CHALMERS

Office Furniture Design to Improve Collaboration

The development of a space efficient workstation to enhance flexibility

Master of Science Thesis in the Master Degree Program, Industrial Design Engineering

CECILIA EDLUND

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CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenborg, Sweden 2014

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Cover photo: Cecilia Edlund & Elin Fouganthine
Print: Repro Service Chalmers

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ACKNOWLEDGEMENTS

During this project, there have been many people who have been of extra help, and to whom we therefore would like to show our gratitude.

First of all, we would like to thank all the participants of our studies, for providing the input that created the foundation of our project.

We would like to thank Caroline Adams, for all the help with the linguistics and for keeping track of our arguments.

Thanks to our opponents, for putting our knowledge to the test and providing wise feedback for the report.

A special thanks goes to the project initiators, Catino, for the motivating encouragement and the valuable insights about the real life as consultants.

Last but not least, thanks to our supervisor and examiner, Lars-Ola Bligård, for all the support and for being our biggest fan during the whole project. But also for his courage to challenge us to make it even better.

Best regards, Cecilia & Elin.

ABSTRACT

The design of office environments is known to be an important factor when it comes to the well-being of employees, and thus also their performance. It is important to have an office environment with a workspace design providing products that aid the employees in their work. Inergo is a furniture company providing such products, mainly focusing on the ergonomic aspects of office furniture, and has long been one of Scandinavia's leading manufacturers of height adjustable tables. Currently, Inergo has expressed a desire for a new product that is innovative within the market and can be launched quickly.

For this reason, a project was conducted in collaboration with the consultancy agency Catino, having Inergo as intended customer. The goal was to step in as catalyst for innovation and help Inergo by providing a concept for a new product to fit their current product range. The purpose of this thesis is to design and develop a space efficient flexible product solution for the open plan office environment in order to enhance collaboration possibilities. Hence, this master thesis report describes the development of a product for the office environment.

The project process initially includes user studies, stakeholder analysis and problem definition to identify the problem to be solved. Thereafter, the process continues with concept creation, development and evaluation to finally end with construction and visualisation of the final concept.

The project resulted in the concept of a flexible product for the open plan office environment, providing both vertical and horizontal workspace that is easy to use and possible to instantly adapt to your needs. It is a concept that saves valuable space within the office environment due to its two separate surfaces and possibility to use these in vertical and horizontal position. Considering the fact that this product could also be used for shielding, it therefore provides the user with five possible field of application within one solution. It is also a product that provides an ergonomic adaptation to physical measurements through incorporating a height adjustable function. This product brings the positive aspects of activity-based environment into the open plan offices by improving collaboration and enable a more interactive and social work environment.

SAMMANFATTNING

Utformning av kontorsmiljöer är känt för att vara en viktig faktor när det gäller välmående av anställda och därmed också deras prestationsförmåga. Det är viktigt att ha en kontorsmiljö med arbetsytor och produkter som hjälper de anställda i deras arbete. Inergo är ett möbelföretag som tillhandahåller sådana produkter, främst med fokus på de ergonomiska aspekterna av kontorsmöbler, och har länge varit en av Skandinaviens ledande tillverkare av höj- och sänkbara bord. För närvarande har Inergo uttryckt en önskan om en ny produkt som är innovativ på marknaden och kan lanseras snabbt.

För dessa anledningar har detta projekt inletts, som är ett samarbete med konsultbyrån Catino, där Inergo är den avsedda kunden. Målet var att gå in som katalysator för innovation och hjälpa Inergo genom att erbjuda ett koncept för en ny produkt som är anpassad efter deras nuvarande sortiment. Syftet med detta examensarbete är att utforma och utveckla en utrymmeseffektiv och flexibel produktlösning för öppna kontorsmiljöer och öka samarbetsmöjligheterna. Denna rapport beskriver därför ett produktutvecklingsprojekt för kontorsmiljö.

Projektprocessen innehåller inledningsvis användarstudier, intressentanalys och problemformulering för att identifiera det huvudsakliga problem som ska lösas. Därefter fortsätter arbetet med konceptskapande, utveckling, utvärdering och avslutas med konstruktion och visualisering av det slutgiltiga konceptet.

Projektet resulterade i ett koncept av en flexibel produktlösning för de öppna kontorslandskapen. Konceptet ger både vertikal och horisontell arbetsyta som är lätt att använda och möjliggör omedelbar anpassning efter användarens behov. Det är ett koncept som sparar värdefullt utrymme i kontorsmiljöer på grund av dess två separata ytor samt möjlighet att använda dessa i både vertikalt och horisontellt läge. Med tanke på det faktum att denna produkt även kan användas för avskärmning ger detta användaren fem möjliga användningsområden med en och samma lösning. Det är också en produkt som ger en ergonomisk anpassning till användarnas olika fysiska förutsättningar genom en integrerad höj- och sänkbar funktion. Produkten kombinerar de positiva aspekterna med en aktivitetsbaserad kontorsmiljö och öppna kontorslandskap genom att förbättra samarbete och möjliggöra en mer interaktiv och social arbetsmiljö.

CONTENTS

INTRODUCTION

This chapter gives an introduction to the subject of office environment, explain the main purpose of this master thesis and link them both together to describe the intended outcome of this product development project.

1.1 INTRODUCTION

Two million people in Sweden work in an office environment and the number is growing rapidly. Most of those people work in open plan offices, which means 10-24 people sit in a room together. This is a cost efficient solution providing the ability of having more employees in a small area. However many people perform their work in a sedentary manner leading to an increased health risk. Sedentary work has been found equal to tobacco smoking, elevated lipoproteins and high blood pressure. Meaning ergonomics and physical activity is important factor to consider when developing products for the office environment.

In todays society there has also become an increased need for team oriented work and more emphasis is placed on space reduction requirements. With this need new trends of office environments have emerged, the flexi-office work environment, which entails an environment with no individual desk stations and more rooms for collaboration and flexibility. This office environment however entails reorganisation of company structures and work process, which can be costly, time consuming and difficult to implement. For these reasons many companies are reluctant to change to a flexible work environment. But the need for space reduction and team oriented working areas remains.

This thesis investigates the possibility of designing a product solution that brings the positive aspect of flexi-office work environment into the open plan offices, while remaining focused on ergonomic requirements and space reduction.

1.2 BACKGROUND

This master thesis presents a project in collaboration with the consultancy agency Catino and the prospective customer Inergo. Inergo is a furniture company providing cost saving, ergonomic quality products for the office environment and has long been one of Scandinavia's leading manufacturers

Figure 1. Logotype of the project initiators Catino.

Figure 2. Logotype of the prospective customer Inergo.

of height adjustable tables. Their main focus is on the personal workspace and adaptations of these through selling products such as chairs, screens, tables and storage units. They have expressed the need to expand their product range with a product that is innovative within the market and can be launched quickly.

Catino is a design agency that steps in as a catalyst to help create innovation. Through utilising user-centred design thinking they help their customers develop new products and services based on the needs of the users, brand values and enforce the business model and technological capabilities of the customers. Throughout this master thesis Catino will work as advisors and support the product development.

1.3 PURPOSE AND GOAL

The purpose of this thesis is to design and develop a space efficient flexible product solution for the open plan office environment in order to enhance collaboration possibilities. To achieve this the target demographic is everyone working in an office environment, placing high demands on usability and ergonomic adaptation. A user centred design approach will be utilised to make

the product intuitive and easy to use while fulfilling the user needs of adaptable design at the office.

The goal of this thesis is to produce a conceptual product design with strong competitive feel and correlation to the business model of Inergo. The product will therefore express a feeling of being stable, calm, confident, adaptable, collaborative, supportive and witty. Furthermore the product should consider environmental aspects as well as manufacturing.

1.4 DELIMITATIONS

Due to the purpose and goal of this project, whilst aspects of material and technical principles will be taken into consideration and discussed, they will not be finalised for manufacturing purposes.

CURRENT KNOWLEDGE

Before the development of the new product starts, current knowledge has to be investigated. Relevant theoretical topics for this project are aspects of ergonomics, knowledge about different office types and office activities, but also previous investigations about office environments and how it affects the target group. Also, theory about methods used will be provided in this section to give a deeper understanding of the procedure.

2.1 THEORY

2.1.1 OFFICE TYPES

There are different ways of classifying office types and throughout this thesis the seven definitions presented in "The Office" (Danielsson, 2005) will be used to differentiate and explain the office environments that may occur.

● fixed space

○ flexible space

The cell-office
This is an individual office space where one person is enclosed in a room together with its office equipment. High level of concentration and independent work often occur in this type of environment.

The shared-room office
These types of offices contains 2-3 people in one room and can be due to two scenarios; due to lack of space in the office or due to team based work assignment. In both scenarios the office equipment is usually outside the shared-room office space.

Open plan offices are defined by employees sharing a common work area. There are no walls separating the employees from each other, however there are usually screens to minimize acoustics or visibility around the individual workstation. There are three different definitions of the open plan offices and these are defined by the number of people that occupy the space.
The small open plan office consists of 4-9 people in the same room.
The medium open plan office consists of 10-24 people in the same room.
The large open plan office consists of more than 24 people in the same room.

The flex-office
In this office environment there are no individual workstations and the layout is most often an open plan. The assumption for this office environment is that most of the work is carried out outside the office and the layout and the employees therefore depend on the flexibility of the workspace.

The combi-office
There are no spatial restrictions for this type of office environment, it is rather defined by its diversity and flexibility of workspaces. The employees do have their own workplace however it offers a wide range of rooms for concentration, meeting, teamwork and common facilities to promote independent work and teamwork.

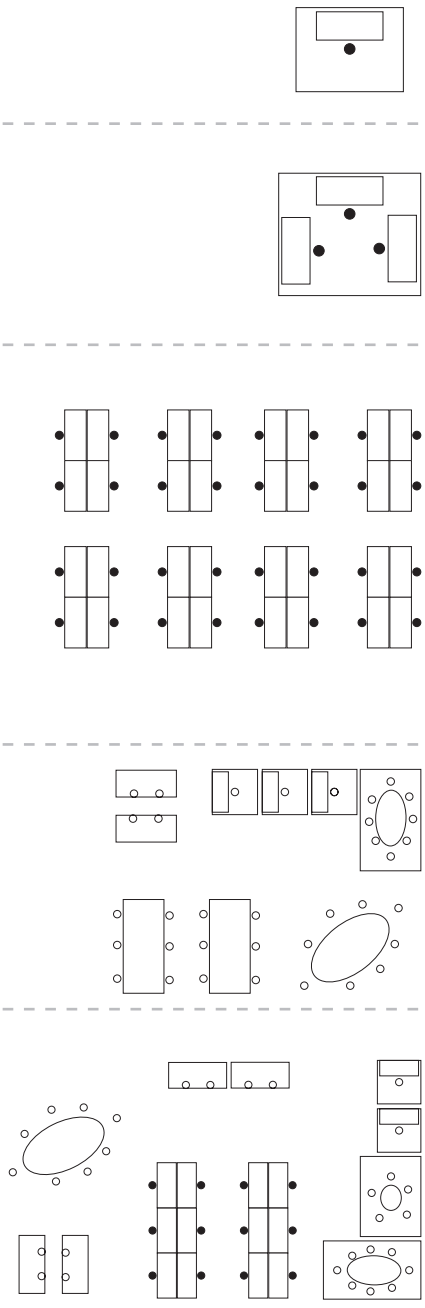


Figure 3. Illustration of the different office types.

2.1.2 OFFICE ACTIVITIES

Activities in the sense of office environment are defined as peoples work patterns and how they interact with each other (Raymond & Cuncliff 1997). Therefor the understanding of what types of activities exist at the office becomes a central role for developing products to aid collaboration. There are two main differentiations in activities at the office, the solo activities and the group activities (Raymond & Cuncliff 1997). The solo or individual work activities involve the personal work that may be performed at the own desk station or common areas, however very little or none interaction with others occur. Group activities include the gathering of participants for a common purpose and may be performed in many different arrangements. The group activities that are of importance for this thesis are:

Mentoring/ counselling
The exchange of information to receive guidance towards a specific task. Usually involves interaction between 2-3 people (Raymond & Cuncliff, 1997).

Teamwork
The cooperative effort of a small or large group of people working towards a common goal (Boundless, 2014). The teamwork related task might be performed in different locations and orientations depending on the organisation and the topic, such as gathering in a room, around a large table or performing activities online

Informal meeting
A short unplanned meeting between two or several participants with no specific task oriented purpose. Usually serve a social need and is performed in a neutral environment (Armstron & Francis, 2012).

Ad-hoc meeting
An informal meeting with a group of participants where a specific topic is to be discussed (Exforsys, 2009).

Status meeting
The formal meeting with a predefined leader performed in a predefined area (Exforsys, 2009).

2.1.3 OFFICE ENVIRONMENT

Two million people work in offices in Sweden. The most common office type is the medium open plan office (Karlén, 2014). The main reason for this being the dominant choice is primarily economic. This workspace namely allows a greater number of employees, which leads to a higher density of workers (Davis et. al., 2011). Cost savings can also be assumed as a result of the flexibility that the open plan office provide. These offices support inter- and intra- team communication since it allows the co-workers to easily share information, promote feedback and create friendship opportunities. This helps reduce conflicts, improve inter-personal relations and therefore also increase the employee's job satisfaction and motivation (Davis et.al., 2011). Enhanced collaboration is consequently seen as one of the major benefits from open plan offices.

However, it is assumed to be a considerable risk that the character of open plan office environment affects the employees negatively. As many as 2/3 of people working in offices in Sweden experience that the office is "stealing energy" due to concentration difficulties and stress (Karlén, 2014). Studies show that there is a risk for negative effects on the cognitive processes and task performance that possibly could also lead to stress (Davis et. al., 2011). Hence there is a greater risk for cognitive overload or over-stimulation when working in an open plan office. This is a result of the relatively high frequency of being interrupted by colleagues, which from one point of view supports collaboration, but from another point of view cause losses of productive time. Another risk with open plan offices is the possible lack of psychological privacy (Davis et. al., 2011). Davis et. al. (2011) describes psychological privacy to concern the amount of control that individuals perceive they have over regulating their social contact with others, also the degree to which they feel visually and acoustically exposed. In relation to this, noise is often considered a major issue and cause of dissatisfaction. When employees are asked to mention aspects that they would prefer to control, noise is the preferred aspect (Davis et. al., 2011). It is proven that people perform worse at a generally high level of noise (Karlén, 2014). Primarily when the sound comes from people talking. Not only should the level

of the sound be considered, but also the speech transmission index (STI). The worst level of STI according to these studies (Karlén, 2014), thus the level when performance is at its worst, is when it reaches STI=32. At that level it is possible to distinguish words spoken, and the brain therefore has a difficulty in ignoring the sound. The result of this is concentration loss, the working memory loses 10% of its capacity, and you underachieve. One reason for this being a big issue is assumed to be due to lack of specific guidelines when it comes to chatter (Karlén, 2014). The Swedish work environment authority (Arbetsmiljöverket, 2014) provides guidelines (AFS 2009:2) for sound levels from ventilations etc., but does not address the STI level.

Despite the disadvantages of an open-plan office, many companies prefer the advantages that this office environment provides, claiming that improving collaboration results in more innovative organisational results (Stegmeier, 2008). Stegmeier (2008) present results showing that, by improving collaboration at the company, the organization can increase both the quantity of innovative output and significantly improve the quality of innovation. This proved that collaboration increase the employee engagement, which requires a physical environment that enables co-workers to define their workspaces for the task at hand, along with a culture that encourages individuals' own initiative (Stegmeier, 2008). If this is achieved, it is assumed to result in improved productivity, driving innovation from collaboration to result in a better outcome.

For this purpose, when considering office furniture design, products offering multiple functions are often desired (Borràs, 2006). Enabling transformation of workplaces and making them more flexible to support efficiency. Although research has shown that it is not enough to provide an ideal office design if the physical workspace is not used as intended (Stegmeier, 2008). When it comes to supporting innovation there are different requirements for the physical work environment. It is therefore important to consider the human behaviour and knowledge about the user when dealing with workplace design.

2.1.4 ERGONOMICS

"Ergonomics (or Human Factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory principles, data and methods to design in order to optimise human well-being and overall system performance." (IEA, 2014). To achieve an ergonomic design there is a need for cross-disciplinary study. Aspects that may be taken into consider are psychology, sociology, physiology, economics, etc. Together these create an environment that optimises the well-being of human beings. Within this project the well-being and needs of humans will be focused on work environment ergonomics. This will be achieved through the consideration of physical, cognitive and some organisational aspects.

Physical ergonomics

Physical ergonomics is a branch within ergonomics that deal with human physical activities (IEA, 2014). It is used to adapt design and technology to the physical needs and capabilities of the human body. When designing a workplace it is important to investigate who will be using it. People working at an office may have different abilities, and it is therefore important to look at and create an inclusive environment that may be adaptable to the needs of everyone. The use of anthropometric measurements is a way to ensure that the products are adapted to humans and not the other way around. (Bohgard et. al., 2008) When considering the physical ergonomics within the workplace, there are various characteristics to consider:

Anthropometrics
The collection of data about the human body and its measurement pertaining to size, shape, strength and work abilities. Anthropometrics can be divided into dynamic and static measurements (Bohgard et. al., 2008)

Dynamic measurements
A description of human measurements in different dynamic body position, such as reach and grip range.

