan ze verzitten.

P6:

Goed, ik ben niet vaak op kantoor en ga eigenlijk telkens ergens anders zitten

Ja, kleine en overzichtelijke ruimte dus we gaan met zelfde raakvlakken bij elkaar zitten

Met onze groep kunnen we sparren over problemen

Nee, mijn tas staat bij de plek die ik voor die dag heb geclaimd.

Ja, eigen plekje is makkelijk. Mensen zijn gewoontedieren

Ja, mijn eigen team weet ik te vinden in de ruimte

Via een chat

Ja, er is een bar waar je altijd aan kunt zitten maar dat is echt niet prettig dus dat wil je niet.

P7

Allemaal prima, alles staat toch op je laptop en als je mensen zoekt kan je er altijd wel bij zitten. Wel jammer dat het een grote open ruimte is. Geen problemen met zoeken van ruimte Skype for business; welke pilaar zit je? Verder maakt het niet uit waar je zit en je kan bij iedereen aanschuiven

Nee, je doet je eigen ding; geen voor en geen nadelen

Ik zit niet op een vaste plek. De belangrijkste mensen hebben wel hun eigen plek, maar met overleggen wordt duidelijk gemaakt dat je wel overal mag zitten. De oudere mensen zitten vaak wel op dezelfde plekken

Liever een eigen kamer voor geconcentreerd werken, niet perse een eigen bureau.

Nee, alleen een aantal; de vaste plekken die bepaalde dingen nodig hebben. Je hebt toch alles in je rugzak

Weer skype voor business; een berichtje sturen of in zn agenda spieken. "Ik ben dit aan het doen en zit daar en

samen met deze persoon”

Nee. Hooguit een keer op vrijdag dan zit je een keer 3 bureautjes verder; niet direct bij je directe collega's. Komt niet zo vaak voor

Appendix D: Scenarios

The scenarios described below present the situations that occur in the working environment where the concept is already integrated. The personas; Jonathan, Gwen and Bob react all differently on the system. They use the features in a different way and for a varies reason. This is depending on the type of responsibilities of the personas and relates to where the function of the employees varies.

Scenario 1

Jonathan is working on his planning and he has some difficulties with his free days and holidays. He needs to ask Bob about this because he wants to make sure that it goes the right way the company wants it. Most of the times, Bob sits in the same space. Therefore he goes to that area and searches for him. When he recognized the bag and laptop from Bob he sees that he is not there. The timer on the tokes is still on 20 minutes which means that Bob will be back after that time. Jonathan leaves a message by pushing the button and walks back to his own desk with the plan to search for

Bob again when the timer ends. After 10 minutes he sees Bob walking towards him. The meeting ended early and Bob has time to help Jonathan with his problems. From the employees around Bob's working place, he figures that Bob is looking for him.

Scenario 2

Jonathan is working on his project and he has gotten stuck in his process. In order to keep a move in his part of the project, he needs some additional insights in his workflow. To get these, he uses the token to find other people working on project Toolbox. The people that work on that project have experience he could use, but he does not fully know who work in it.

By setting the token to "Toolbox only", the lights of the tokens currently set to working on project Toolbox light up. As Jonathan walks throughout the room, he can see whether there are people working on team Toolbox that he could request help from. When Jonathan has found someone that could help him further along, he holds down the button on the token of that person and dismisses the alert for all

employees working on project Toolbox.

People that are currently working on team Toolbox but do not have the time to help someone, can simply press the token in order to dismiss the beacon.

Scenario 3

Bob is currently working on tasks for the project he is leading, project Athena. He has a meeting planned for the coming 30 minutes. He selects the timer function on his token and creates a timer for 30 minutes, notifying other employees that he will be back then.

During his meeting, he will obtain no notifications from the token - not even when someone presses the notify button during his absence.

When he returns to his desk, he sees that he has received one notification when he was gone. He asks the people who sit around his place who it was from - Jonathan, they respond. He has two options at this point. Either wait for Jonathan to come back again, or go look for Jonathan himself. As Bob's meeting has ended earlier than planned, he decides to go look for Jonathan. He knows where he sits today as he

bumped into him before. However, if he didn't, he can use the search function on the token.

Scenario 4

Gwen has her own routing through the company. Since she already worked there before the renovation, she is still using the previous route to her desk although this takes longer. The first thing she does is getting some coffee from the machine, then she goes to the printer to check them and walks by the windows towards her preferred desk. Because of this route, she is missing the token panel to get a token. She likes the dimmed light and because she is next to the window she does not need to adjust it. During the morning she is organizing some papers all over her desk and tries to have the best logistic plan possible.

At 11 o'clock she has a meeting. She brings her laptop and bag since it is the new collection bag from Michael Kors.

When she comes back, her desk is not available anymore and her whole organized paper setting is stacked in the wrong way. She gets frustrated by the person sitting on her chair but he reacts indigent. Gwen did not have a token and did not set

a timer. Her taken desk was free for the system. For the sake for the system she needed to get a token, take her papers and find a new place to work for the rest of the day.

Appendix E1: Future Plan User test: Interaction mapping validation

In order to keep the interactions simple, familiar and fluent the choice was made to design the interactions according to scenarios, personas and metaphors as described in the 'Interaction mapping' sub-chapter of this document. In practice, a user test must be conducted in order to validate if the choice of using these interactions was right, and if interactions can be improved or changed according to the input of potential users. Due to time limitations and the complexity of finding legitimate potential users a full user test could not be conducted within the time limits of the project. However, the set-up of the user test as it would be conducted was made inspired by the DECIDE-framework (Preece, J., Rogers, Y., Sharp, H., 2002) to guide the evaluation of the design. The DECIDE framework consists of the following steps:

- Determine the goals
- Explore the questions

- Choose the evaluation paradigm and techniques
- Identify the practical issues
- Decide how to deal with the ethical issues
- Evaluate, interpret, and present the data

According to these points, the following user validation method was set up to test if the logic of the interactions constructed during the various methods of the design process is also shared by potential users:

Goals

Study whether the interaction mapping is easy to learn and logical to use. At this moment in concept development, the primary functions and interactions have been defined and mapped. However, the necessity and mapping of some functions are uncertain. This contains the function of searching for other people in through the use of the token. This study should point out whether that should or should not be included as it would clutter the interactions of the device. Questions that arise during this study are "Do the interactions conflict?", "Are the interactions logical?", and "Are

wrong interactions perceived easy to revert?”

Method

The test exists of two testing days. At the first day, participants are taught and able to put into practice the interaction mapping. Unbeknownst to their knowledge, at the second testing day, their memory is put to the test. The core of the test, regardless of the testing day, is testing where users physically try out the interactions. On top of that, users are asked to think out loud.