Static measurements
A description of human measurements in different static body positions, such as standing upright with the arms beside the body.

Percentile
A segment of body measurements that deals with a large or small range of the human population. Most commonly described using the 5th, 50th and 95th percentile. The 95th percentile are those who are larger than 95% of the population, 5th are those who are smaller than 95% of the population and the 50th is the median of the human population (Antropometri 2011).

Design for all
An expression used to target a wide variety of users. When designing for all, the 5th and 95th percentile of the human population should be taken into consideration (Bohgard et. al., 2008), placing high demands of adaptation on the product design.

Sedentary work has become an increased health hazard and is now considered equal to tobacco smoking, elevated lipoproteins and high blood pressure (AFS 2009:2). This finding has increased the understanding and the importance of creating an ergonomic work environment. But it has also increased the understanding that an ergonomic adaptation of physical products is not enough. If sedentary work is performed ergonomically correct it is still sedentary and may cause health issues. Therefore a flexible work environment where a change of position is performed regularly is considered the best option. Ergonomists often say, "The next position is the best position". These words are of value when considering what contributes to a better ergonomic situation. Offices should according to AFS 2009:2 be constructed to stimulate some physical activity. The employer also has a responsibility to uphold an ergonomically correct work environment (Arbetsmiljöverket 2014).

Cognitive ergonomics

Cognitive ergonomics concerns the mental ability to process information through the use of human senses, and translating the information received to make decisions and act accordingly (Bohgard et. al., 2008). Perception, motor responses, memory and reasoning are used to process this information and decisions are made based on this series of factors (IEA, 2014). There are two main processes to describe information input, bottom-up processing and top-down processing (Bohgard et. al., 2008). Bottom-up processing is primarily dependent on information received from the sensory system and the quality of this information. It is an unconscious process that deals with colour, shape and size of objects. Top-down processing perceives information through experience, knowledge and desires. It is a conscious process that can fill a void when information from sensory information is incomplete. Cognitive ergonomics is also used to describe the interaction between human-machine systems and how well these two interact. The goal with human-machine systems is to develop a system that provides a functioning interaction and cooperation between the two (Bohgard et. al., 2008). When designing a system to fulfil these goals it is important to highlight efficiency, safety and usability.

Safety
Accidents can occur everywhere and in different formats. In order to limit the potential for accidents when using a product it is important to understand why they occur (Bohgard et. al., 2008). Human errors are part of the risk for accidents and designing products so that errors are not possible or that the consequences of them are limited is therefore important.

Usability
For a human-machine system to function properly, the products need to be user-friendly (Bohgard et. al., 2008). Usability is a term to describe the user-friendliness and is defined as "... the effectiveness, efficiency and satisfaction with which specified users can achieve specified goals in particular environments" (ISO DIS 9241-11). Effectiveness is the completion or incompletion of a task or goal. Efficiency refers to the effort required to complete a goal, whereas satisfaction is the level of comfort the user feels when performing the goal (Jordan,

2004). The terms efficiency and effectiveness are correlative terms, the less effort required in a task the higher the efficiency becomes in completing the goal. Efficiency can be measured through the amount of errors the user makes.

Organisational ergonomics

The interaction in-between individuals and the work environment, its organization and the psychosocial aspects are part of organisational ergonomics (IEA 2014). This branch of ergonomics is important to maintain high quality work, productivity and well-being at the office (Bohgard et. al., 2008). The psychosocial aspect of organisational ergonomics concern the interaction between components within the work environments and how these can be developed to enhance social well-being amongst the employees. One important aspect of this is to be independent and have control over your situation (Bohgard et. al., 2008).

2.2 METHOD

2.2.1 INTERVIEWS

When collecting data from a wide range of situations, interviews are a basic method for gathering information around people's thoughts, knowledge and experience (Bohgard et.al., 2008). It provides subjective data in either a qualitative or quantitative manner depending on the interview structure. There are the unstructured, semi-structured and structured interview techniques. Unstructured interviews provide a qualitative result, structured provide quantitative results and the semi-structured provide something in-between the two. Before any of the interviews begin it is important to describe the purpose, in what manner the interview will be documented and how the result will be used to give the interviewee an understanding to the interviewers purpose. To get the interview started, short and precise questions pertaining to factual information are desirable. The unstructured interviews are used when the topic of questioning is wide and the knowledge surrounding the topic is low. It provides the interviewer with the possibility to steer the interviewee in a desired direction with open answers. The semi-structured and structured interview technique has predefined topics of questioning, and the interviewee has good knowledge of the topic. When using the semi-structured technique the interviewee has the possibility to follow up on the answers given by the interviewee and decide the order of questions during the interview. Providing the possibility to have both open and predefined questions, whereas the structured technique follows a strict structure with either open answers or predefined scales for the interviewee to answer.

2.2.2 FOCUS GROUP

A focus group is a group discussion or interview often used instead of large market analysis involving many customers or customer companies (Johannesson et. al., 2004). The focus group is a limited study where 5-15 participants are chosen to represent the user group. The group discusses a predetermined theme, preferably supported by mediating objects such as pictures or products, lead by a moderator that makes sure that the discussion stays relevant (Bohgard et. al., 2008). The nature of a focus group should be free to create an open discussion and aims for the participants to contribute with unexpected ideas or thoughts through associations emanating from each other's viewpoints. That way the group will be reaching views that might have been missed in comparison to an interview with individual users (Johannesson et. al., 2004). The focus group is often recorded for further analysis (Bohgard et. al., 2008).

2.2.3 CONJOINT ANALYSIS

A conjoint analysis is a method for compiling a large amount of data to get an overview of the result. The result from the data collection is noted on small pieces of paper and sorted in groups according to themes. These groups are then assigned a headline, which creates a bottom-up strategy, starting with the details to finally end up as an overview of the result (Bligård, 2011).

2.2.4 BRAND COHERENCY ANALYSIS

To assess the brand coherency of a company, a brand coherency analysis method displayed in Hestad's book Branding and product design (2013)

can be used. The method enables an overview of the brand as a result of a dynamic interplay, and provides a picture of the brand today. Also, it provides hints of what could be achieved with the new product in terms of branding. Using the method, you list aspects regarding promotion, organisation, product and consumer in a table. The purpose is to investigate if the different aspects give a coherent view of the brand, or find the reason for what makes it incoherent.

2.2.5 REQUIREMENT SPECIFICATION

The pre-study is to culminate in a requirement specification, which is a detailed description of the design criteria. This information is to be used both as a base for the product development but also as reference when evaluating the solutions and final result. The requirement specification is supposed to be a living document, thus should be developed and updated during the project as knowledge increases. The purpose of the specification is to concretise the problem, provide a unified view of the project objectives, facilitate management of the development, ensure that account is taken of all stakeholders and also work as support for decision-making.

The requirement specification contains the criterion to be fulfilled by the product. Each criterion is given a number and divided after which areas they address. They can be divided into two categories; functional related criterion (F) and limiting criterion (L). The requirements are also weighted according to importance on a scale from 1-5, where 5 represent the requirements that must be fulfilled. This is to be able to compare future solutions and determine which one is the best later on in the evaluation. (Johannesson et. al., 2004)

2.2.6 EXPRESSION BOARD

When working with visual material there are different types of collages to make, so called boards. There are lifestyle boards, addressing the aspired lifestyle of the users. Expression boards, also referred to as mood boards, visualising the intended expression of the product using adjectives. Finally theme boards, documenting the elements or designs that have attributes conveying the intended expression (Baxter, 1995).

Visual material is useful because images often include information that is reduced when described with labels. Pictures may convey messages that we lack the vocabulary to express. Using them for creating boards is also good for providing inspiration and to explore visual solutions. Also, creating the board is a way of documenting and communicating visual information, and making sure that everyone involved in the product development process has the same view of the visual goal.

When creating a board you need to make an active choice regarding what the board is to be used for. The purpose with an expression board is to document the intended expression of the product. It is normally expressed by adjectives chosen to describe what the product should be. These adjectives can be gathered and documented in an expression association web to be used as complement to the expression board. Creating an expression board starts by gathering material in a spontaneous manner, collecting pictures that catches one's attention. Thereafter, the images are clustered and revised for the next step, which is formatting the layout of a collage. (Hjort af Ornäs, 2013)

2.2.7 PERSONA

To create a representation of the user demographics, information about their characteristics, knowledge and limitations, the persona method is used. It is a fictional representation of the target demographic that can be utilised to get a better understanding of the users (Bohgard et. al., 2008). Usually the persona is a description in text format of a fictional person where pictures and/or mood boards are used to aid the understanding and representation of this fictional person.

2.2.8 SENARIO

A description of an event when the user might encounter a need or come in contact with a product is called a scenario (Bligård, 2011). This method is used to make the event come to life and make a realistic description of what might happen in the user situation. A scenario should describe the event

in detail from start to finish, contain factors that might affect the outcome but most importantly, it should convey the users thoughts and feelings during the event. The scenario is usually described in text format.

2.2.9 IDEA GENERATION

Creativity and innovation is desired when developing new products. Idea creation is the phase where different methods are used to achieve vast variations of ideas to develop these new products (Breiler & Michanek, 2012). Using a diversity of methods is therefore an important part of extracting this variation. The following methods of idea creation are found in the book "Idé agenten" by Breiler & Michanek (2012).

2.2.10 BRAINSTORMING

This is an open idea creation method that utilise open discussion to create new ideas. It can be performed through utilising tools such as drawing and writing combined with time limitations to make the sessions more effective. However the main idea is to focus on an open discussion forum within the participant group.

2.2.11 IDEA SHIFTING

When creating ideas, inspiration is a key feature. This method utilises the possibility to get inspiration from others. This is done by everyone sketching 3-5 ideas pertaining to a specific problem. Then after five minutes, the participants shift paper and start creating new ideas based on the previous owners thoughts. Once there are no more ideas left to create, the method stops and a discussion continues based on the ideas that have been created.

2.2.12 RANDOM WORD ASSOCIATION

This method is usually used during the start-up phase of idea creation to kick-start the thought process. It creates a variety of ideas that has no direct link to the problem at hand and is therefore used to widen the scope. It is based on the associations people have to different words and how a specific word can be used to create ideas. Two or more people can perform this method and it starts by one person saying a random word. The next person in turn says the first word he/she thinks of when hearing the previous word and so on. This continues until a vast variety of words are created, making a list. From the list, words are then randomly selected one by one and used to create ideas around a desired problem.

2.2.13 NEGATIVE IDEA CREATION

This method uses the process of thinking negatively in order to create new ideas. The participants are asked to solve a negatively formulated question. The solutions to the negative question are then translated into positive solutions. This forces the participant to think in new patterns thus creating solutions and/or ideas that have not been thought of before.

2.2.14 THE DREAM TRAVEL

In the dream travel method the participants are asked to imagine a perfect world. In this perfect world all the problems are solved, both physical products and social behaviours. These imaginary worlds are then analysed by asking the question; how come it is perfect? The participants analyse these worlds together, trying to find common denominations that can be implemented in reaching the perfect world for future products. The analysis of the different scenarios may thus find solutions that have not yet been created.

2.2.15 MERLIN

The famous wizard, Merlin, is the inspiration for this method. Merlin can transform objects in any way he prefers, smaller, larger, make one object into the complete opposite, etc. By asking, "What happens if we take our product and transform it into one of Merlin's magical ways?" the participants can change and develop an existing product into something new. This method is mainly used for further development of an already existing product or concepts.

2.2.16 REPERTORY GRID

This method is a technique for investigating the perceived experience of a number of elements (object, pictures etc.) and how they differentiate from each other (Hjort af Ornäs, 2013). The repertory grid is conducted using a form with scales addressing opposites of expression that are interesting for the investigation. The result is then compiled to show the collective perception of each element to be further analysed and compared with each other.

PROCEDURE

The procedure of the project will be dealt with in this chapter, guiding you through the process and explaining the most important activities and decisions that successively resulted in the final outcome. The chapter begins with a description of the process.

3.1 PROCESS

This chapter is initiated with a description of the process that was used during the project and its phases.

The initial phase of the project process is planning. Planning how to conduct the project is especially important when having a time frame. It enables verification that the different parts of the process will be performed in time. In this case, the planning was made after an introductory meeting with both companies involved and an initial visit to the Stockholm Furniture Fair to ensure that everyone had the same view of the project. Furthermore the planning phase was used to identify necessary steps within this project. These steps are; user studies, stakeholder analysis, problem definition, concept creation, concept development, concept evaluation, construction and visualisation. Besides these steps, research and evaluation are two important phases of the process. These phases are included along all steps in an iterative approach, because each step has a need of both finding new information and evaluating current results for further work. Evaluation provides feedback that may question the result and challenge the project participants to define each step further, whereas research provides more knowledge and information to better base the result. Since this is a master thesis project, documentation and finally a master thesis presentation is part of the project process. The documentation is done through the creation of a report.

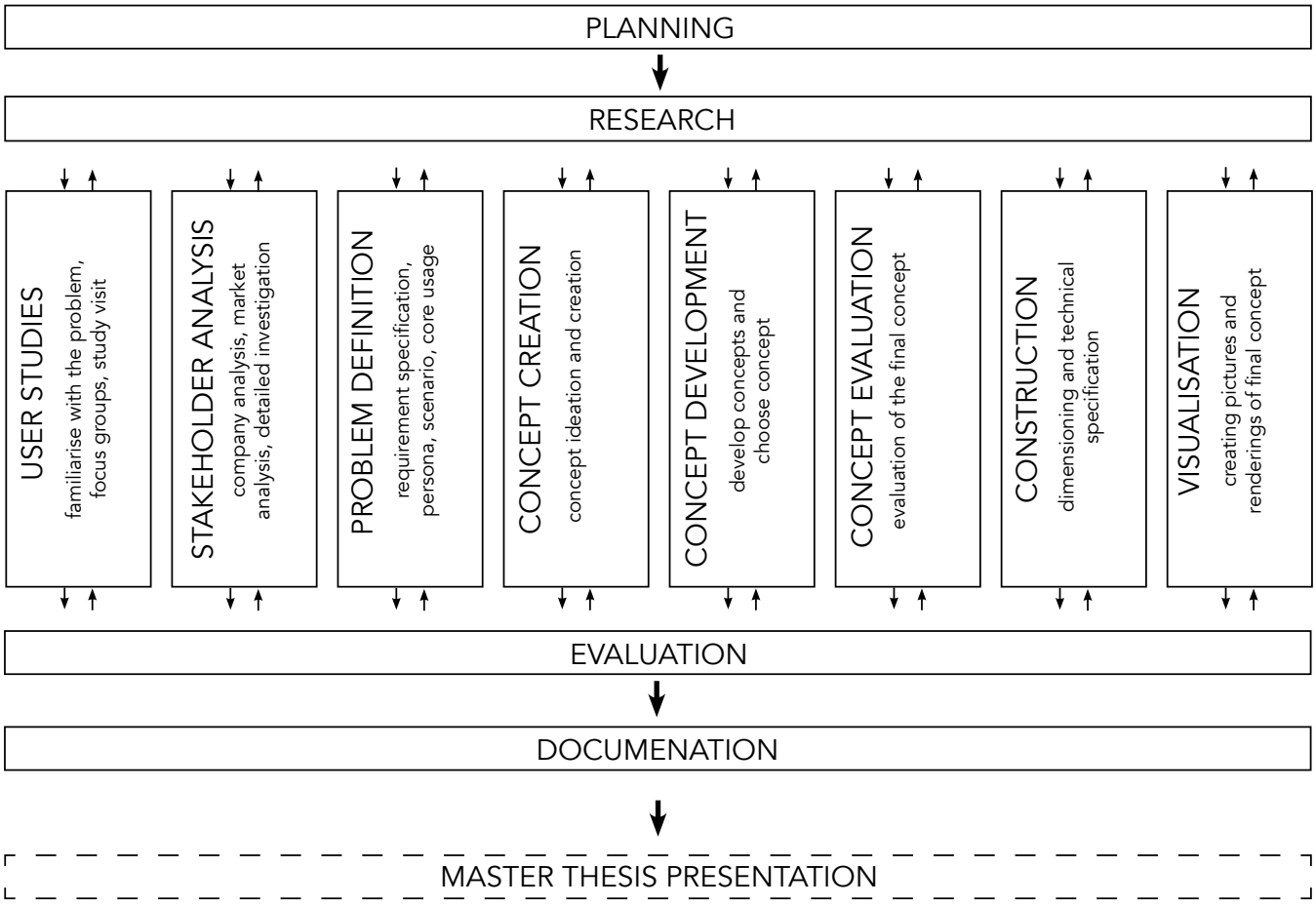


Figure 4. Illustration of the project process, explaining the phases and their respective activities.