Potential users are asked to try out the concept. First, they are told the first function of the device (table 1). Then, they are shown the designed interpretation of a presumably logical

interaction and ask them to think out loud as they perform it. After that interaction is clear, the next interaction is tested.

If the participants do not talk out loud sufficiently, researchers trigger the participants by asking questions such as “why do you perform this action?”, “do you feel like you could easily reverse the action”, and “why do you think this interaction is coupled to that function?”.

An appointment with the test participant is made for 1 week after the first study. During this study, the same interaction mapping is tested. Yet this time, participants are not told the interactions to perform. They are only told the function that they need to perform.

Order	Function	Interaction
1	Increase light intensity	Rotate top clockwise
2	Decrease light intensity	Rotate top counterclockwise
3	Absence	Flip upside down
4	Notify during absence	Press bottom
5	Timer time increase	Rotate bottom clockwise (whilst upside down)
6	Timer time decrease	Rotate bottom counterclockwise (whilst upside down)
7	Go through your projects	Press
8	Search for projects	hold-> release
9	Cancel all searches	hold

table 1: List of order, function and mapping of the user test.

Execution

Timeline

10 minutes in total

Welcome

Participants are welcomed as they enter the room and made comfortable.

Instructions testing day 1

Participants are explained that this a concept developed in order to get a grip in flexible working spaces. It helps workers to obtain autonomy over the working space and have an influence in the environment. Various functions have been added to this device in order to support that, such as setting a project you'll be working on, and placing a timer as you leave the working space. Our question to you is to determine what constitutes as a logical interaction.

As mentioned before, participants are led through the mapping one function at a time. The functionality and interaction is explained, after which the participant has to perform the interaction and talk out loud as this is performed. After this interaction is clear, the next interaction on the list

is explained. This continues until all interactions have been tested.

As an appointment is made for the second testing day, participants are explained that this entails a different prototype and different interaction mapping. This is done in order not to prime them for remembering the interactions.

Instructions testing day 2

Participants are told that this user test has the same interactions and functions as the first test. During this test, the same list of functions are gone through as with the first test. However, interactions are not mentioned - only the functions. All other factors remain the same as in the first test.

Environment

It is not necessary to book a private room for the participants to have the test conducted in, as the real world scenario of the concept also exists in an office environment with various external stimuli.

Wrap up

At the end of the test, an appointment is made on which we

will test other interactions for the concept using a different prototype. However, the users are not aware it is to test whether the interaction mapping has hold up well against the time.

Ethical considerations

Participants will be anonymized as the results are progressed. Users are videotaped throughout the test, and need to sign a form stating they agree with this. The data and video are only to be accessed by the researchers and supervisors.

Evaluate, interpret, and present the data

A timer will run during the test to determine how long each participant takes to understand an interaction. Furthermore, qualitative feedback will be gathered as the participants are filmed and they talk out loud during the study.

The same data will be gathered during the second study. There are two conclusions to be drawn. (1) The speed at which the interactions are remembered during the first test, and (2) the capability of the participants to use the interactions after a week without prior explanation.

Appendix E2: User test: token lights

An user test was executed to evaluate how changing the light on the desk influences the individual workers on a desk. At this stage, the decision if the search feature should be included was not yet made. With this test the assumptions being made were validated. The assumptions on this aspect were;

The employees with a token on the desk will be influenced and sometimes distracted by the changing lights.

The employees want to have the ability to control the light and turn it off when not desirable.

Procedure

The duration of the test was 20 minutes with a questionnaire that took approximately 5 minutes to fill in afterwards. Users who were asked to participate were students working individually on their laptop. They did not have to do any special actions within this test besides filling in the questionnaire.

The questions of this questionnaire are;

How often did the light turn on?

Did the color change? Yes;No

Did the brightness change? Yes;No

Do you think the light influenced your working behaviour?
Yes;No;Sometimes

Were you distracted by the light? Yes;No;Not distracted but aware of the light

Were you waiting for the light to change? Yes;No;Sometimes

Do you want the control to turn the light off? Yes;No

What is, according to you, the meaning of the changing light?

A separate prototype was being used whereby a light randomly would turn on and off. The amount of this action was five times. The color of the light was blue and the brightness stayed the same. During the 20 minutes, the participants were observed to see how they reacted on the changing light and what expression was given towards the token. The participants were not acquainted with any information about the functionalities of the token or the meaning of the light. The only thing mentioned was the task to work the same as normal.

Results

A total of seven students participated in this user test. For the results of these, see the next page (figure 6.4 -)

Insights

Less than half of the participants did not notice the light changing completely. This because the amount of changing was not answered correctly by 57.2% and half of users thought the brightness changed. Most participants were not distracted by the light but it did influence their work since they were aware of the light. This test provided none background information. Because of this the participants were speculated about the function of the changing light. This reason resulted in the final version of the questionnaire where the users were asked to give the meaning of the light according to them. Although the right meaning was mentioned twice, it was perceived unknown. The last interesting result was related to second assumption made beforehand. Supposing the token should give the ability to be controlled, this was not the result of the question.

Conclusion and Discussion

To conclude, the employees with a token on the desk will be influenced and sometimes distracted by the changing lights. This assumption is correct. The second assumption is not true since no one of the participants wanted the ability to turn of the light.

The results named by students for Industrial Design. These students are not directly related to the context set for this project. Also all background information was neglected with the argumentation that the participant would not alter their response. In contrast, this could influence the question about the meaning of the light. The information that the light represented an approved approach, could affect the answer.

How often did the light turn on?