3.2 USER STUDIES

3.2.1 PROBLEM FAMILIARISATION

In order to understand and familiarise with office environments, the company Inergo and the problems that can occur at the office, study visits and interviews were conducted.

A visit to the Stockholm Furniture Fair was conducted in order to get an understanding of the current and future products on the market as well as gathering an overview of the up and coming trends. Observations and interviews were utilised to gather this information with the different exhibitors. During the fair, Inergo was also interviewed using semi-structured interview techniques. The focus of the interview was towards the needs of the company and towards finding their core values.

The initial study visit was conducted at Microsoft's office in Stockholm, who in November of 2013 won Sweden's award for most beautiful office (sveriges snyggaste kontor 2013, 2014).Their office entails a flexi-office environment and they pride themselves in having an office space that everyone enjoys. A guided tour was provided to gain an insight into their community.

3.2.2 FOCUS GROUPS

To investigate problems that the users experience in their current office environment, two focus groups were held. This was done with the purpose of finding and prioritising problems that need to be solved, in order to delimit the project to a more narrow range.

The first focus group was held with five people in the age of 22-30. All participants have previous experience from working in office environments, or are currently working in such context. Their profession varied, as well as their workspace design, to create diversity within group enabling an exploration of different ways of working and potential needs. During the focus group, which lasted for one and a half hours, the participants were asked to initially address problems in their office environment followed by requests for change. The implementation was performed in two similar sections accordingly. To start with, the users were involved in a short ideation were they each had a number of small pieces of paper to note their problems. After three minutes they were asked to pass the notes forward to the person beside them to use as trigger for another three-minute session. This procedure was repeated three times. The sections were then each finished by a discussion with the intention for the participants to agree upon the five most prominent problems respectively requests. These five were to be placed on a scale showing the relative rating of the topics.

The second focus group was held through a joined Skype conversation with three people in the age of 23-25. The focus group was held though Skype due to all participants living in different cities and was therefor unable to gather in one location. These participants were all currently working in different office environments with a variety of professions. Due to the nature of the focus group, hence the fact that the conversation was held online, the users were only asked to talk and discuss the topics of problems and requirements for the workspace. The procedure was therefore similar to a semi-structured interview, but it began with an ideation session like in the first focus group. Since there was no possibility to pass the notes on, this was only done in one step. Thereafter, they talked about the prioritisation of the problems relative to each other.

To analyse the results from the focus groups, a conjoint analysis was made. The focus groups were recorded and transcribed, which formed the basis for the analysis. The content was labelled according to who said what (with anonymous codes) and which focus group the person making the comment participated in.

3.2.3 STUDY VISIT

Another study visit was made to a motor vehicle inspection company, Dekra. The reason for choosing Dekra was due to the fact that they were placed second in the competition of Sweden's award for most beautiful office 2013, the same competition that Microsoft won. Since Microsoft and Dekra are such different companies, visiting them both for comparison was assumed to be

very interesting. Also, conducting a second study visit after having a better view of the problem was considered necessary for defining the problem. The study visit involved a short interview with one of the employees followed by a guided tour around the office.

3.3 STAKEHOLDER ANALYSIS

3.3.1 COMPANY ANALYSIS

Stakeholders

To get an overview of the stakeholders that come into contact with the products, a mapping of them was compiled. This is helpful when trying to get information about all different aspects of a possible future product for Inergo considering everyone from the first creator to the end users.

Brand coherency

A part of the scope is to make sure that the concept is suitable for Inergo's current product range and complements it for a desired result. Therefore, a brand coherency analysis was conducted to map the appearance of Inergo and give an accurate view of the company as it is today. The result was gathered in a table showing the brand coherency regarding four topics; organisation, product, promotion and consumer. These topics were investigated first separately and then in comparison to each other.

3.3.2 MARKET ANALYSIS

The market of furniture is a dynamic market, with changing trends and focus areas. The office environment and furniture for the offices are no different. The manufacturers and companies therefore deliver similar products with a slight difference in expressions. In order to understand these differences and what the trends are, an analysis was performed. The major competitors of Inergo are; Kinnarps, Martela, Lanab design, IKEA, Edsbyn and Holmberg partner. They all deliver ergonomic office furniture with slight differences in expression to each other. The compilation of the results was performed in a matrix with the product range on the x-axis and the company name on the y-axis. At the end of each company column a small expression board was compiled to convey the company differences.

Current products

For further market analysis a more specific investigation was performed about current products that aim to solve the same kind of problem this master thesis project addresses. This could be a variety of products, but all with the intention of creating a temporary or flexible workspace for the office. This was done mainly to get a view of what already exists on the market and what possible gaps there are to fill. To document the exploration an inspiration board was made.

3.3.3 DETAILED INVESTIGATION

In order to deepen the perception of the need and its character, additional investigations were made. These involved both the end users and the interior designers with the intention to cover aspects from a larger amount of possible stakeholders. Also this was done to confirm already existing findings and verify their importance.

Interviews

The interior designers are assumed to have a somewhat different view of the problem in comparison to the end users. They are the ones who decide what will be available in the stores, or what products to recommend for the companies whose offices they are furnishing. Therefore, asking them about their way of dealing with the problems and needs are important when fully understanding the big picture and why the current office environments look the way they do. For this purpose, interviews were held with individuals from this profession. Three semi-structured interviews were held with interior designers from three different companies. This was suitable due to the assumption that each interior designer gets in contact with many different offices and that this would be enough to cover a variety of aspects about office environments. The desired aspect of the result was depth and not quantity.

Survey

The end users are an important part of product development and product design. Without knowing or investigating the needs and problems that end users encounter, the probability of creating usable products will reduce. The end user is therefore a vital part of this project and to get their opinion regarding office environments, a survey was created. It was done to get quantitative responses with qualitative answers, and to receive this result short consist questions were created (Bohgard et. al., 2008). The survey (appendix 1) was created in Google Drive's own online survey software and contained 9 questions with different answering options. The questions were created to address issues regarding space at the office. A preliminary assessment of the survey was performed on four people to find questions that can be misinterpreted or otherwise needed reformulation. After the preliminary assessment and adjustments of three questions, the survey was distributed online. To reduce the amount of unreliable answers, the users were encouraged to only take the survey if they are currently working in an office environment. The result from the survey was analysed using both statistical methods and analytical knowledge of the written responses.

3.4 PROBLEM DEFINITION

Understanding and defining the problem that users face at the open office environment is an important step before moving into the concept creation phase. The gathered data and analysis was used together with methods such as a requirement specification, persona, user scenario, expression board and expression association web to define this problem as well as the core usage.

3.4.1 REQUIREMENT SPECIFICATION

One step of defining the problem is to make a requirement specification. This was done based on the results from the pre-study, compiling the insights from study visits and interviews along with knowledge gathered during the theory study. Also, the results from the company analysis specifying the demands from the intended customer Inergo was taken into consideration when creating the specification. Since the requirement specification is a living document that is supposed to be edited during the project, the list was made to reach a detailed enough level to be considered sufficient to advance.

3.4.2 PRODUCT EXPRESSION

In addition to the technical requirements it is also important to define the desired expression of the product. This was done by creating an expression board. The adjectives used for describing the intended expression were compiled into an expression association web. Both the expression board and the expression association web were used for providing inspiration henceforth in the process, but also for the evaluation when investigating if the final concept meet the requirements or not.

3.4.3 PERSONA

Creating fictional users based on the information gathered throughout the project is a vital part for this project. It provides an insight to whom the users are, what they prioritise and what needs have to be taken into consideration when developing products. To better understand the users, two personas were created with different backgrounds personalities. These two personas were deemed to be the typical users based on the gathered information, and their diversity creates a good representation of the end user.

3.4.4 SCENARIO

The method of creating scenarios for understanding and concretising the problem was used in addition to the personas. In this project this was very useful since it is a good way for describing the event in which the future product will serve as a solution. Giving this explanation through scenarios will create a better understanding of the needs to be met with the product. Since there is not just one specific issue happening that exclusively covers all the aspects of the problem to be addressed, two scenarios were created. Both cover more of the aspects, as well as conveying that the product can be used for more than one application.

3.3.5 CORE USAGE

To further define and understand the problem and what the purpose of the product is, a definition of the core usage is required. The information gathered through the requirement specification, persona and scenario were used as a basis for this definition.

3.5 CONCEPT CREATION

At the beginning of the idea generation, the aim is to find a wide variety of possible solutions. To achieve that, a variety of idea creation methods were used to facilitate the distribution and quantity. Firstly, a session of brainstorming was conducted to start the process of creating ideas. This was then followed by the idea shifting method, to help provide new ideas by getting inspiration from others. To further expand the character of the ideas, the method of using random word association was used. This method is good for the purpose of forcing yourself to create ideas from something that is not directly related to the problem. Following, another brainstorming session was held, but this time with the guidance of form specific constraints. This was made to explore the different solutions it can bring by forcing yourself to use a certain shape. Another method used for broadening the perception of possible solutions was the dream travel. This method was used as a way of considering not only the products, but also the environmental and social aspects of office that could affect the product solutions. In addition to this, the method of negative idea generation was used for the purpose of finding aspects of what is important regarding usage, handling and sales of the product that could influence the design.

When the created ideas were viewed, it was found that certain aspects were frequently occurring. These aspects were analysed and grouped into categories, forming six concept categories with ideas that have different characters. The ideas within each category have similar principles for solving the problem, yet they can solve the problem in different ways. These categories were used as frameworks for further development of the ideas, acting as a starting point for finding a variety of solutions within these six categories.

3.6 CONCEPT DEVELOPMENT

To develop the ideas and further specify their purpose and usage, concept development was performed in two phases; phase 1 and phase 2. These two phases deal with an iterative process of creating and evaluating ideas with different depths of detail to reduce the amount of ideas to finally end up in one final concept.

3.6.1 PHASE 1

The six concept categories created in the concept creation were subject for further development. From the six categories, 23 ideas were developed and documented through the use of sketching. To evaluate these 23 ideas, a theatrical evaluation method was created. This method utilised both scenarios and personas to tailor the evaluation for the needs of the users.

When using this theatrical method the participants were asked to read the scenarios one at a time, then look at and choose one of the 23 product ideas to preferably use for the need that emerge in the respective scenario. Once one of the ideas was chosen, they were asked to act out and involve themselves in the different scenarios imagining using the chosen product. The feedback provided from this method was utilised to develop and choose five concepts.

3.6.2 PHASE 2

The five chosen concepts were subject to further idea generation to explore options within form, function and variations on technical solutions. The most important functions within each concept were then ranked and evaluated to define five improved versions. These five improved concepts were presented to the company Catino for a discussion and evaluation. To add depth to the evaluation, a matrix was compiled of criteria pertaining to core usage based on the requirement specification. The concepts were evaluated using pass/fail where a pass resulted in a score of 1 and fail in a score of -1. The result from the matrix together with the input from Catino resulted in the choosing of two concepts. To investigate the positive and negative aspects of the two remaining concepts, the ideation

method Merlin was utilised. This then prompted a discussion, which lead to the selection of the final concept.

3.7 CONCEPT EVALUATION

As the initial step of evaluation, the formal design was developed for the final concept. This was done through an idea sketching session where shapes and additional features were dealt with. During the idea development, the necessity of integrating chairs within the concept was questioned, and therefore investigated separately. The purpose of this was to see if an existing product could be used together with the concept or if a separate design of a chair was needed to create a comprehensive look. This was partly done through a market analysis of seating solutions.

During the idea development, some aspects were decided upon as the most suitable for the formal design without the need for questioning, whilst other aspects needed a deeper evaluation. The formal design of the legs was such an aspect. Therefore, the design of the legs was evaluated in comparison to the expression board and the expression association web. The evaluation was done using a repertory grid (appendix 2) carried out with ten participants, comparing sketches of the different designs. The result from this was then used as basis for the decision of which design to proceed with for the final concept.

When the final concept was set, a quick mock-up was made to give a feeling of the appearance that the product would have. This mock-up worked as a final validation of the concept before dealing with construction details, dimensioning etc.

3.8 CONSTRUCTION

At the beginning of the construction phase, all functions were listed and evaluated to define what possibilities and limitations the product should offer. The functions were considered based on product complexity, both addressing usage and manufacturing. Once the desired functions were specified, the mechanisms for solving them were investigated. Exact components were not determined but rather the technical solution as a whole.

Before visualisation can begin, or the concept measurements can be set, calculations of mechanical forces were made to ensure proper dimensioning of the product. This step also includes choosing suitable materials for the concept, since the properties of the material will affect the calculations. Restrictions from the requirement specification worked as guidelines and constraints.

3.9 VISUALISATION

To provide a good perception and comprehension of the final concept, the visualisation of the product was done using computer aided design (CAD) for creating realistic renderings. This enables the development of infographics, showing the key features of the product and explanations concerning its usage.

USER STUDIES

Within product development projects it is of highest importance to address the needs of the users. Also, defining and gaining knowledge about the users is crucial when designing for a specific target group. Therefore, thorough user studies were made to investigate the user needs and aspects to be considered throughout the development. This chapter describes the results from these studies.

4.1 PROBLEM FAMILIARISATION

The first part of familiarising with the problem was visiting the Swedish furniture fair in Stockholm. The observations from visiting the fair and the different exhibitors showed that silencing is a big trend this year. Both when it comes to products in terms of different screens for the office environments, but also when it comes to material and decoration. The majority of the furniture was partially or completely made out of felt material. One company were even offering framed mats, to be used as decoration but also with the purpose of silencing. Another spotted trend were earthy colours, yet very bright colours. Even though there were a lot pastel colours, they were more dimmed rather than colourful. There were predominantly solid-coloured products, but it appeared to be commonplace to match different colours within the same group of furniture or arrangement of furniture sets. It seemed to be more common to mix materials rather than using patterns. In some way, that mixture created a different kind of pattern that appeared more unstrained, which was a common parameter at the fair. Besides observing the exhibition, a short interview was also held with Inergo. They explained that the company is mainly focused around their height adjustable tables and chairs. They also provide some other products, such as the recently designed drawers for storage that they were displaying at the fair. Their customers are mainly ergonomists, since the company has an ergonomic focus, but they claimed themselves to be the cheaper alternative at the office furniture market. When talking to them it became clear that they are a small company with great ability to be flexible. If their customers need a slight change to some of the products, they can arrange that quickly to meet the customer needs. However, Inergo does not have their own manufacturing, so they depend on their subcontractors and their ability. Lastly, the company was asked to elaborate on what they would like for the future. They expressed a desire to be providing more products, good from an ergonomic point of view, whilst still remaining a cheap alternative for the customer. In that way, they hope to become the first choice, not only the cheaper option.

During the Microsoft visit, observations were made regarding office behaviours. Even though a variety of workstations and workspaces were provided. The majority of employees were sitting around grouped workstations. Meaning, one large desk with 4-10 people clustering together or 4-6 individual desks clustered together in one group area. They all had individually adjustable chairs to provide an ergonomic sitting area and no silencing

Figure 5. Relaxing and playful product within the office environment at Microsoft.

Figure 6. Teamwork in progress by large stationary tables at the Microsoft office.

dividers, providing an unobstructed view to their co-workers. Even though Microsoft had reduced their need for space by 25% and maintained the workforce, there were lots of unused workstations including an entire floor that had been shut down. These unoccupied spaces included social areas, individual desks with silencers and comfortable individual areas. However, the one thing that there was still a shortage of was meeting room. Lots of small individual rooms were occupied as well as large meeting rooms. When talking to the employees there was a sense of pride over the office, the way of working and the dynamics within the company. When trying to reach this goal it did require a change in behaviour by the employees.

4.2 FOCUS GROUPS

During the first session the participants repetitively described their; loss of concentration, lack of space, individual adaptation, ergonomic, resource distribution as recurring issues at the office. Even though individual participants addressed different aspects regarding these five categories they all agreed that these were the main issues encountered at the office. The highest-ranking issue was the category; loss of concentration. Due to the fact that interruption by co-workers and acoustics were deemed a large contributing factor to inefficient work environments. Within this category, the participants debated solutions of enclosed environment vs. open environment and found both positive and negative aspects of each. Therefore an environment with adaptability was preferred. The 2nd and 3rd highest-ranking categories were individual adaptation and lack of space. The category; individual adaptation, dealt with the possibility to adapt, change and manage your own work environment to your personal preferences without disturbing the neighbours. Lack of space was an issue dealing with the need for more space at the personal workstation, but also when working within a project oriented environment.

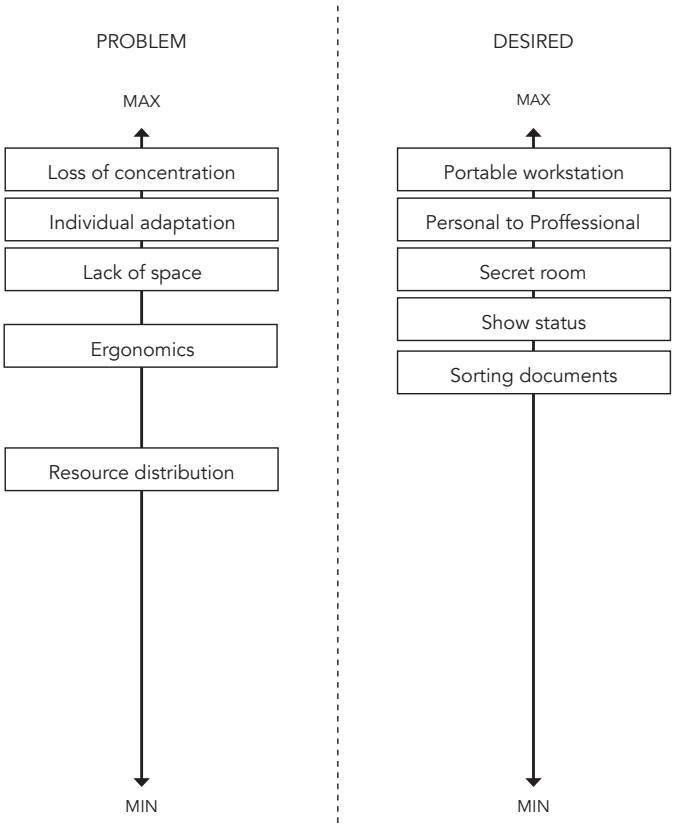


Figure 7. Participants' ranking of the problems and desired solutions within the focus group sessions.

With the desirable outcome from the categories (figure 7), the highest desire was a portable workstation and being able to shift from professional work to private time. One of the participants even stated that playing 'Candy Crush' in the bathroom was nothing unusual due to the uncomfortable feeling of others being able to see the unprofessionalism of playing 'Candy Crush' near the workstation. This person was not the only one sharing the feeling of discomfort even though personal breaks are acceptable and encouraged.

During the second focus group the information provided resulted in a slightly different approach to issues at the office. However one of the main issues was also lack of space, especially within team oriented work. One of the participants even stated; "when I want to visualize something, I just want to hang it up and have everything in front of me. But there is no available space at my office to do this, especially if the information should be stationary for a couple of weeks". This argument together with the lack of desk space at the personal workstation was the reason for ranking this as the highest issue. The 2nd highest-ranked issue was ergonomic adaptation of equipment and a desire to create an ergonomic working position. With this the participants meant that they know how to use the equipment ergonomically, but it was either not provided as an option or they ignored the recommended usage. Therefore the participants wanted something, either a product or system that solved their own ignorance of ergonomically correct usage.

4.2.1 CONJOINT ANALYSIS

The results from the two focus groups were analysed altogether in a conjoint analysis. Eight categories were found addressing the topics of; ergonomics, flexibility, storage and lack of space, communication, acoustic environment and concentration, personalisation, psychological privacy, and lastly one category compiling the rest. The topics were viewed and weighted with the intention of choosing one to be used for finding a specific problem to solve.

The aspects of ergonomics are always to be considered no matter what the problem is. So ergonomics alone is not enough for defining a specific problem. Communication was frequently discussed in both focus groups. The focus groups however highlighted the fact that companies often have separate system solutions for communicating within the company depending on their needs, which can mean that a product for this problem easily can interfere with an already existing one. When it comes to storage and lack of space, the biggest issue seems to be a lack of space for working in the teamwork or meeting situation. In other words, there is not enough room for spreading out and collaborate when needed. So in terms of storage and space, it is rather the active workspace than the long-term storage that is required. The need for a bigger, or temporary, work area is more important than extra personal space. The acoustic environment is a big issue at many offices as well, and as could be seen at the Stockholm furniture fair, addressing silencing has been a big trend lately. Making a product contribute to a better acoustic environment is desirable, but not in itself chosen for the main topic. When talking about flexibility a need for a quick, easy and available substitute for the regular conference rooms emerged. Many of the participants expressed a desire for an alternate workspace when shifting activity, especially when comparing teamwork and individual work activities. Also, they pointed out that the workspace should if possible not exist when it was not needed. Flexibility hence is about providing variation regarding workspaces, but also having a fast and accessible workstation for spontaneous meetings. The participants claimed to experience a varied amount of this need, but they all expressed a desire for variation. Addressing flexibility covers aspects of other problems such as lack of space, ergonomics and supporting communication. Also, the needs discovered from this investigation on the topic of flexibility have not commonly been solved previously. Therefore, flexibility is the chosen topic for further investigation.

4.3 STUDY VISIT

The study visit at Dekra consisted of a tour at their office guided by Joakim Wikeby while asking questions about their opinion of the office environment. When talking about the specific

need of a temporary workspace, Wikeby[1] says that they have one big table available for everyone to use, which is used frequently. They use it mainly when there is a need for displaying big drawings or discussing sketches. When doing so, he said, it is good to leave your ordinary desk so that you do not disturb others, as these occasions often involve some kind of discussion or meeting.

Dekra recently relocated, and had a hard time finding a new location due to their need for workshop halls. The new office is a bit too large for the company at the moment, so they have a lot of space even for people that work from other locations most of the time. This means that they utilise the space inefficiently and have a higher ergonomic standard than what is required, but not where it is needed the most. For example, when deciding what chairs to buy they wanted to have the same piece of furniture everywhere due to simplicity. Since the personal workplaces determined the standard at the office, even the workshops are equipped with ergonomic office chairs, which Wikeby[1] thinks is unnecessary. However there is no ergonomic adaptation of the conference room. The assumption is that the furniture is not picked out with the consideration of what the usage is and the needs that follows. In general though, the ability to adapt the furniture for those that provide this possibility is used by many people at the company. Wikeby[1] claims that these functions are used since they became informed about it and the importance of using them in conjunction with the relocation. It was observed also that the employees actually had adjusted their tables to different heights, varying from sit to stand height, which implies that the ergonomic aspects of the furniture functions are used.

When asking about the process of choosing new furniture for the office Wikeby[1] explained that they hired a relocating consultancy firm, but he made sure to have a good communication with the architects responsible for the interior design. Modern offices are so boring, he thinks, and they can often be formal and impersonal. One thing that was requested to create a warmer atmosphere was to use hardwood floors instead of carpets. It makes it easier to clean and also it is a type of floor directly glued on to the subfloor, which gives it very good silencing properties. When knowing this, it was pointed out that not much other silencing product in terms of screens or similar existed at the office. Wikeby[1] claimed that the floor made it unnecessary, and that the sound level at the office was never a big issue. But on the other hand, they are rather few present at the office, which may be a contributing factor.

The most important findings from this study visit were the need of a temporary space for the ad-hoc meeting when displaying drawings or having a discussion regarding a decision. They had themselves addressed these activities to an ordinary table that everyone was allowed to use. This table was used frequently, but yet they only had one. If the ability to perform these activities would be aided using a more space efficient product, maybe it would be easier and hence result in that it was performed more frequently.

Figure 8. Product to display and discuss drawings at the DEKRA office.

[1] Joakim Wikeby, Buisness Unit Director at DEKRA Industrial AB

STAKEHOLDER ANALYSIS

To understand the problem from a broader perspective, it is important to know not only the details but also the holistic view of the office furniture market and the stakeholders. A stakeholder analysis was conducted during the project, addressing aspects of the company, the market and detailed investigations. Throughout this chapter the results of these investigations are provided.

5.1 COMPANY ANALYSIS

5.1.1 STAKEHOLDERS

The mapping of the stakeholders (figure 9) shows the intended customer, Inergo, and the different stakeholders of the company. When developing a product for a customer it is important not only to consider the aspects of the product, but the entire range of contact points that the product is likely to have. From the mapping, one can see that Inergo themselves do not come into contact with the end users. They collaborate with resellers who are purchasing their products for further sales. These resellers in its turn have contact with the purchasers, who are responsible for buying the products intended for the end users. The final customer therefore does not necessarily have to be the end user. It could be a representative from the company or an interior designer that, on behalf of the user, recommend products to purchase. In that case, the interior designer becomes an intermediary between the purchaser and the user. The ergonomists are also included in the mapping having contact with the company, the purchasers and the end users. They are important for the ergonomic aspects of

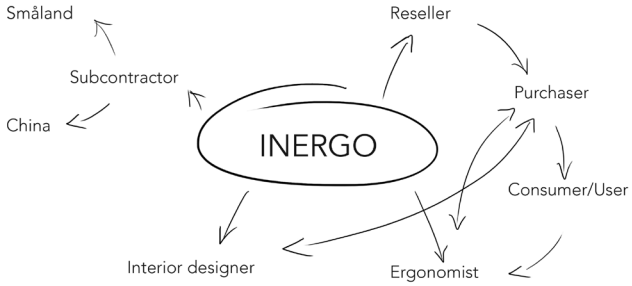


Figure 9. Map over the different stakeholders and their interaction.

the products for all involved, but can sometimes be found among the other stakeholders. For example, the purchaser can have some kind of education within the field of ergonomics, in which case the contact with an external ergonomist becomes excessive. Lastly, Inergo also has contact with different subcontractors, since they do not have their own production. When they have a new product or are about to make changes on an existing one,

Figure 10. Brand Coherency Table, an illustration of Inergo´s brand coherency.

they contact their subcontractor for discussion on possibilities and solutions for changes. Inergo have subcontractors in Småland (Sweden) and China.

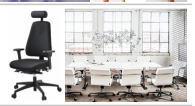
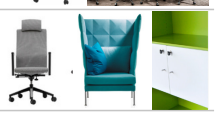
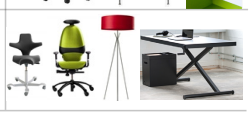
5.1.2 BRAND COHERENCY

When addressing brand coherency aspects of promotion, the consumers' perception of the brand, the organisation and the products are investigated (figure 10). Inergo promote themselves as one of Scandinavia's leading manufacturer of height adjustable tables, and the company have a clear ergonomic approach. The products are destined for office environments and they primarily provide height adjustable tables and office chairs, but also additional furniture such as conference chairs, table partitioners and lamps. Inergo as organisation claim to focus on creating value for the users and defend their position as a brand that delivers most value for money. These three aspects altogether seem to correlate, keeping a unified view of Inergo as a company. The view of the consumers was investigated by asking some users about their spontaneous perception of the brand and the products. The users were mainly familiar with Inergo's height adjustable tables and had recently visited their home page. They described Inergo as fairly generic and neutral, giving an impression of stability and being professional, yet providing movement due to the properties of being adaptable. Also, they all agreed that the products probably suit every environment, due to their appearance of being rather subtle. The investigation indicates that Inergo as a brand gives a coherent impression, even though that impression is fairly modest.

5.2 MARKET ANALYSIS

From the market analysis table (table 1) it is visible that the companies within the market for office furniture have a wide range of products and most companies offer complete solutions for their purchasers with specific theme. When comparing Inergo with their competitors it is visible that they have the same product line but with a toned down and neutral impression. Their competitors on the market have either a more playful impression such as Edsbyn or a more Scandinavian theme like Lanab design. This provides Inergo with the competitive advantage of being able to fit into any of the companies' profile.

Table1. Market analysis table, an illustration of different competitors to Inergo and their product range.

Company	Ergonomic work chairs	Conference chairs	Ergonomic tables	Conference tables	Storage	Partitioners	Lighting	Accessories	
INERGO	●	●	●	●	●	●	●	●	
Kinnarps	●	●	●	●	●	●	○	●	
IKEA	●	●	●	○	●	○	●	●	
Matela	●	●	●	●	●	●	●	●	
Lanab design	●	●	●	●	●	●	○	●	
Edsbyn	●	●	●	●	●	●	○	●	
Holmbergs partner	●	●	●	●	●	●	●	●	

5.2.1 CURRENT PRODUCTS

When investigating the current product solutions that already exist on the market, some findings have been made. Examples of these existing solutions were documented in a collage to get an overview. There are many foldable furniture solutions, providing the ability to transform and shrink. Although, these rather create temporary workspaces for a single person, and therefore are not meant for the same usage as the product in this project aims. There is also a large range of wall-mounted products on the market, which therefore might not provide the level of flexibility desired. Many of the multifunctional solutions are furniture that has the extra feature of providing additional, often hidden, storage. This is also common for the products that provide a cosier private workspace, which often are large and require big empty areas. The solutions that exist for quick and creative meetings where you are able to display documents are in general not comfortable enough for working over long time periods considering the ergonomic aspects. Not many of them even provide the ability for taking notes on a computer or notepad, other than keeping those in your lap. Overall, the conclusion is that there are a large variety of fun and interesting products, but not when it comes to solving the same kind of problems to be addressed in this project. Mainly it is due to the combination of problems to be solved and the final appearance of the product. For example, solving the intended problems while remaining flexible and easy to use is very important. If this is achieved with the new product, it assumes to fill a gap in the market.

5.3 DETAILED INVESTIGATION

5.3.1 INTERVIEWS INTERIOR DESIGNERS

Three interior designers were subjects to semi-structured interviews regarding creation and furnishing of office environments for an insight into the interior design industry. According to all three interior designers the project missions and demands set by the customers shifts from entire office solutions including walls, ceiling and flooring, to the rearrangement of furniture and organisational behaviour for optimising use of existing space. Within these different project missions, the needs of the customers differ as well. Some like a calm and spacious environment whereas others enjoy the look and feel of an "English gentlemen's club" according to Allende[1]. But the main objective is to create a change. And the most common change asked about today is an activity based office environment, which is categorised as a flexi-office. However the customers rarely understand the gist of this type of office environment, which is why many shift to another type of office solution when it is realized, says Sahlqvist[2]. Most often it is the employer that encourages the activity based work environment due to the advantages regarding space efficiency. Sahlqvist[2] also seems to believe that activity based office solutions is a trend that will fade away. Mainly due to peoples desire to have a personal desk, feeling of ownership or a sense of belonging to the company rather than being anonymous. However, according to Karlén (2014), the activity based office environment can cater to our personal needs better than any other office environment. Due to the fact that it provides workers with power over their own situations, giving them the freedom to choose whatever they desire at any specific instance.

There is also a great deal of space shortage within the open office environments and Sahlqvist believes that "touchdown" office spaces or "focus rooms" will become more important. "Touchdown" workspaces are temporary workstations where people can go away from their own desk to do work for a short period of time. "Focus rooms" is a place or room that provides an escape for workers to carry out high concentration work. These spaces are especially important within the open office environment according to Allende[1], because you should be able to move around the office, change your environment or have short meetings without the hassle of booking a room. The technical requirements of being connected and available during and after office hours have contributed to the demand of these types of office spaces, since they can be used for many purposes including relaxation or high individual concentration work. When furniture for these types of work do not exist on the market, the interior design firms usually design and manufactures their

[1] Boel Allende, Interior Architect BSK, 13/3-2014
[2] Jacob Sahlqvist Senior Interior Lead Architect Tengbom MS.c MFA, SAR SIR/MSA 12/3-2014

own customised furniture. The main aim of such furniture is to create a good environment for the person or persons working at the office space, in order to become a better solution than the already existing one, according to Sahlqvist[1]. There is also a need for the large Italian dinner table. These types of spaces are desired when a group of people want to gather around and work on small or large projects. The most important aspect about these stations are that you should be able to leave the work laying around for a couple of weeks while others can move around freely.

The main objective of interior designers is to create a change for the customers. The change can involve everything from purely reorganisation of the interior products to complete organisational restructuring. Solutions that are frequently implemented are those addressing space saving products. These product are however hard to find on the market and the interior design companies therefor design their own furniture, a process that is both time consuming and expensive.

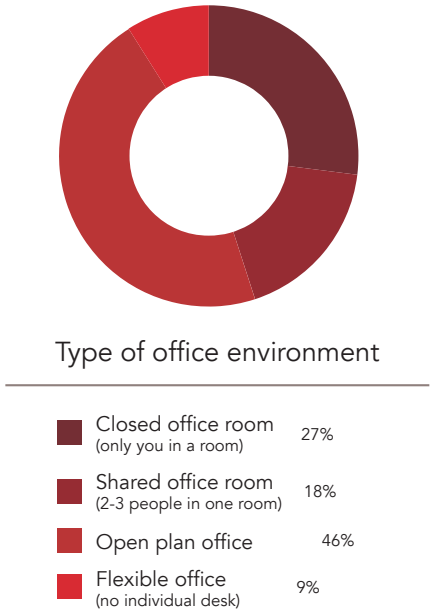


Figure 11. Pie chart describing what type of office environments the participants currently work in.