7 reacties

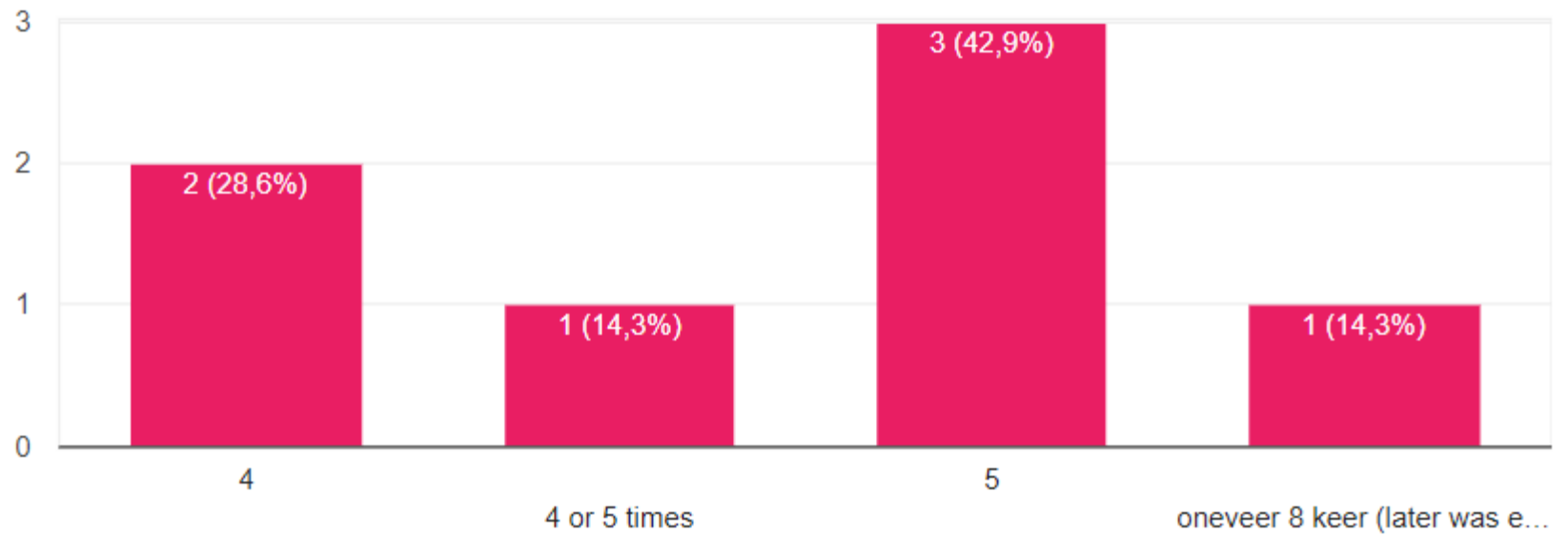


figure 6.4: Results tokenlight usertest

Did the color change?

7 reacties

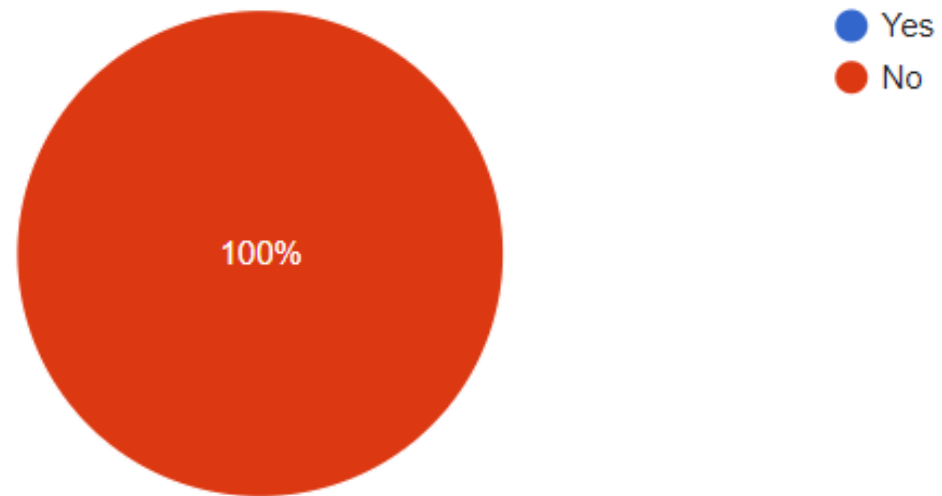


figure 6.5: Results tokenlight usertest

Did the brightness change?

7 reacties

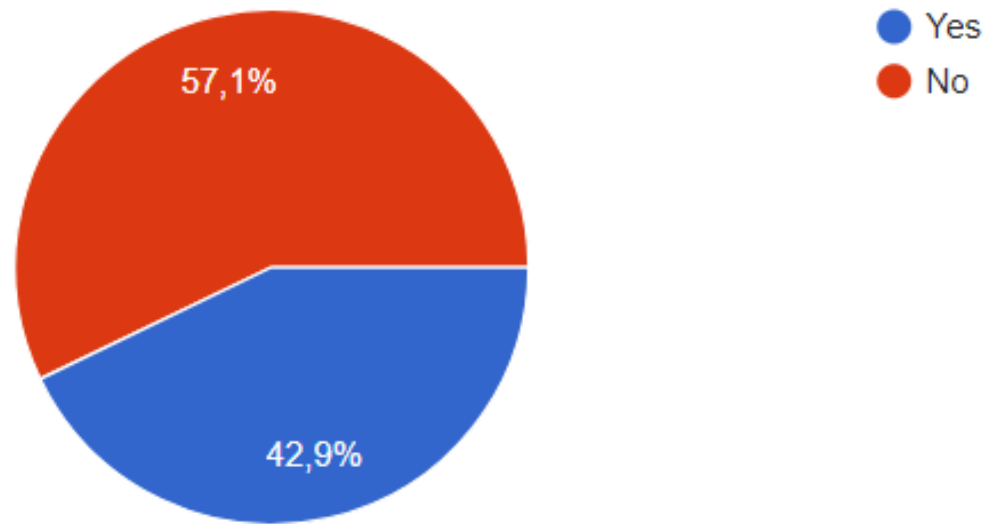


figure 6.6: Results tokenlight usertest

Do you think the light influenced your working behaviour?

7 reacties

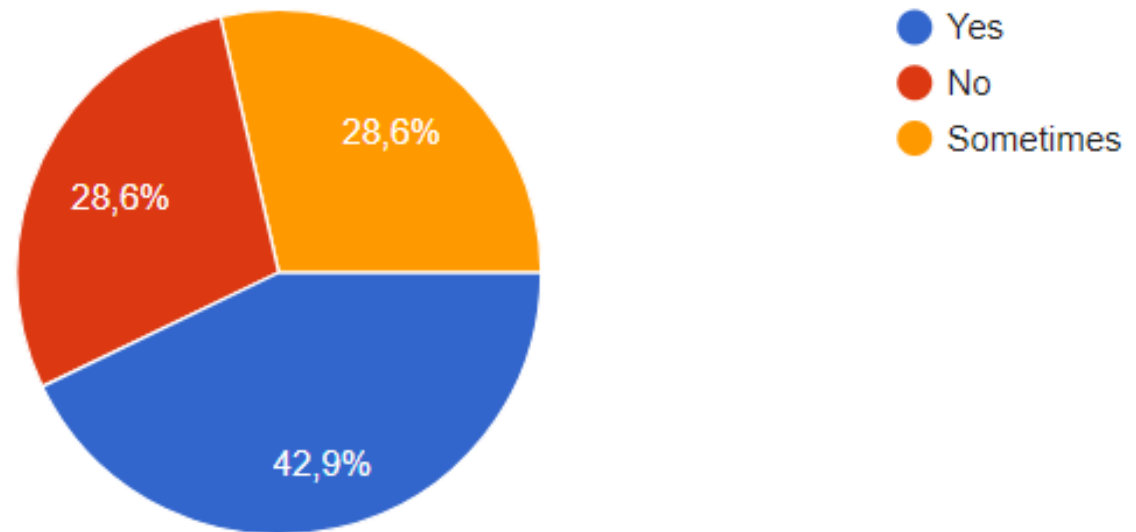


figure 6.7: Results tokenlight usertest

Were you distracted by the light?

7 reacties

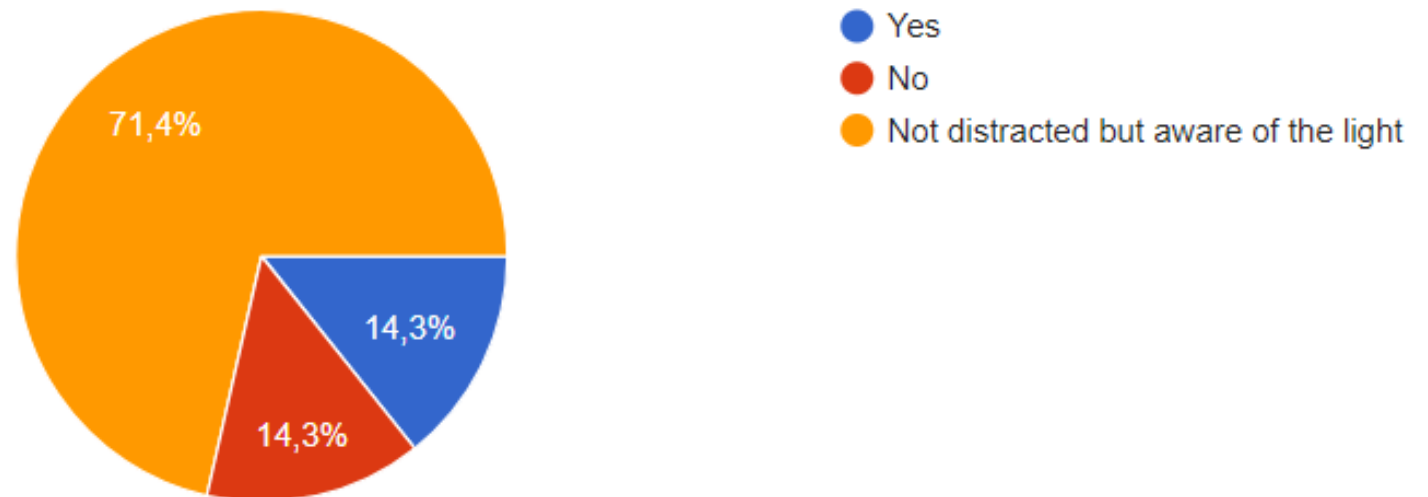


figure 6.8: Results tokenlight usertest

Were you waiting for the light to change?

7 reacties

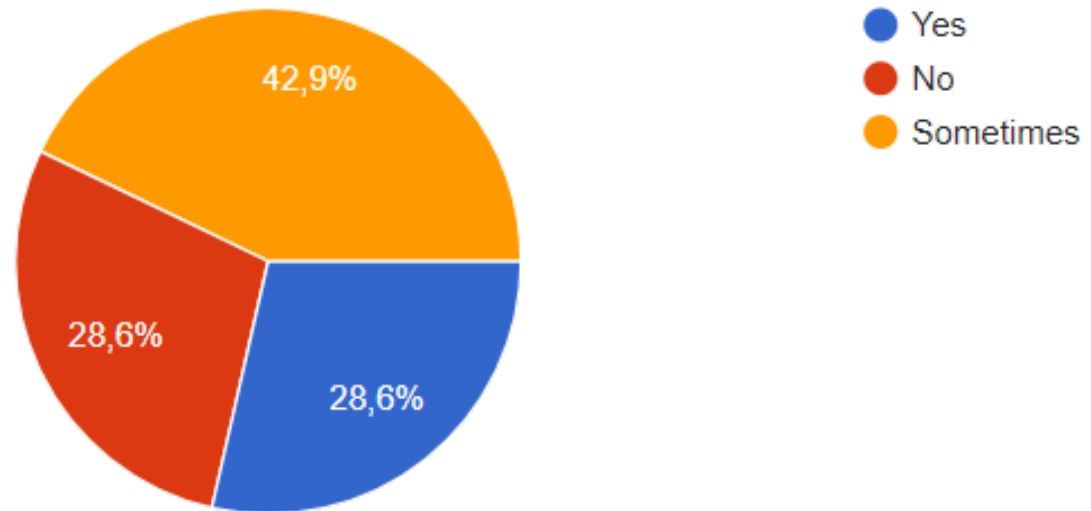


figure 6.9: Results tokenlight usertest

Do you want the control to turn the light off?

7 reacties

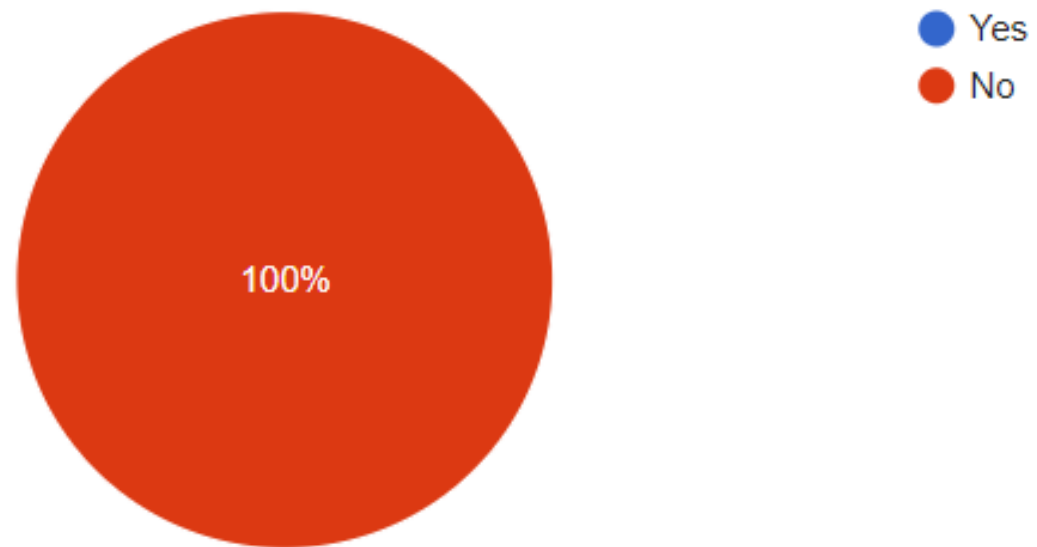


figure 6.10: Results tokenlight usertest

Appendix G1: Form and Material Explorations

Images from the form and material exploration are seen in figure 6.11 through figure 6.16.