5.3.2 SURVEY

56 people answered the survey where 3 were deemed invalid due to the nature of the response. In total 53 valid responses were obtained from a wide spread of workplaces and work experiences. The results show that a majority of people answering this survey work in an open plan office and spend most of their office hours doing individual work (figure 11-12). An interesting result was that 66% answered that they do not have a lack of workspace at their office, however 52% have felt the need for a temporary workspace (figure 13). This indicates that even though it might not always exist a need for more space, it does exist a need for temporary workspace. The remaining 48% described that their need for temporary workspace is already provided at their office in the format of fun/playful rooms, meeting rooms or that the space provided is large enough to be utilised for this purpose, which again indicates that the wish to have a temporary space is desired amongst the end users. One participant even stated that the need for a temporary workspace exists every day,

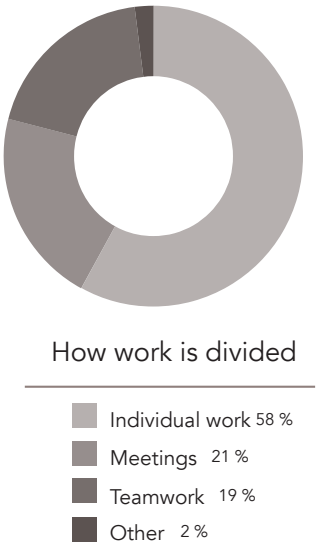


Figure 12. Pie chart describing how work is divided within the office hours.

[1] Jacob Sahlqvist Senior Interior Lead Architect Tengbom MS.c MFA, SAR SIR/MSA 12/3-2014

Figure 13. Illustration of the distribution of Yes and No answers to the questions.

for a variable amount of time and for different kind of purposes. Amongst the free text questions, 20% of the participants described the need for an inspirational/motivational space. This space could take any form, however they lacked the possibility to be inspired or have an environment where they could sit down and be motivated/inspired to do work, teamwork or workshops. There were also a few participants who described the desire to use whiteboards more often or pin up documents for a short period of time. One participant described the need for a temporary workspace that "suits multidisciplinary tasks that require special tools other than the usual desk".

The results indicated that there are a variety of spaces required at the office and that these spaces can take different appearances and fulfil different needs. An important result is that the need for a temporary workspace is substantial and therefor should be provided to enhanced productivity amongst the end users. For further results from the survey, see appendix 4.

PROBLEM DEFINITION

Before moving on to the development of a product concept, the findings from the investigations has been gathered and compiled into a problem definition. Describing the users, the intended user scenario and the requirements for the future product is part of the definition. It is the results from this chapter that the final concept will be evaluated based on.

6.1 REQUIREMENT SPECIFICATION

The categories addressed within the requirement specification where: usage, geometry, ergonomics, safety, environment, branding, capacity and additional. Within these categories, 19 requirements were assigned a 5 (must be fulfilled) and 6 requirements were weighted 4-1 (appendix 3).

6.2 PRODUCT EXPRESSION

The expressions defined for the concept to fulfil were; adaptable, confident, stable, witty, calm, supportive and collaborative (figure 14). Adaptable was chosen to give the impression of being easily adapted to your needs, so that the users are encouraged to do so and thereby gain full usage of the product. Confident and stable were chosen to gain trust, so that the users feel like it is a quality product that stands to be moved around and changed without being unstable and unsecure. Calm and supportive are important expressions because the product should rather aid the work to be done, not take over. The intention is that the users will have the ability to focus on the work at hand, not the handling of the product. Calm specifically also address the desired aspect of a workplace that is not there when not used, so it should blend in and feel calm in the environment. Witty addresses the smart functions and the flexible use that should provide a feeing of that the product is a bit witty, resulting in a joy when using it thanks to its smart simplicity and ease to use. Altogether, these expressions work to improve the collaboration at the office, hence the word collaborative was chosen as the most important expression. To improve collaboration is the main goal of the product and also desired for the product expression.

Together with the adjectives, an expression board was created, compiling the pictures chosen to represent the defined expression (figure 15). The pictures were chosen to complement each other, but also so that every picture individually addresses a specific aspect of an expression. For example, the picture of the bridge in the top left corner represents stability, but also providing the metaphor of being supportive and in some way expresses confidence. It also fits the overall expression of being collaborative with its ability of connecting two ends together.

Figure 14. Expression association web illustrating the words that the product is desired to express.

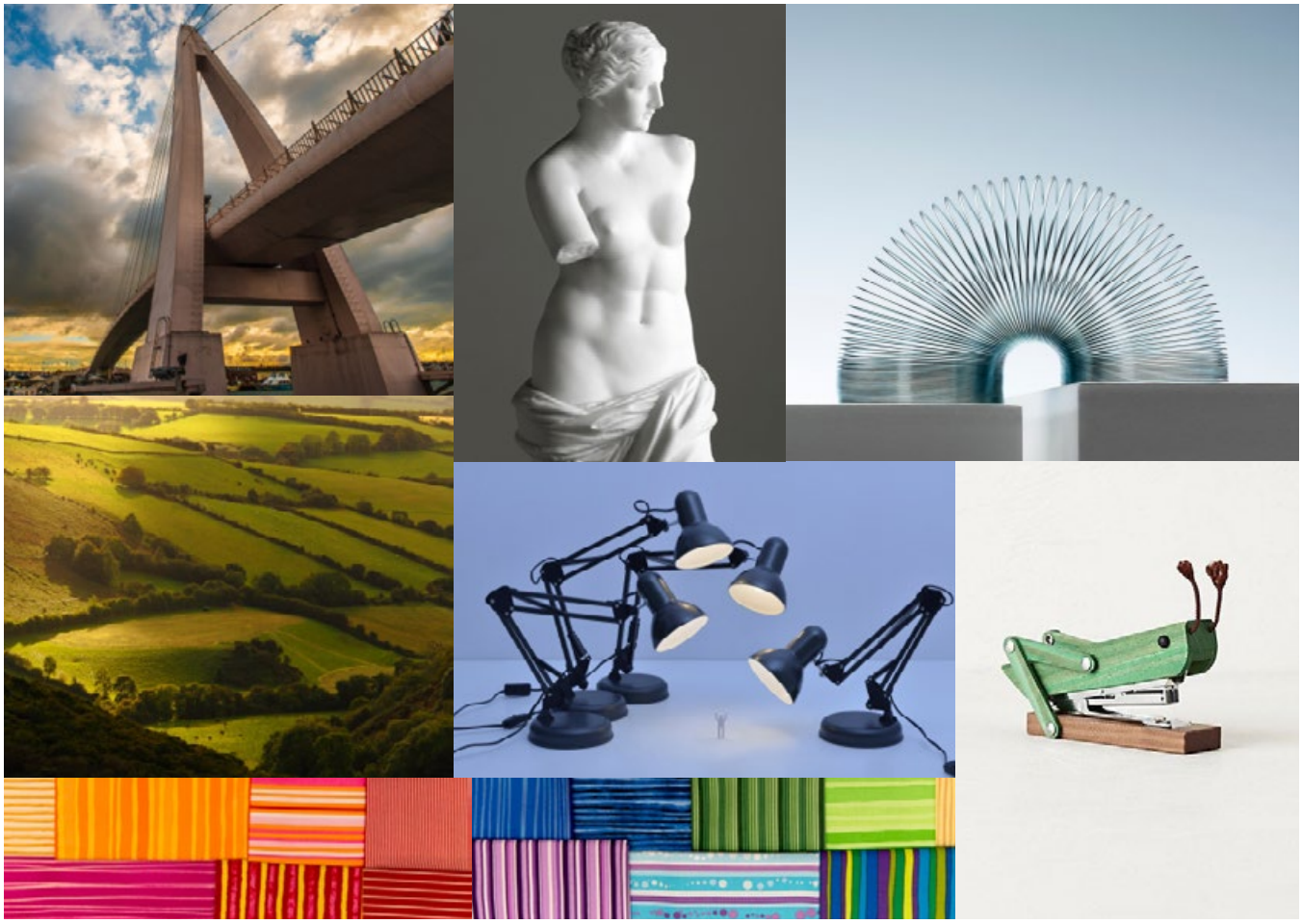


Figure 15. An expression board describing the desired product expression.

6.3 PERSONA

From the gathered information two personas of the primary users were created.

6.3.1 PERSONA 1

Patrik Ljunggren, 29 years old from Malmö, Sweden, works at a company designing and manufacturing telecom solutions stationed in Lund. He has a master degree in project management and bachelor degree in mechanical design engineering from Lund University. Directly out of university he got the opportunity to work for this Lund stationed company and has now been working there for a year and a half. Since he is relatively new he wants to do a lot but is not completely comfortable with the working pattern of the other employees. He does not want to get stuck in the same old way of working as the others have, he wants to move forward and develop, yet struggles with the feeling of being too forward. He has raised his concern with the manager who encouraged him to take initiative and keep his passion for developing. It will give the company the boost it so desires.

Patrik lives in a three-bedroom apartment in Malmö together with his girlfriend Sophia. They have been together for three years and met during their studies in Lund. During Patrik's spare time he is training for the Malmö half-marathon, which he has

Figure 16. Patrik Ljunggren, persona no. 1.

Figure 17. Katarina Nilsson, persona no. 2.

been completing twice. He is also an adventurous person who loves hiking and mountain biking, but his work and location of residence limits the performance of these activities.

6.3.2 PERSONA 2

Katarina Nilsson, 42 years old born and raised in Södertälje, Sweden, currently working at an architecture firm in Stockholm. She gained her architecture degree at the Stockholm based University KTH and since then have been working at numerous architecture firms within Stockholm before she became manager 4 years ago, at her current employment. She is known as a talkative person who both listens and values her employees. In short she is described as a great manager. Katarina is interested in new things and this is a must within the field of architecture. However organisational changes is something she avoids during her project assignments since they are both time consuming and hard to implement. This does not mean that she never does organisational changes at offices, although she does prefer smart problem solving solutions.

Katarina has two children, 5 and 9 years old, and a husband for 10 years. They live in a four-bedroom apartment in Vasastaden, in the centre of Stockholm. She and her husband love doing activities with the kids such as taking picnics or going swimming. Every Sunday she plays tennis with her girlfriends at a local racket centre. Someday when the kids are a little older she hopes to bring them with her on the court and have tennis as their common activity.

6.4 SCENARIO

Two scenarios were created. Both addressing events that can occur in the office environment, and that represents the problem this project aims to solve.

6.4.1 SCENARIO 1

Patrik is working at a company that designs and manufacture telecom products. Recently he has been working with a project at the office, and is now wondering about a big decision. He is really excited about some new technique to be used at the factory, but feels as if he needs some advice from another colleague with more experience within the subject. However, he knows how busy this colleague often is, and is pondering about when he will get the opportunity to seek advice. The project really depends on this decision, which makes it even more important for him to get some help rather quickly. While thinking about what to do, he goes over to the coffee machine to grab a cup. On his way over, he meets his colleague and takes the opportunity to explain his need for advice. Luckily, his colleague actually has an extra fifteen minutes just before another meeting and so is available at the spot. Since the meeting was very spontaneous, Patrik has not been able to book a room for the meeting and as they are in a bit of a hurry, they cannot wander around looking for an empty room. They cannot have the meeting at his desk, because he is afraid that their discussion will disturb the others around. He simply just has to go grab his notebook, and they will have to have the meeting out there in the corridor. It is not the best solution, he thinks, but it is necessary for the project to proceed. He gets his advice, and can continue making his decision, but he can not help feeling irritated about the troublesome meeting conditions and keeps wondering if the decision was taken under the best circumstances.

6.4.2 SCENARIO 2

Katarina has been working at an architect company for many years, and she is often asked to take responsibility for the collaboration between different departments within the projects. Right now, her firm have been asked to create an environment for a library, including everything from the architecture to lighting and colouring. The different departments have been working for a while on their own with concept development, and Katarina now feels as if they have to be entering the next step in a more collaborative manner to make the big picture as good as possible. Therefore, she decides that one member from every department should get together for a couple of days to discuss their results so far and come up with a joint idea about how to continue. Since the departments are placed at different locations at the office, she needs to find somewhere else for them to be able to work. She believes this work could take a few days, so she does not want to book one of the meeting rooms for the entire time. That will interfere with the work of others at the office, since there are not that many meeting rooms available. On the other hand, the team will need a spot where they can display all of their drawings, without having to put them away when the go home every day. At the end, she finds no other solution than to actually book one of the rooms, even though she knows it will probably create some inconvenience for the others at the office. This makes her feel a bit guilty every day when coming to work, and she even hopes for this work to be done quickly. At the same time, she feels anxious about that feeling affecting her work.

6.5 CORE USAGE

The product should provide a temporary workstation that utilise space more efficiently than equivalent product solutions do today. Based on this it is desirable to provide a workspace that would not otherwise exist and improve the possibility for collaboration between co-workers. The product should also enable a more interactive and social work environment.

The product should provide a flexible workstation but does not have to satisfy all user needs that can exist in an office. However, it is possible to add complementary products to ensure all user needs are meet. The product should enable usage by everyone working at the office, meaning adaptation to anthropometric measurements and possible disabilities need to be taken into consideration. The primary placement of the product should be in the work related areas of an open plan office environment. Therefore, the product not intend to be placed in environments such as corridors, due to the risk of disturbing co-workers' flow of passage and the hazardous blocking of exits.

CONCEPT CREATION

In this chapter the initial part of the concept ideation and creation will be clarified. Here is where the problems and needs becomes solutions for the first time, starting off with a broad perspective and then narrowing it down for a more specific framework of solutions.

7.1 CONCEPT CREATION

The different methods used for creating concepts resulted in slightly different outcomes. The initial brainstorming used to start the process delivered a wide range regarding types of ideas. It includes everything from specific technical solutions to larger systems of a whole range of products to be used together. The idea shifting method furthermore developed these ideas due to the inspiration provided from already created ideas, and therefore the outcome of this method was slightly more developed. Continuing with the random word association contributed to an even wider range of ideas, where the solutions not directly focused on the problem. The essence of the ideas from this method was meant to expand the variety and the perception of possible solutions. Also, the brain storming using constraints were used for this purpose. Using the constraints of simple shapes, such as round or square, and force it onto the ideas creates a new dimension of the result. For example, only using round shapes is a constraint at the same time as it forces the idea to utilize the benefits of the shape and create a function that follows the form. It was in the negative idea generation session that followed where the ideas were translated into problems to be solved. For example, this method dealt with topics such as 'how do we make people really wanting to use the product?' and 'how do we make the purchaser to actually buy it?'. The intention of using the dream travel method was to address also the social and environmental aspects of the office, to create ideas that emerge from taking those into account. The results from that method were mainly about the perception of the atmosphere at the office, creating very futuristic ideas such as the sky reproduced in the sealing and technique that enable hologram based meetings etc. Even though these types of ideas seems difficult to apply, details and aspects of them are very valuable for further concept creation.

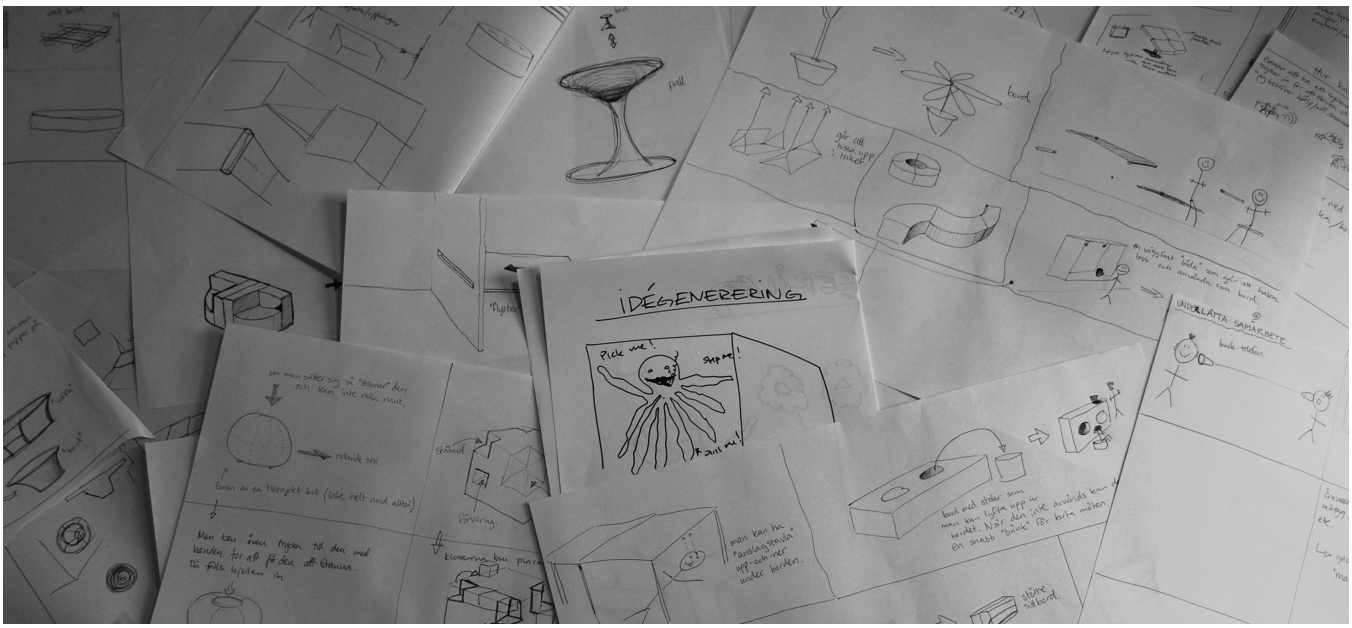


Figure 18. A collection of ideas sketched during the concept creation phase.