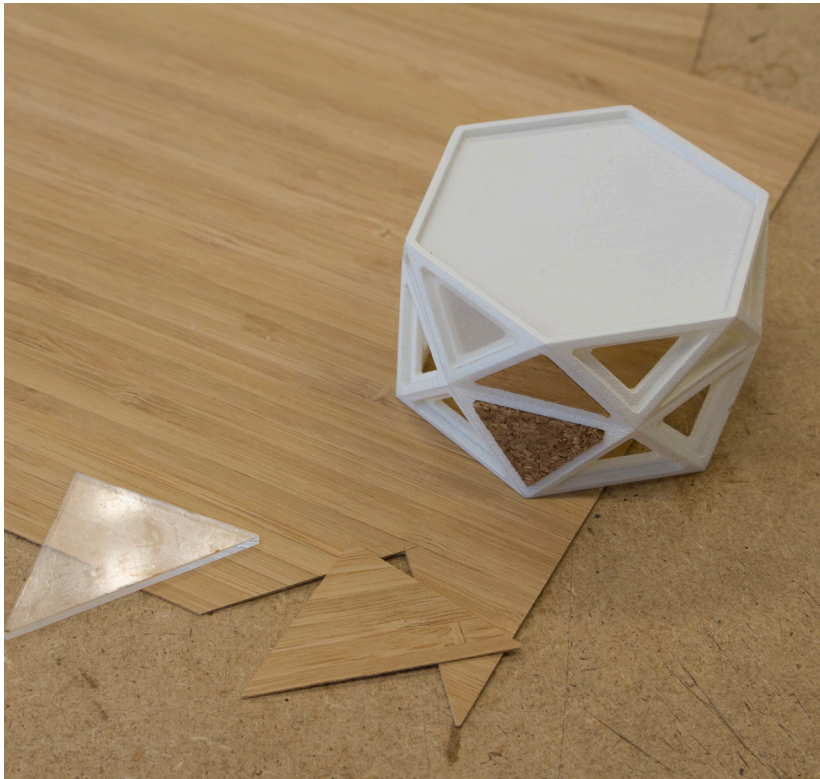


figure 6.11: experiments of bamboo on the token



figure 6.12: application of different materials on the token

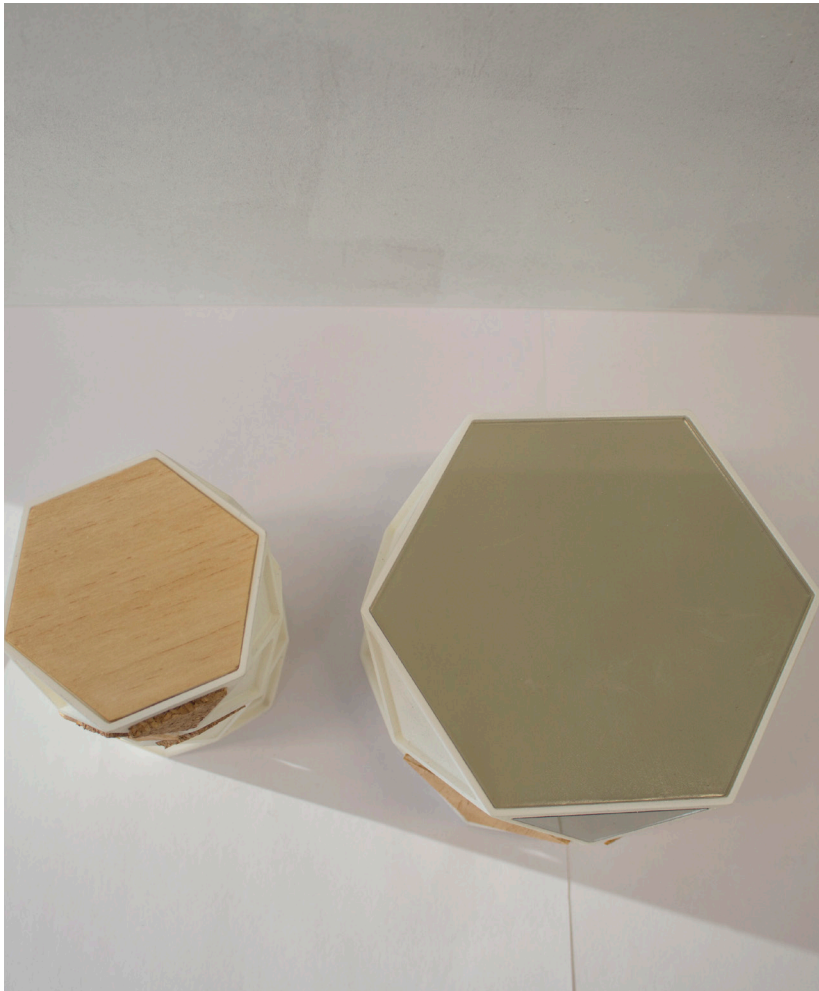


figure 6.13: two types of top pieces of the token; balsa and plastic wrap

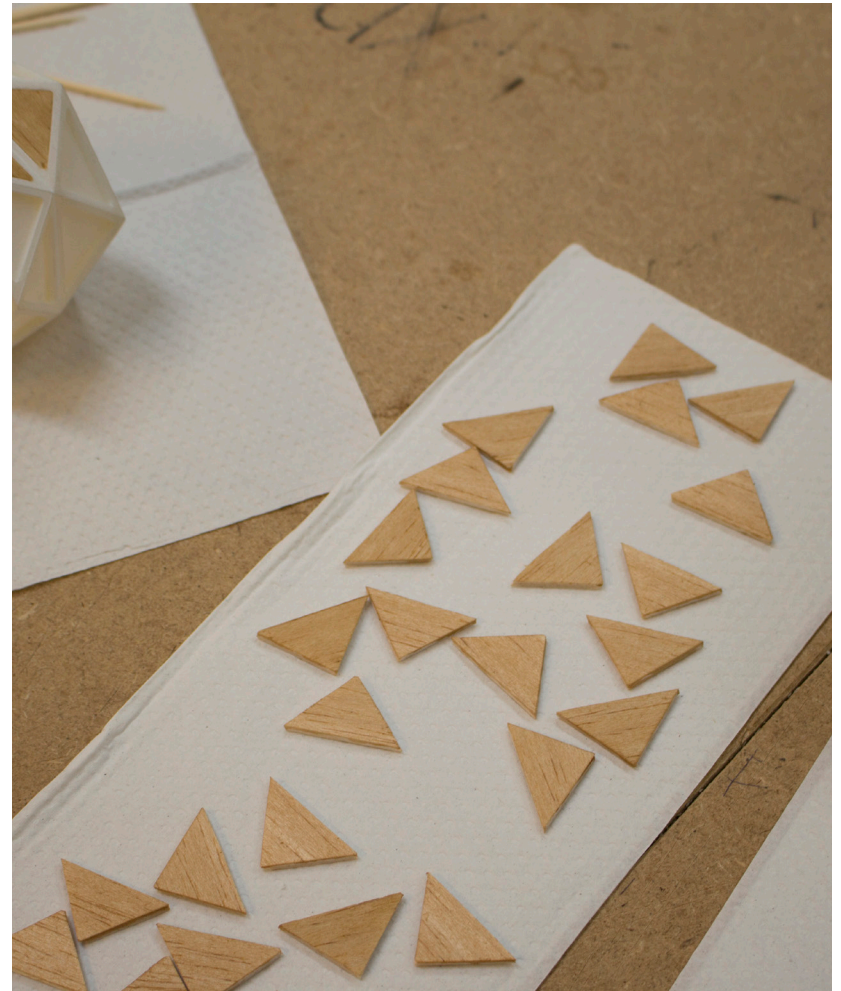


figure 6.14: cutting balsa wood to size

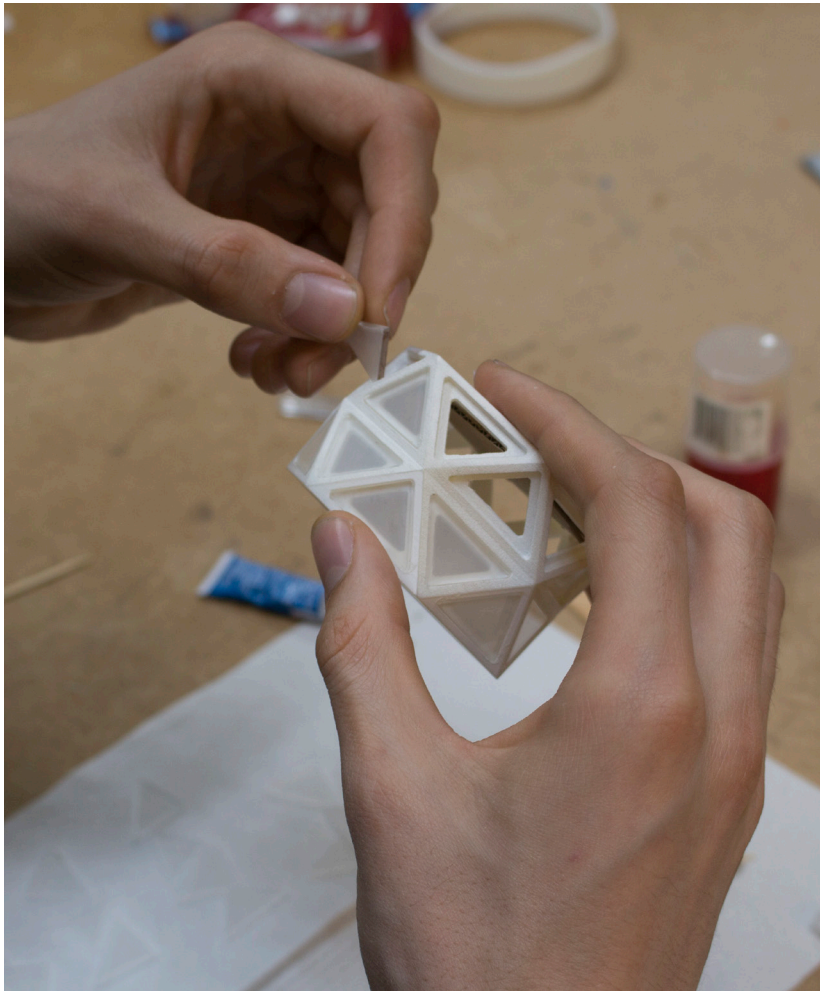


figure 6.15: applying the plexiglass triangles to the token



figure 6.16: using caustic soda to remove Objet support

Appendix G2: Software program

[code]

```
#include <Lithne.h>
#include <Adafruit_NeoPixel.h>
#ifdef __AVR__
#include <avr/power.h>
#endif
#define NeoPIN D6
#define inPin D0
#define buttonPin D15
int lampID = 9; //Choose to which lamp you want to connect
long lastSend = 0;
long lastSend2 = 0;
long lastSend3 = 0;
int brightness = 0;
int pixel = 0;
int fadeAmount = 15; // how many points to fade the LED by
int pixelAmount = 1;
unsigned long currentTime;
```

```
unsigned long loopTime;
const int pin_A = D4; // pin 4
const int pin_B = D2; // pin 2
unsigned char encoder_A;
unsigned char encoder_B;
unsigned char encoder_A_prev=0;
int state = LOW;
int reading;
int previous = HIGH;
long time = 0;
long tiltTime = 0;
long debounce = 20;
long tiltDebounce = 0;
int activity = 0;
int activityMode = 0;
int previousActivity = 0;
unsigned long previousMillis = 0;
unsigned long currentMillis;
unsigned long timerCount = 0;
unsigned long timerCount2 = 0;
unsigned long previousButton = 0;
```

```

unsigned long previousPulse = 0;
int interval = 5000;
int countDown = 10000;
int notifier = 0;
int previousNotifier = 0;
int pixelNotifier = 0;
long millis_held;    // How long the button was held
(millisecons)
long secs_held;    // How long the button was held (seconds)
long prev_secs_held; // How long the button was held in the
previous check
byte previous2 = HIGH;
unsigned long firstTime; // how long since the button was first
pressed
Adafruit_NeoPixel strip = Adafruit_NeoPixel(19, NeoPIN,
NEO_GRB + NEO_KHZ800);

void setup()
{
    // Begin the Lithne communication; if you use a Lithne board,
the XBee is connected on Serial1, in other cases use Serial

```

```

Lithne.begin(115200, Serial1);
// Now you may add nodes that are in your network to a list;
specify any chosen ID and the XBeeAddress
// The ID may be any unique number from 1 to 254 that
you like. 0 is reserved for the COORDINATOR and 255 for
BROADCAST
Lithne.addNode(COORDINATOR,
XBeeAddress64(0x00000000, 0x00000000));
//Lithne.addNode(BROADCAST
,
XBeeAddress64(0x00000000, 0x0000FFFF));
//Lithne.addNode(1, XBeeAddress64(0x0013a200,
0x4079ce40)); // Add as many nodes as you like
pinMode(pin_A, INPUT);
pinMode(pin_B, INPUT);
currentTime = millis();
loopTime = currentTime;
Serial.begin(9600);
pinMode(buttonPin, INPUT_PULLUP);
pinMode(inPin, INPUT_PULLUP);
strip.begin();
state = LOW;