The concept creation utilising many different idea generating methods altogether resulted in a large variety of possible solutions. These solutions were grouped according to character into following six categories:

The jackknife
Compiling solutions that can be folded and put away.

The fake wall
Consisting of wall fixed solutions that reveal a larger product when unfolded.

The hybrid
Providing variable solutions that changes depending on their placement.

The jigsaw puzzle
Composed by smaller individual pieces with the possibility to be assembled into different alternatives.

The modular giant
Being a rather large product and therefore fairly stationary, yet changeable.

The convertible couch
Integrating seating possibilities with different amount of supporting surfaces.

These were the categories used as framework for further ideation.

CONCEPT DEVELOPMENT

The initial ideas from the creation phase go through an iterative process of evaluation and development, emerging in more detailed solutions for concepts that is presented in this chapter. Finally, the development settles with only one remaining concept of a product to be presented as the most suitable solution to the main problem of this project.

8.1 PHASE 1

The result of the 23 ideas created was sketched on A4 paper, one idea on each paper. These 23 ideas were used throughout two rounds of theatrical evaluations, performed with two participants within each round. The participants from each round choose three products to solve their scenario, resulting in a total of six different product solutions being chosen. These ideas, together with a compilation of a sample from all the 23 ideas, are displayed within figure 19. When acting out the scenarios important user aspect such as needing an area to place items on, or being able to manoeuvre the product with one hand was highlighted. Both seated and standing work as well as the possibility to place or pin items was expressed as desirable within scenario 2 from all participants. This scenario was the one that placed highest flexibility and functional demands on the product, which provides a reasonable explanation to why products with multiple functions were chosen.

Within scenario 1 the participants chose very different products. One pair of participants chose simple cylindrical chairs that could be used as both an unloading area and seating area depending on the size. The others chose a hidden wall solution for a quiet, standing meeting spot. Both groups addressed that the product does not have to provide a comfortable temporary area due to the short period of time that it is used. However, they wanted the possibility to look at each other rather than being seated next to them.

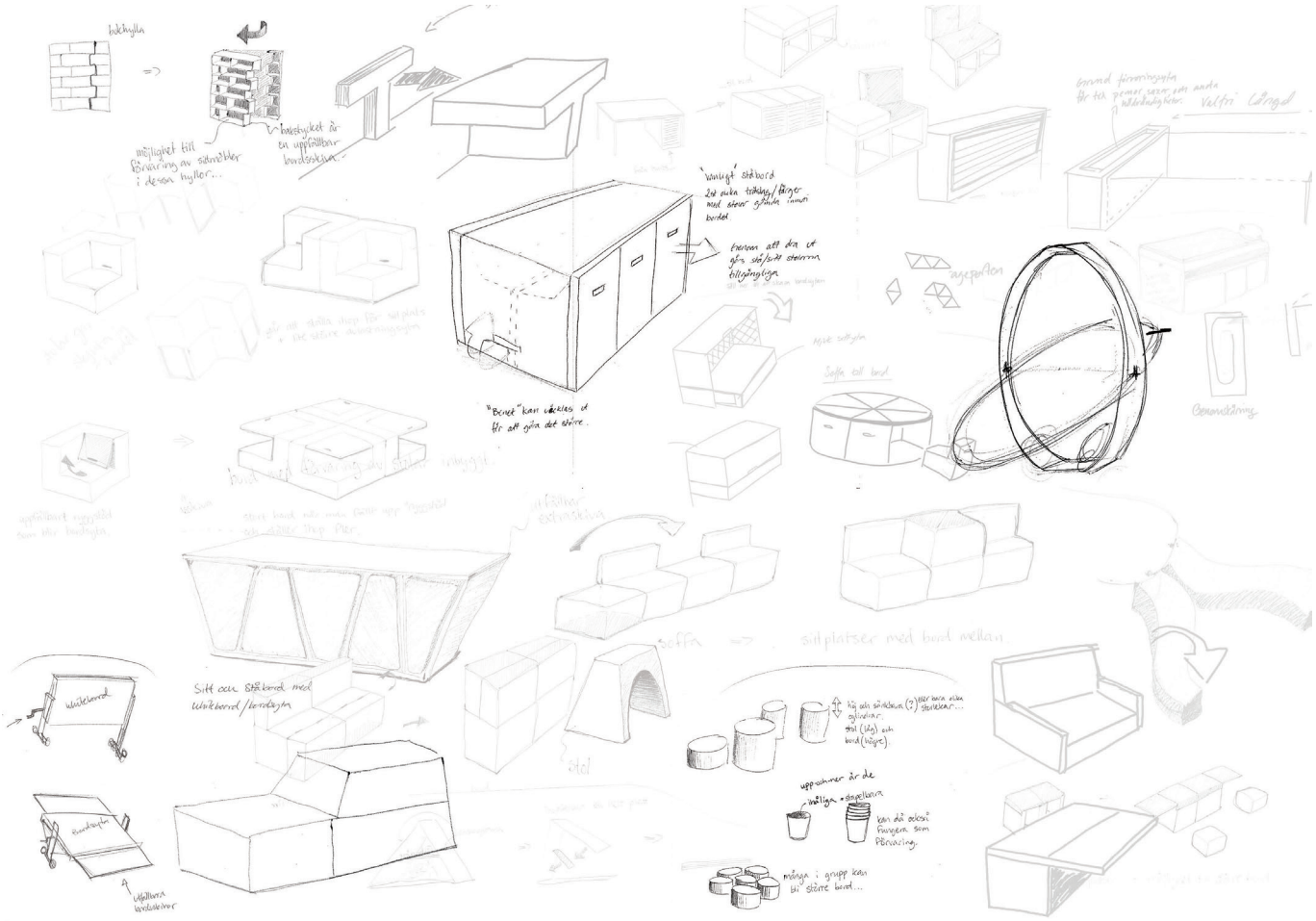
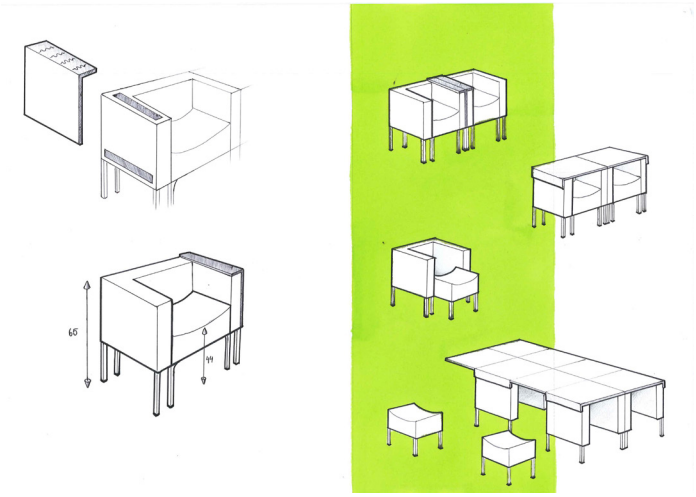
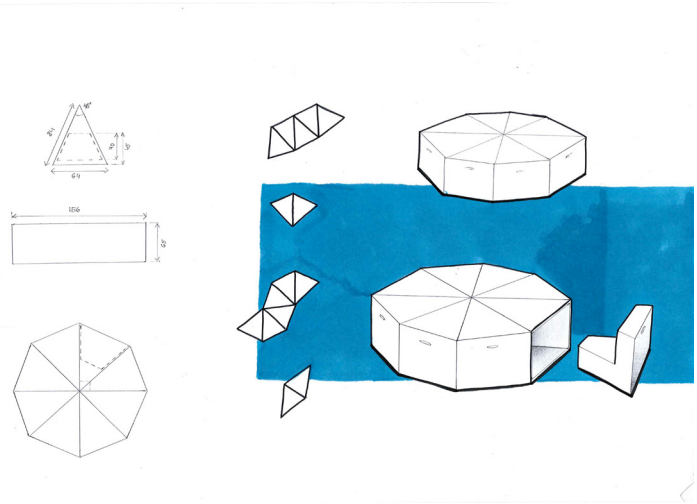


Figure 19. A collection of the 23 ides created. The six ideas that were chosen within the theatrical evaluation are slightly highlighted.

The input from the theatrical method was used to combine different solutions with each other using sketching to illustrate the combinations. To eliminate and further define these ideas into concepts an evaluating discussion with criteria's such as fast accessibility, permitting seating possibilities and providing a horizontal surface was used. This evaluation was used to eliminate 23 ideas into five concepts, and these five concepts are displayed and explained below (figure 20).

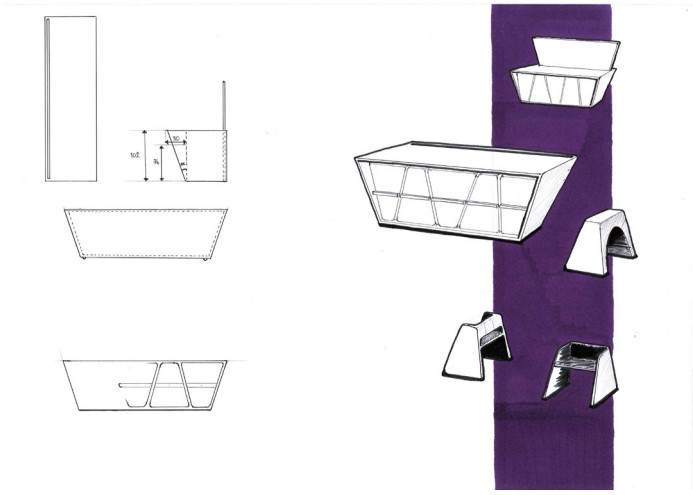


The green concept is an armchair with a detachable seat, providing the ability to be both independent products and parts of a large system. The armchairs could either be used in pairs, for the spontaneous meeting, or be unfolded and put together for creating a bigger workspace for the teamwork situation. This ability is possible thanks to the fold out table surfaces and the detachable seats that creates the pieces of the larger system.

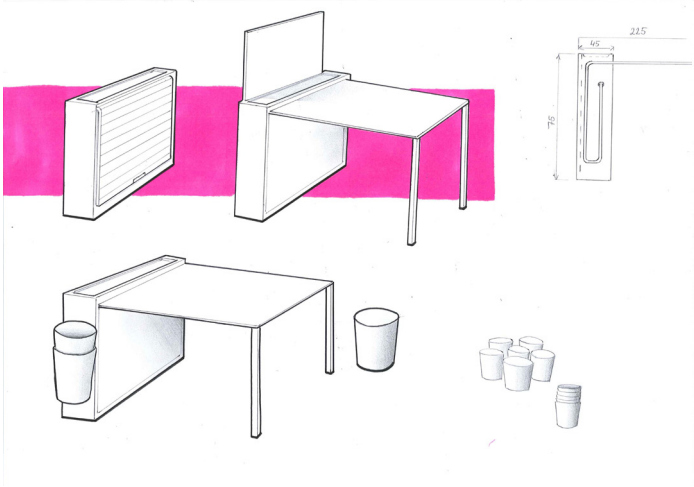


The blue concept, just like the previous, consist of products that is to be put together in a larger system, providing the ability to adapt the size of the furniture for the temporary need. The pieces are triangular tables, giving the opportunity to create different shapes when put together, and with the advantage of being space efficient due to the integrated seating possibility.

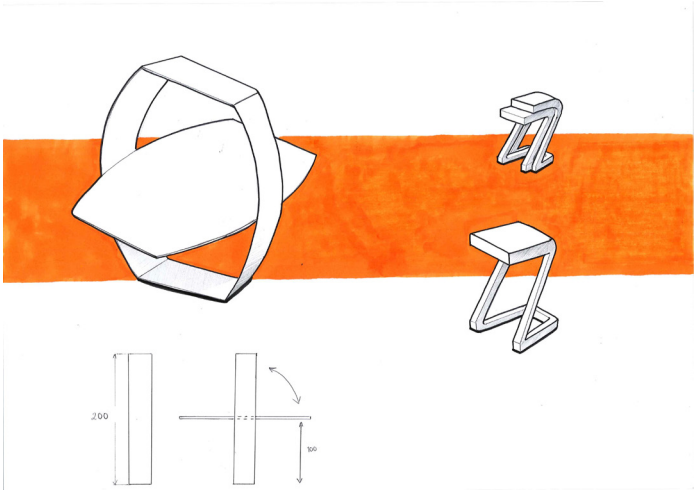
Figure 20. The five concepts chosen for further development (continues on next page).



The purple concept is a high desk solution with an integrated storage of chairs underneath. The chairs are adapted to the high desk, providing the option to either sit or stand when working at this table. The concept also provides a vertical surface for shielding and displaying material, and can also be combined with another piece of furniture for creating a larger workspace.



The pink concept is a foldable table using the technical solution similar to a garage door for making the table surface larger or smaller. When no table surface is used, the product is a space efficient bench providing a temporary countertop for the instant need. The concept also provides a vertical surface for shielding and displaying material, and has a simple seating solution of stackable chairs to complement the concept.



The orange concept is a portable frame providing the possibility of being both a screen and a table surface. This enables the option of using either a vertical or horizontal workspace, while the adaptability of the product enables a very space efficient and flexible solution. The concept also includes stackable chairs as complement to enable seating.

Figure 20. The five concepts chosen for further development.

8.2 PHASE 2

The five chosen concepts differentiate from each other while fulfilling the essential needs of being an adaptable and flexible workstation. To evaluate the concepts a presentation was performed for Catino, which ended in a group discussion about the positives and negatives with each concept. The orange and blue concepts were deemed the most innovative and suitable to the defined user scenarios, based on the discussion from the meeting.

In order to eliminate concepts based on the fulfilment of requirement criteria together with the input from Catino, an evaluation matrix was performed. This method showed that the blue concept was not a suitable concept solution due to its lack of flexibility and adaptation. The orange concept was the highest-ranking concept with a passed score in all categories (table 2). Since the purple, pink and green concept received an equally high score they were evaluated with respect to the criteria of which they failed in. The purple concept was found to violate a core usage requirement, which lead to its discarding. The pink was discarded due to difficulties of installation for the user as well as technical principles. The failed criteria of the green concept were however not found severe enough for being discarded. This meant that both green and orange concept needed further development and evaluation.

Positive and negative aspect of the two remaining concepts were investigated and discussed using the ideation method Merlin. When this was performed it was clear that the orange concept had more positive aspect. These aspects involved possibilities to use as a screen, enhance collaboration, provide vertical surface and flexibility. Hence the orange concept was chosen as the final concept.

Table 2. Evaluation method used to eliminate based on the requirement specification.

Concepts/criteria	Blue	Green	Orange	Pink	Purple
Enable seating	1	1	1	1	1
Provide horizontal work surface	1	1	1	1	1
Provide vertical work surface	-1	-1	1	1	1
Enable change of space distribution	-1	1	1	1	-1
Provide multiple functions	-1	1	1	1	1
Provide active usage in all installation levels	1	1	1	-1	1
Enable collaboration	1	1	1	1	1
Total score	1	5	7	5	5

PASS = 1
FAIL = -1

Figure 21. Meeting with Catino at Chalmers University of Technology.

CONCEPT EVALUATION

This is the chapter where the final concept is tested against the requirements and goals set up to be fulfilled by the concept. Also, the evaluation entail the final modifications and designing of the concept, making the last pieces fall into place.

9.1 FORMAL DESIGN

The initial idea development resulted in a diversity of outcome with regard to the formal design language. Early on in the development, a table top with a rectangular shape was chosen due to the benefits it brings, both regarding available surface and easy construction for rotation axis. The previous feature of having a frame surrounding the entire product was discarded, even though this feature created a comprehensive design language and an illusion of a more private area with its enclosed environment. It was also deemed an obstacle for collaboration and disruption to the interaction between co-workers. Also, a manual height adjustable function was chosen over an electric. This is because an electric one would in most cases result in a solution where the product is connected by a wire to a power source. Since the main profit from the product is to be flexible, this solution was discarded. In addition to the benefit of being flexible, a manual function would require some sort of movement for the user when adjusting the height. From an ergonomic point of view, movement is desired if adapted correctly to the users' abilities.

Figure 22. Gathering of result from the investigation of current seating solutions.

9.2 SEATING

Whether the concept should include some kind of seating or not was harder to decide. Therefore, an investigation of existing seating solutions was conducted with help from a market analysis. This market analysis (figure 22) showed that there is an extensive amount of differentiated seating solutions. There are foldable, stackable, ergonomic and other types of chairs that could be used together with the orange concept. The vast variety of existing seating solutions and the extent of possible adaptation of these, made the creation of an additional seating solution unnecessary. The orange concept was also evaluated as having more value on its own without the combination of a seating solution, given its flexible nature providing both a horizontal and a vertical surface. The product also provides adaptability to different office environments and their interior design without the integration of a chair, enabling a more neutral expression to be achieved. Just as for regular tables provided for office environments, one can assume that there will be chairs available to enable seating in combination with the orange concept. Also, given the short and brief nature of the ad-hoc meetings that the concept most likely will address, encouraging people to stand would entail additional benefits. It could help making sure that the meetings do not drag on, or provide the participants with a change in work position etc. Therefore, the concept does not include the design of a separate seating solution. Although, the concept is carefully tailored for many different types of chairs that could possibly be used together with the product, so that the possibility to sit will be provided but not required.

9.3 LEG CONSTRUCTION

Another aspect that also required deeper investigation was the design of the leg construction. The results from the repertory grid were compiled into one table (table 3) highlighting the variant that was finally chosen. The result showed that most of the variants scored fairly equal, in many cases according to the desired expression, which indicates that all concepts were rather suitable regarding the aim. The most divergent expressions were stable/wobbly, serious/witty and calm/excited. Regarding these expressions the concepts differed the most. The desired expressions that all concepts meet the least were collaborative and adaptable. Collaborative is assumed to be difficult to address due to the fact that the sketches used for the evaluation only focus on the construction of the legs, which when separated from the rest of the product can give a low perceived sense of collaboration. The same goes for adaptable. A sense of adaptability can be hard to address given that the perceived expression is based on a static sketch, which in itself reinforces the feeling of being fixed rather than adaptable. The decision on which design to choose for the final concept was aided through converting the results into scores, and then evaluating the variants with respect to the aspects of difficulties in addition to the scores. This resulted in the decision of using variant no. 6 (figure 23) as the design of the leg construction for the final concept. A compilation of all variants can be seen in appendix 2 for comparison.

Table 3. The compilation of result from the repertory grid.

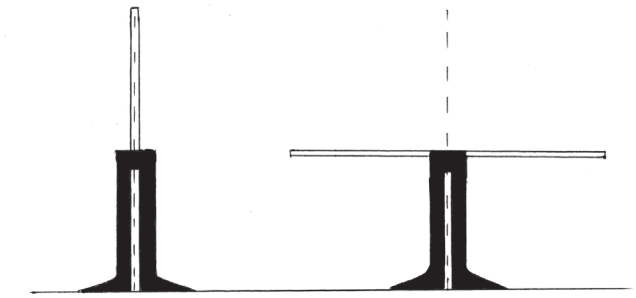


Figure 23. The chosen leg construction.

Figure 24. Sketches of different leg constructions.

Having the different design features defined, a quick mock-up was put together in order to summarise the formal language and get an overall perception of what the compiled concept would look like (figure 25). This mock-up shows that the size of the leg construction suits well together with the frame construction, that the dimensions are manageable to move in and out of a room and also around the office environment.

Figure 25. Mock-up displaying the final concept

CONSTRUCTION

When having a final conceptual design, it is important to address the realizability by calculating the necessary dimensions and forecast the user scenarios to be managed by the product. Also, looking deeper into the technical solutions and defining the details of the concept gives it a higher credibility and value. This is what the construction chapter will address.

10.1 TECHNICAL SPECIFICATION

The final basic functions of the product were set to be:

- Ability to rotate the table top relative to the horizontal centric axis within a range of 180°.
- Ability to fix the table top in three different positions (upright, table side 1 and table side 2).
- Provide two different table top surfaces (chosen from writeable properties, ability to set documents and traditional table surface).
- Ability to rotate the product relative to the vertical centric axis within a range of 360°.
- Height adjustable table top.
- Enable movability.

The functions were solved with following technical solutions:

- To fix the table top a locking mechanism using a pin in three positions was chosen with the motivation that: a lock that uses sprints makes it obvious for the user when able/not able to move the table top, which reinforces the reliability of the product. Also it provides a visual and audial confirmation that the table top is fixed firmly in position. The clear feedback gives an increased sense of stability. It is also easy to understand due to the high recognition and familiarity of such a mechanism.
- To achieve movability, the bottom part of the frame will have wheels. The wheels will allow both motion but can also be locked into position for stability when required. This mechanism was chosen because it is a simple technical solution for providing movability, solving the problem in an easy and inexpensive way.
- The height adjustable function will be solved by the principle of having a mechanism attached to the table top frame climbing along a gear rack at the leg construction. The solution can be either mechanical or electronic, though a mechanical one is preferred for this concept, and the technical infrastructure will be lead through the bar in the horizontal central axis of the frame structure.

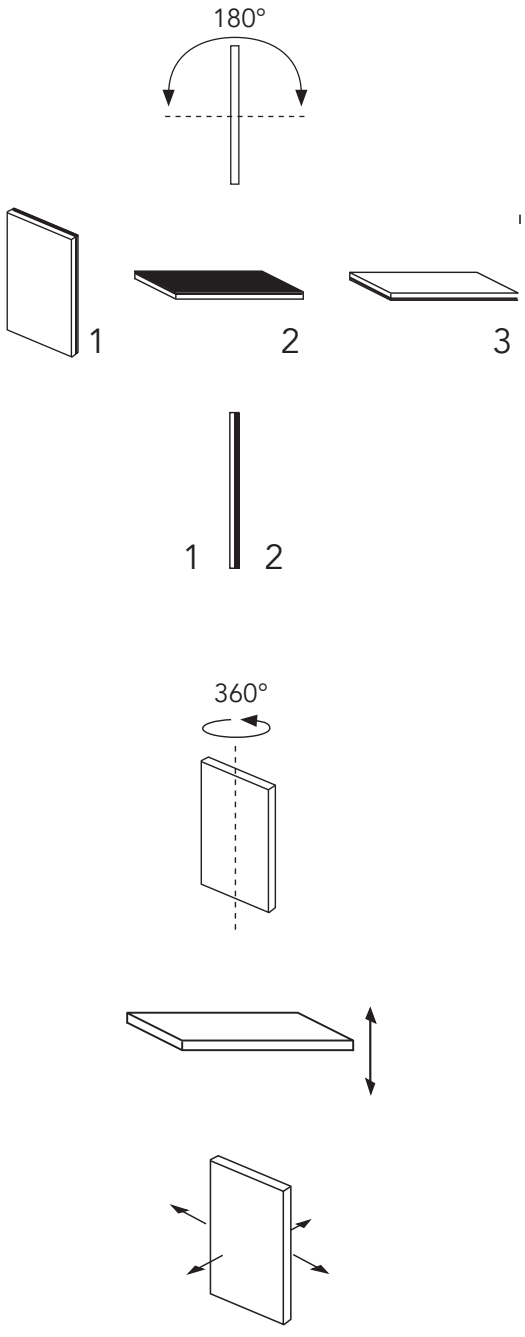
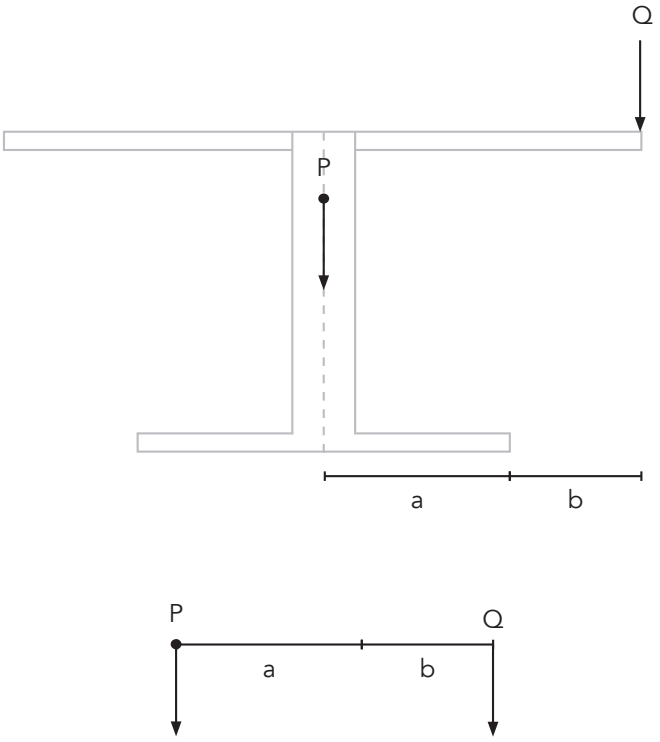


Figure 26. Illustrative icons describing the basic functions of the product.



$Q = 1200\ N$
$a = 0{,}5\ m$
$a + b = 0{,}9\ m$

$P \cdot a = Q \cdot b$

$$P = \frac{Q \cdot b}{a} = \frac{1200 \cdot 0{,}4}{0{,}5} = 960\ N$$

$P = m \cdot g$

$$m = \frac{P}{g} = \frac{960}{9{,}82} = 97{,}759 \ldots kg \approx 98\ kg$$

Figure 27. Mechanical calculations.

10.2 DIMENSIONING

One of the most important parts when dimensioning the concept is to make sure that the product will not tip over when a user leans on the table top. For doing so, calculations were made using the estimated force from a person of 120 kg placing their full weight on the short end of the table top (external force Q = 1200 N). The constraint from the requirement specification claiming that the maximum length of reach to be accepted is 1850 mm, due to anthropometrical measurements, was also used as a limiting demand when dimensioning the concept. The width of the abutting face, which corresponds to the width of the table-leg ends, was estimated to the desired length of 50 cm in the formal development of the product (a = 0,5 m). Since this measurement is crucial for the stability of the product, calculations were made to confirm the reliability of these dimensions.

These calculations (figure 27) shows that with the given dimensions of the table top and legs, and the estimated force from a user of 120 kg, the total weight of the product has to be at least 98 kg. When compiling the dimensions, assuming that the product is manufactured mainly in steel (=7850 kg/m^3), this total weight seems acceptable. Therefore, the design is assumed to be carrying the load without tipping over.

When dimensioning the function of height adjustability, special concern was taken to relevant anthropometric measurements and recommendations regarding table top height for deciding the final stroke length. The used measurements (figure 28) were those regarding table top height in both sitting and standing position, but also the maximum reach length for

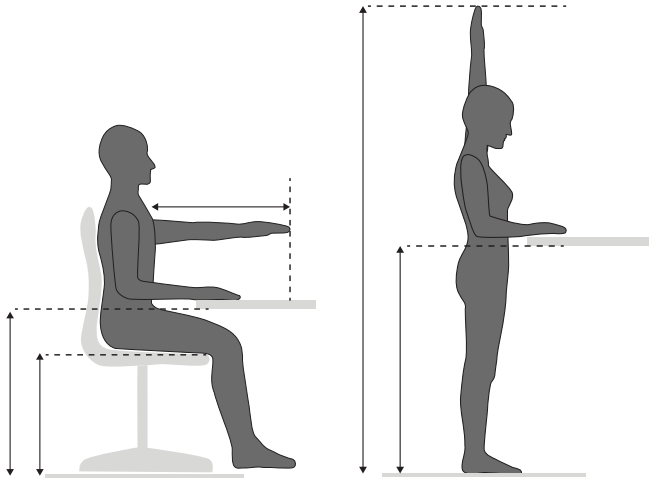


Figure 28. Illustration of anthropometric measurements.

small women. These measurements guided the dimensioning, defining the stroke length of the table to have a range that result in the minimum table top height of 650 mm, the maximum table top height of 1150 mm and the total height of maximum 1900 mm (figure 30). This resulted in a stroke length of 500 mm, with the default position set to a height of 1000 mm. This was chosen due to symmetrical aspects of the concept, but also since this height is recommended as suitable table top height during standing work for both women and men, according to the Swedish work environments authority (Arbetsmiljöverket, 2014). Choosing a height suitable for most people provides a suitable height of the table top for the default position, which is important since the most commonly used height probably will be the default one.

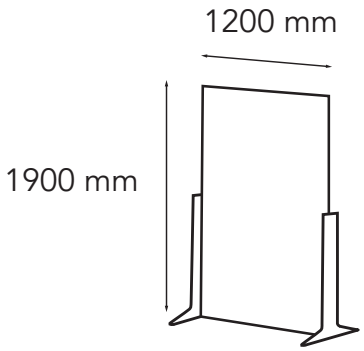


Figure 29. Main dimensions of the product.

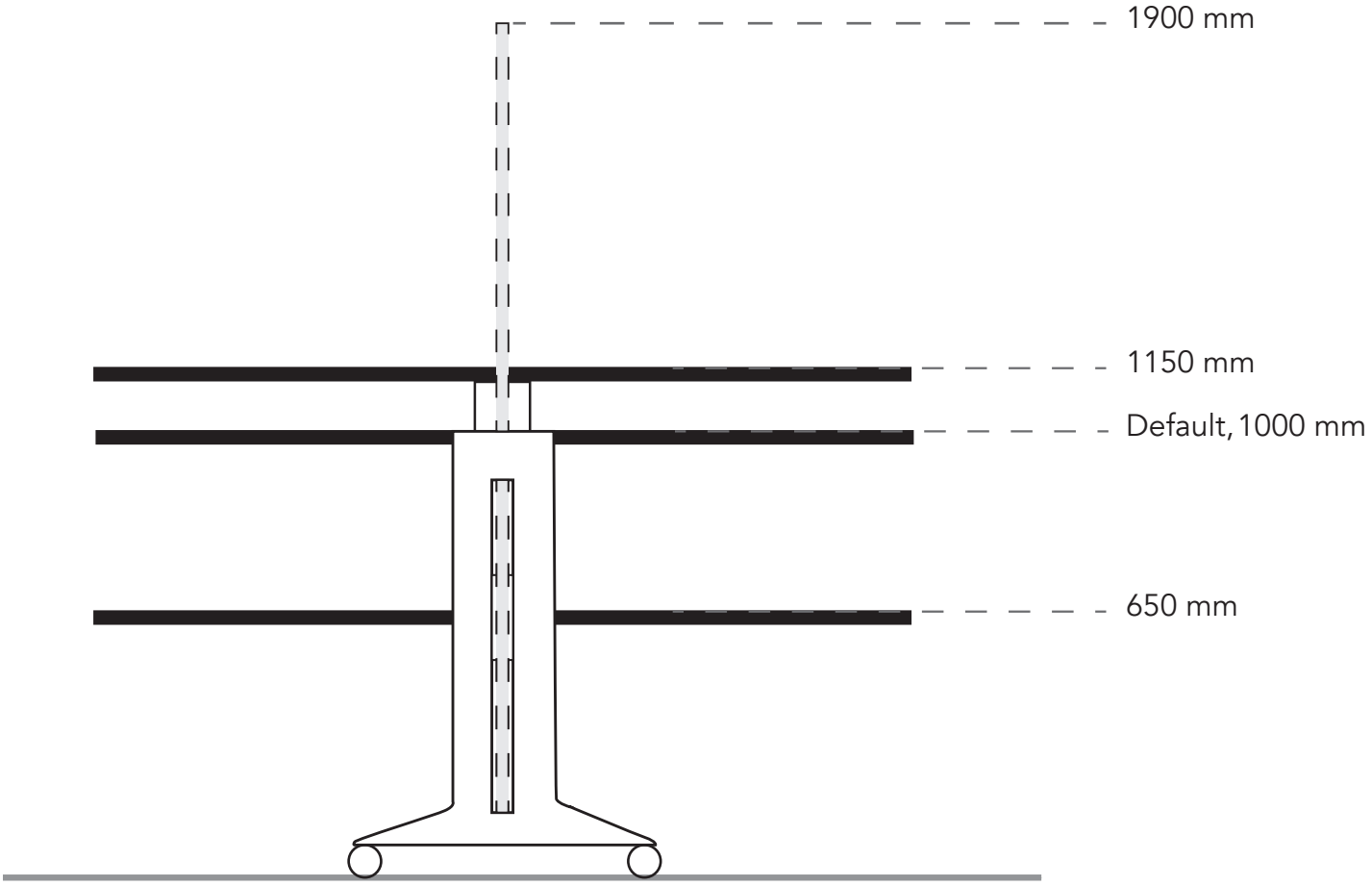


Figure 30. Illustration of the product stroke length and dimensions.

VISUALISATION

This chapter is visualising the final product, and therefore also the definitive result of this master thesis. Using pictures and explanations, this chapter provides the final understanding of how the product looks like, how it is used and for what purpose.

11.1 THE SCRABLE

The final concept has been given the name Scrable. The name refers to the fact that the product has the function of being both a screen and a table, hence a Scrable. Also the character of the name is similar to the word "scribble", which can be explained as writing something hasty or to cover something with drawings and writings, aspects of which the Scrable is intended to be used for. Doing something hasty refers to the ease of use and flexibility, whilst covering something with drawings and writings is one of the many fields of applications for the Scrable.

Figure 31. The Scable, illustrated in vertical and horizontal position.

The Scrable allow the user to have access to two different surface materials in two different applications, both vertically and horizontally. The Scrable therefore provide the function of being both a screen and a table. This allows the product to become flexible and adaptable to the users' needs within both teamwork and short meeting scenarios. It rotates 90° forward and backwards from an upright position to expose the different table surfaces and has a hinge within its rotation axis that allows it to lock into place.