```

```

    Serial.println("Lithne Setup Complete");
}
void loop() {
    reading = digitalRead(inPin); //reads the tilt-switch
    if (millis()- tiltTime > tiltDebounce){ //debounce the tilt-
switch reading to account for unstable readings
        state = reading;
        tiltTime = millis();
    }
    // Serial.print("Tilt state:");
    // Serial.println(reading);
    if (state == LOW) { // If the token is upside-up change
the ceiling lights and choose activity.
        ButtonScroll(); // regulates the timing and display of the
button-presses for activity
        previewOff();
        // Serial.println("LOW");
        pixel = 0; //resets the number of pixels of the timer
        pixelNotifier = 0; //resets the number of notifiers when
absent
        activity = digitalRead(buttonPin); //reads the encoder

```

```

button and writes it to the activity selector
        if (activity == LOW && previous2 == HIGH &&(millis()-
firstTime) > 200){
            firstTime = millis();
        }
        millis_held = (millis() - firstTime);
        secs_held = (millis_held / 1000);
        // This if statement is a basic debouncing tool, the button
must be pushed for at least
        // 100 milliseconds in a row for it to be considered as a
push.
        if (millis_held > 100) {
            if (activity == LOW && secs_held > prev_secs_held) {
                }
            // check if the button was released since we last checked
            if (activity == HIGH && previous2 == LOW) {
                if (secs_held >= 1 && secs_held < 3) {
                    startMode();
                    Serial.println("Change lights to orange");
                }
            }
        }
    }
}

```

```

}
previous2 = activity;
prev_secs_held = secs_held;
if (state == LOW && previous == HIGH){ //clears the LED strip
from remaining timer and notifiers
    timedSender();
    timerCount = 0;
    timerCount2 = 0;
    setColorOfStrip(0,0,0);
    previous = state;
}
previous = LOW;
// This block of code regulates the scrolling through activities
with the rotary push button
if(activity != previousActivity && millis() - time > debounce){
    if (activity == HIGH){
        activityMode ++ ;
        timerCount = 600;
        timerCount2 = 0;
        if(activityMode > 5){
            activityMode = 1;

```

```

}
    Serial.print("activity:");
    Serial.println(activityMode);
}
}
previousActivity = activity;
// activity scroll block ends
// This block of code regulates the reading of the rotary
encoder and writes this to the Lithne system to control ceiling
lights
currentTime = millis();
if(currentTime >= (loopTime + 5)){
    // 5ms since last check of encoder = 200Hz
    encoder_A = digitalRead(pin_A); // Read encoder pins
    encoder_B = digitalRead(pin_B);
    if(!encoder_A && (encoder_A_prev)){
        // A has gone from high to low
        if(encoder_B) {
            Serial.print("brightness:");
            Serial.print(brightness);
            Serial.println("clockwise");

```

```

    // B is high so clockwise
    // increase the brightness, dont go over 255
    if(brightness + fadeAmount <= 255) brightness +=
fadeAmount;
    timerCount2 = 500;
    timerCount = 0;
}
else {
    Serial.print("brightness:");
    Serial.print(brightness);
    Serial.println("counter clockwise");
    // B is low so counter-clockwise
    // decrease the brightness, dont go below 0
    if(brightness - fadeAmount >= 0) brightness -=
fadeAmount;
    timerCount2 = 500;
    timerCount = 0;
}
    timedSender(); //this is an external function found at the
bottom of the code
    setColorOfStrip(brightness,brightness,brightness);

```

```

}
    encoder_A_prev = encoder_A; // Store value of A for
next time
    loopTime = currentTime; // Updates loopTime
}
}
//END of ceiling lights
else if(state == HIGH) { // If the token is upside-
down change the timer and notify during absence.
    // Serial.println("HIGH");
    if (state == HIGH && previous == LOW){ // Resets the LED
strip from any lights of the previous state
        setColorOfStrip(0,0,0);
        previous = state;
    }
    previous = HIGH;
    notifier = digitalRead(buttonPin); //read the button pin and
write it to the notifier function
    // This block regulates how to use the rotary encoder as
setting a timer
    currentTime = millis();

```

```

if(currentTime >= (loopTime + 5)){
  // 5ms since last check of encoder = 200Hz
  encoder_A = digitalRead(pin_A); // Read encoder pins
  encoder_B = digitalRead(pin_B);
  if(!encoder_A && (encoder_A_prev)){
    // A has gone from high to low
    blackOut();
    if(encoder_B && activityMode == 1) {
      strip.setPixelColor(pixel, 100,0,0);
      strip.show();
      Serial.print("pixel:");
      Serial.print(pixel);
      Serial.println("clockwise");
      // B is high so clockwise
      // increase the brightness, dont go over 255
      if(pixel + pixelAmount <= 19) pixel += pixelAmount;
    }
    else if(encoder_B && activityMode == 2) {
      strip.setPixelColor(pixel, 0,100,0);
      strip.show();
      Serial.print("pixel:");

```

```

Serial.print(pixel);
Serial.println("clockwise");
// B is high so clockwise
// increase the brightness, dont go over 255
if(pixel + pixelAmount <= 19) pixel += pixelAmount;
}
else if(encoder_B && activityMode == 3) {
  strip.setPixelColor(pixel, 0,0,100);
  strip.show();
  Serial.print("pixel:");
  Serial.print(pixel);
  Serial.println("clockwise");

  // B is high so clockwise
  // increase the brightness, dont go over 255
  if(pixel + pixelAmount <= 19) pixel += pixelAmount;
}

else if(encoder_B && activityMode == 4) {
  strip.setPixelColor(pixel,235,226,0);
  strip.show();

```

```

Serial.print("pixel:");
Serial.print(pixel);
Serial.println("clockwise");

// B is high so clockwise
// increase the brightness, dont go over 255
if(pixel + pixelAmount <= 19) pixel += pixelAmount;
}

    else if(encoder_B && activityMode == 5) {
strip.setPixelColor(pixel, 100,0,100);
strip.show();
Serial.print("pixel:");
Serial.print(pixel);
Serial.println("clockwise");

// B is high so clockwise
// increase the brightness, dont go over 255
if(pixel + pixelAmount <= 19) pixel += pixelAmount;
}
else {

```

```

strip.setPixelColor(pixel, 0,0,0);
strip.show();
Serial.print("pixel:");
Serial.print(pixel);
Serial.println("counter clockwise");
// B is low so counter-clockwise
// decrease the brightness, dont go below 0
if(pixel - pixelAmount >= 0) pixel -= pixelAmount;
}
}

encoder_A_prev = encoder_A;    // Store value of A for
next time

loopTime = currentTime; // Updates loopTime
}
// Timer ends

//This block makes sure the amount of pixels set in the
timer function will decrease with a set time.

//It also makes sure notifiers are not erased in the countdown
unsigned long currentMillis = millis();

if ((unsigned long)(currentMillis - previousMillis) >=
countDown && activityMode == 1 && pixel >= 0 ){

```



```

Serial.println((currentMillis - previousMillis));
pixel -= pixelAmount;
Serial.print("Pixel:");
Serial.println(pixel);
strip.setPixelColor((pixel+pixelNotifier+1), 0,0,0);
strip.show();
previousMillis = currentMillis;
}
else if ((unsigned long)(currentMillis - previousMillis) >=
countDown && activityMode == 2 && pixel >= 0){
Serial.println((currentMillis - previousMillis));
pixel -= pixelAmount;
Serial.print("Pixel:");
Serial.println(pixel);
strip.setPixelColor((pixel+pixelNotifier+1), 0,0,0);
strip.show();
previousMillis = currentMillis;
}
else if ((unsigned long)(currentMillis - previousMillis) >=
countDown && activityMode == 3 && pixel >= 0){
Serial.println((currentMillis - previousMillis));

```

```

pixel -= pixelAmount;
Serial.print("Pixel:");
Serial.println(pixel);
strip.setPixelColor((pixel+pixelNotifier+1), 0,0,0);
strip.show();
previousMillis = currentMillis;
}
else if ((unsigned long)(currentMillis - previousMillis) >=
countDown && activityMode == 4 && pixel >= 0){
Serial.println((currentMillis - previousMillis));
pixel -= pixelAmount;
Serial.print("Pixel:");
Serial.println(pixel);
strip.setPixelColor((pixel+pixelNotifier+1), 0,0,0);
strip.show();
previousMillis = currentMillis;
}
else if ((unsigned long)(currentMillis - previousMillis) >=
countDown && activityMode == 5 && pixel >= 0){
Serial.println((currentMillis - previousMillis));
pixel -= pixelAmount;

```

```

Serial.print("Pixel:");
Serial.println(pixel);
strip.setPixelColor((pixel+pixelNotifier+1), 0,0,0);
strip.show();
previousMillis = currentMillis;
}
if(notifier != previousNotifier && millis() - time > debounce){
  if (notifier == HIGH){
    pixelNotifier ++ ;
    Serial.println("Notifier:");
    Serial.println(pixelNotifier);
  }
  if (pixelNotifier > 19){
    pixelNotifier = 0;
  }
  strip.setPixelColor((pixelNotifier - 1), 100, 100, 100);
  strip.show();
  previousNotifier = notifier;
  time = millis();
}
}

```

```

}
void timedSender() { //Regulates the brightness of the ceiling
lights
  if( millis() - lastSend > 1000 )
  {
    // set the brightness of the ceiling light:
    lastSend = millis();
    Lithne.setFunction("Tobi"); // Always set a function name
for a message
    Lithne.setRecipient( COORDINATOR ); // Determine the
recipient of the message; in this case send to the network
coordinator
    Lithne.addArgument(5000); // color temp in kelvin
    Lithne.addArgument(brightness); //brightness 0-255
    Serial.print("Send this brightness to Lithne");
    Serial.println(brightness);
    Lithne.addArgument(lampID); //lamp ID
    //Lithne.addArgument(16);
    //Lithne.addArgument(20);
    //Lithne.addArgument(21);
    Lithne.send(); // Now we really send the message

```

```

}
}
void blackOut() { //Regulates that the ceiling lights go out
  if( millis() - lastSend2 > 5000 )
  {
    // set the brightness of the ceiling light:
    lastSend2 = millis();
    Lithne.setFunction("Tobi"); // Always set a function name
    for a message
    Lithne.setRecipient( COORDINATOR ); // Determine the
    recipient of the message; in this case send to the network
    coordinator
    Lithne.addArgument(5000); // color temp in kelvin
    Lithne.addArgument(0); //brightness 0-255
    Serial.println("Turn off the lights");
    Lithne.addArgument(lampID); //lamp ID
    //Lithne.addArgument(16);
    //Lithne.addArgument(20);
    //Lithne.addArgument(21);
    Lithne.send(); // Now we really send the message
  }
}

```

```

}
void startMode(){
  if( millis() - lastSend3 > 1000 )
  {
    // set the brightness of the ceiling light:
    lastSend3 = millis();
    Lithne.setFunction("Tobi"); // Always set a function name
    for a message
    Lithne.setRecipient( COORDINATOR ); // Determine the
    recipient of the message; in this case send to the network
    coordinator
    Lithne.addArgument(2000); // color temp in kelvin
    Lithne.addArgument(160); //brightness 0-255
    Serial.println("Start Mode");
    Lithne.addArgument(lampID); //lamp ID
    //Lithne.addArgument(16);
    //Lithne.addArgument(20);
    //Lithne.addArgument(21);
    Lithne.send(); // Now we really send the message
  }
}
}

```

void setColorOfStrip(int r, int g, int b){ //makes coding the LED strip easier.

```
  for(int i = 0; i < 19; i++){
    strip.setPixelColor(i, r,g,b);
  }
  strip.show();
}
```

void ButtonScroll(){

```
  if (activityMode == 1 && timerCount != 0){
    setColorOfStrip(100,0,0);
    timerCount = timerCount - 1;
    timerCount2 = 0;
    Serial.println(timerCount);
  }
  if (activityMode == 2 && timerCount != 0){
    setColorOfStrip(0,100,0);
    timerCount = timerCount - 1;
    timerCount2 = 0;
    Serial.println(timerCount);
  }
  if (activityMode == 3 && timerCount !=0){
```

```
    setColorOfStrip(0,0,100);
```

```
    timerCount = timerCount - 1;
```

```
    timerCount2 = 0;
```

```
    Serial.println(timerCount);
```

```
  }
```

```
  if (activityMode == 4 && timerCount !=0){
```

```
    setColorOfStrip(235,226,0);
```

```
    timerCount = timerCount - 1;
```

```
    timerCount2 = 0;
```

```
    Serial.println(timerCount);
```

```
  }
```

```
  if (activityMode == 5 && timerCount !=0){
```

```
    setColorOfStrip(100,0,100);
```

```
    timerCount = timerCount - 1;
```

```
    timerCount2 = 0;
```

```
    Serial.println(timerCount);
```

```
  }
```

```
  if (timerCount <= 1 && timerCount2 <=1 ){
```

```
    setColorOfStrip(0,0,0);
```

```
  }
```

```
}
```

```
void previewOff(){
  if (timerCount2 != 0){
    timerCount = 0;
    setColorOfStrip(brightness,brightness,brightness);
    timerCount2 = timerCount2 -1;
    Serial.println(timerCount2);
  }
  // if (timerCount != 0 && timerCount2 != 0){
  //   timerCount = 0;
  //   setColorOfStrip(brightness,brightness,brightness);
  //   timerCount2 = timerCount2 -1;
  // }
  if (timerCount <=1 && timerCount2 <= 1){
    setColorOfStrip(0,0,0);
  }
}
[/code]
```