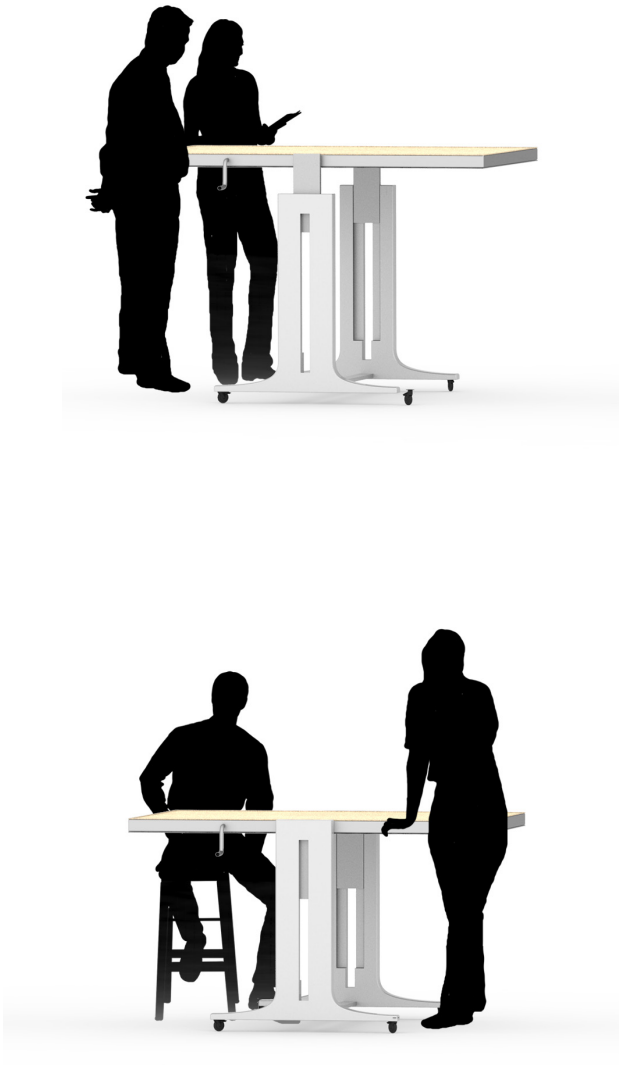


Figure 32. The height adjustability of Scrable, from 650mm - 1150 mm.

Figure 33. Scable frame construction in exploded view.
1 and 3 - showing different surface materials.
2 shows the frame.
4 shows the attachment.
5 shows the wire that enables height adjustability.

The Scrable provides height adjustability with a span of 650-1150 mm (figure 32). The height adjustability of the Scrable is enabled through the use of a mechanical winch and gear rack that moves along the inside of the leg construction (figure 34). The gear climbes alongside the leg, thus allowing the frame and table surfaces to change height depending on which way you rotate the winch. This is a simple manual mechanism for adjusting the height and also a simple technical solution that encourages the user to embrace active behaviour. The winch is placed on the edge of a steel frame construction with direct contact to wires. These wires are placed on the inside of the frame construction enabling the Scrable to rotate 180° around its horizontal axis without twisting and thus remaining fully functional in all positions.

This frame construction holds both the wiring to enable the height adjustability, the hinges for locking the Scrable into different positions and the attachment of different surface materials (figure 33). The surface materials are easily changeable through attaching and detaching with screws. This

Figure 34. Exploded view of the height adjustable function.

steel frame construction enables the Scrable to become a modular system and allow it to rotate into different positions.

Since the Scrable is a modular system the surface materials can be changed and compiled in any way wanted. The intended offered surface materials are whiteboard, wood and felt materials, which from the user studies were deemed the most important surfaces in order to perform collaborative activities within the office. The felt material will enable a pin board surface, allowing the user to attach desired

information. The whiteboard will allow for quick and creative notes and the possibility to attach material due to its magnetic surface treatment. The wood material will allow for a regular table surface. The Scrable can also be used for partitioning, a function that may lower both acoustics but also minimise visual exposure. The possibility of combining surface properties, but also the aspects of choosing colours, creates a large variety of Scrable solutions. This also provides the customers with the possibility to adapt the Scrable to their specific need, an expressed desire from Inergo.

The caster wheels enable product mobility and rearrangement of the Scrable for the sake of flexibility. The caster wheels can also be locked into position for the possibility of obtaining stability.

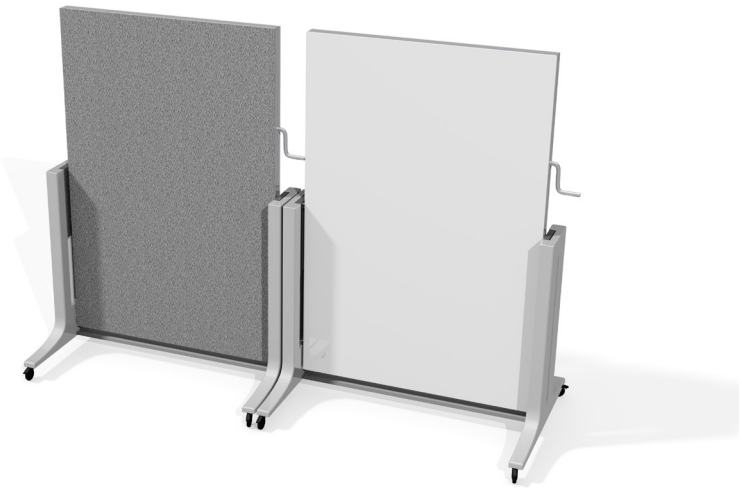


Figure 35. The product Scrable with two different surface treatments, on one side it is a whiteboard surface on the other a felt material

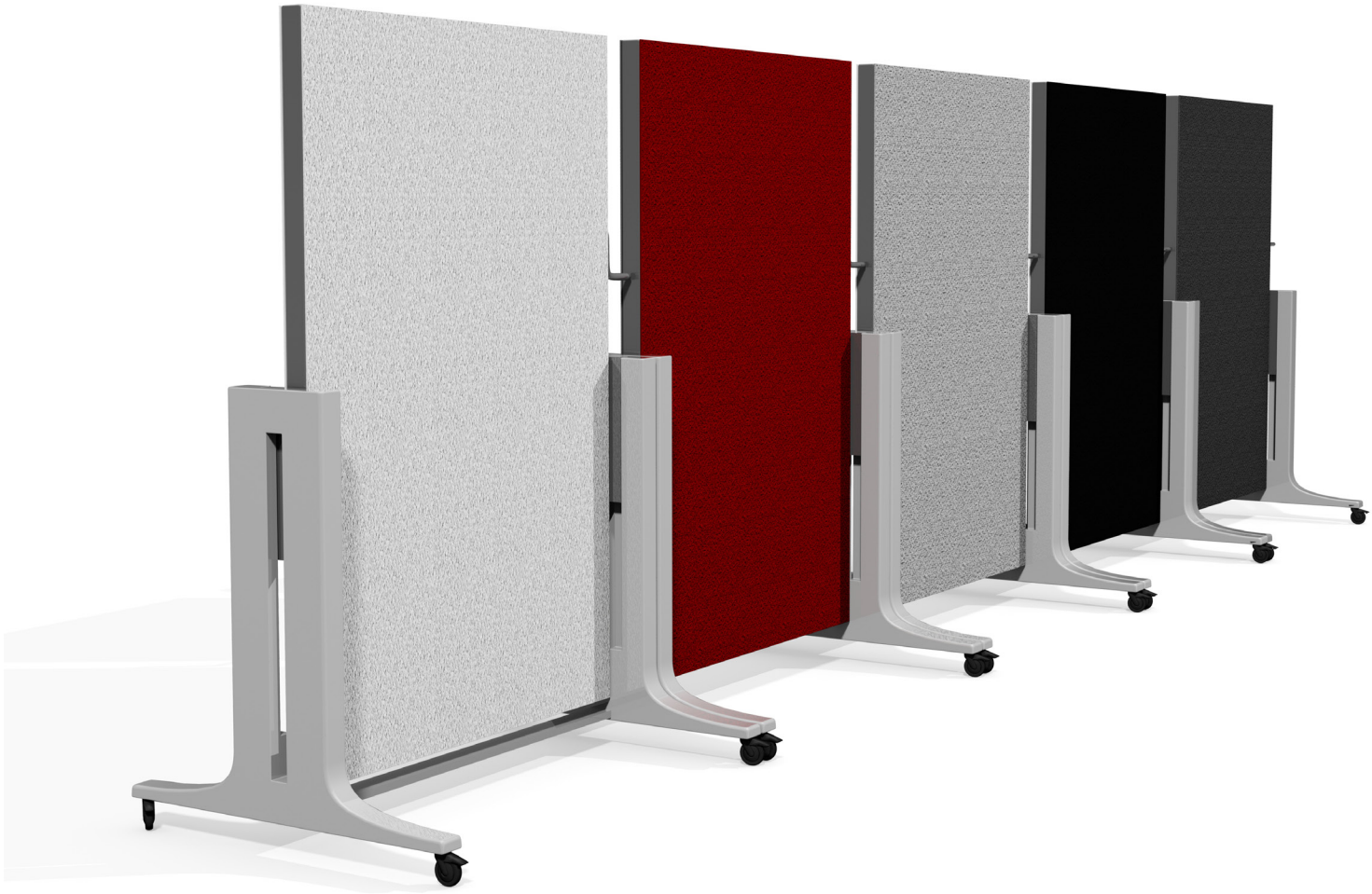


Figure 36. Modularity of the Scrable illustrated using different surface colours.

Figure 37. Modularity of the Scrable illustrated using different surface materials.

From the user studies the desire to be active and have fun during office breaks were expressed. Since the Scrable is a modular system, there could exist a possibility to add an additional feature to the product. That is the feature of using the Scrable as a Ping-Pong table. A Ping-Pong table will encourage collaboration and physical activity, something that is important to minimise the negative physical effects of sedentary work at the office.

Figure 38. The Scrable illustrating the function of being a Ping-Pong table.

Figure 39. The five concepts chosen for further development.

Scenario

The Scrable may be used in any way wanted and is only limited by the creativity of the user. However, it is designed to be utilised within two different user scenarios. These are the short meeting and long teamwork scenarios described in the problem definition chapter.

What this illustrates in figure 39 is how you can interact with the Scrable during these scenarios. Within the short meeting scenarios it may be used as a hangout spot to aid the fast nature of the meeting while providing a place to put material. For instance, the user can easily grab the top of the frame and pull it down and it will lock into a table position, a quick and easy way to provide a hangout spot without having to book a meeting room.

For the teamwork scenarios it is more suitable to use two Scrables. One Scrable in vertical position to pin up material and another one in horizontal position to lay down computers or other items. This was a request from the users to utilise both these types of surfaces within team related work. It is possible to use one Scrable and change it from vertical to horizontal position and the other way around, however the use of two products simultaneously will increase productivity and encourage movement around the products.

The Scrable may also be put together to create a larger surface area to enable the user to spread out their work and aid those large teamwork scenarios. The possible arrangements of the Scrable are only limited by the users creativity and once they are finished using the Scrable it can easily be lifted back up and the users can walk to their next activity.

Figure 40. The Scrable product compiled together in both horizontal and vertical position for creating a larger system.

DISCUSSION & CONCLUSION

12. DISCUSSION

The presented result has to a great extent achieved the goal of developing a product that enhance collaboration and save valuable space in an open office environment. According to the literature study, interview and observations it has become clear that an increase in collaborations can be achieved through allowing employees to define their workspaces after a desired usage, optimise communication and increase social interaction. The Scrable does this through providing multiple functional surfaces with the possibility to transform from vertical to horizontal workspace and permitting mobility. Allowing the users to choose the surface desired for different tasks and the location of which they should take place. It is a concept that saves valuable space within the office environment due to its two separate surfaces and possibility to use these in vertical and horizontal position. Considering the fact that this product could also be used for shielding, it therefore provides the user with five possible field of application within one solution. With the open and intuitive design, the Scrable also invites to be used together with others and optimise the efficiency, a desired goal for a user-friendly design approach. The extent of the usability and intuitive design of the product is only based on assumptions, since no full-scale functional prototype have been created or tested. The product can also be viewed as a space saving solution due to the stationary measurements of the product being less than the size of that in precipitated mode.

12.1 STAKEHOLDER BENEFITS

An important aspect when evaluating the concept is how the product favours the different stakeholders. The users benefit from it because it meets the goal, enhancing the possibilities for collaboration and helps creating a more flexible work environment. Interior designers will benefit from it since, according to the study, there is no existing product solution available at the market addressing this issue today. Therefore they have to develop a new product for each time this occurs. If there were an existing product solution on the market, this would not be necessary, and hence they would save time and resources. The resellers benefit from it because they would be able to provide a new type of product that fulfil needs that has not been addressed in one single product before. Since the intention throughout the project has been to address ergonomics to a high extent, also the ergonomists will benefit from it. The product aims to address flexibility, and through that encourage the users to adapt a more active work habit. Hence, the aim is to contribute to an improved ergonomic aspect of the work environment. For the sake of Inergo, the benefit for them is accompanied by the fact that they would be manufacturing the product and gains the profit that it brings.

Another important factor since Inergo is the intended costumer is of course how the concept suits the company and their current product range. For Inergo as a company, ergonomics is a large focus, and adapting this manner is pursuant to their approach. Also, flexibility regarding the provided products is important for the company, giving the customers the ability to chose and adapt the products to their specific needs. Therefore, having addressed flexibility is considered suitable. The studies also has shown that the concept will fill a gap in the market, which for the sake of Inergo is beneficial, since they exclusively will be providing a solution that meets the different needs. Offering a unique product also contributes to the likeliness of customers buying other products as well, which might contribute to an overall increase in sales. Maybe this consequently result in that Inergo becomes the number one choice of the customers to a higher extent, just as they expressed a desire

for in the beginning of this project. Another one of their desires was for the product to be able to sell in large quantities. Since the concept is intended to use as a modular system, giving the customer the possibility to combine several items, this creates an opportunity for Inergo to sell more products. Inergo said about their customers when buying a table that they only look at the table top surfaces, that it was the main aspect when choosing a table. Developing a concept where the choice of the table top surface plays a central role is therefore assumed to be desired. Both because it suits Inergo's current perception of the market, but also because they therefore can easily meet the customers' behaviour and request, providing the customer with a clear opportunity to chose and adapt the product to their specific needs. In that sense, the concept is assumed to be suitable for Inergo to a high extent, exaggerating the positive aspects of Inergo as a company.

12.2 PROJECT PROCESS

12.2.1 PRIORITISATION

A major part of this project has been to investigate the problems and needs existing in office environments, to be able to define the specific purpose of the concept. Having this investigation as part of the process, with such a wide scope to start with, means that the prioritising of the different steps in the process becomes important. For this project, finding the right problem and needs was very important, and therefore this step was highly prioritised. However, awareness of that this step needs to be kept short in order to have enough time for the concept development meant that effort was made trying not to make it stretch over an excessively long period of time. Regarding the concept development, creating the proper solutions to the problem and encouraging a change of behaviour that improves the collaboration at the office was the main goal. Therefore, focus was also set on the step of the process were different solutions emerged and were developed; the concept creation and development phase. This resulted in a slightly lower prioritising on the parts were formal design and details were dealt with. The conclusion of this is that the concept is to be viewed as just that, a concept, where further work will be necessary. The next step for further work would preferably consist of user evaluation and usability testing. This is something that was found desired in the project, but was not included. Also, further work need to be done regarding construction and material selection, including definition of how to manufacture the product later on. Since the deliverable was determined to be a concept however these aspects were deliberately not performed, even though aspects of manufacturing and material selection has been considered to some extent.

12.2.2 RELIZABILITY

Calculations and decisions have been made using estimations of these aspects, aided by recommendations and the assumptions based on Inergo's current products. However, these assumptions would preferably have been completed with actual recommendations and guidelines directly from Inergo themselves. This was not enabled in the project since Inergo did not provide such information, and therefore decisions were made simply based on the assumptions drawn from current products and general recommendations regarding those aspects. This has of course affected the result in that sense that the concept might have been even more specifically designed to suit Inergo's prerequisites regarding manufacturing if this information had been provided. The assessment however is that, under the circumstances, enough consideration has been made to ensure the realizability of the concept.

12.2.3 USER GROUP

Another important aspect to discuss is the selection of participants for the different studies. For example, when arranging the focus group, the goal was to have a wide target group amongst the participants. This was not fully achieved, and the users were all relatively young and fairly inexperienced in the office environment. This could of course give a slightly narrow view of the problems. However,

this user group is assumed to have a fresh view of the different problems and also be open to changes, which are beneficial attributes for the purpose of product development. Also, the target group from the survey that was performed after the focus group covered a wider range of users, complementing the focus groups in a good way. As many as 51% of the participants in the survey had been working in an office environment for 5 years or longer, and 36% for as long as 11 years or more. Therefore, it has been assumed that the participant used for this project considering both studies represents the target group in a satisfactory way.

12.3 FORMAL DESIGN

The final concept changed appearance in the late part of the development phase as a result of material selection, manufacturing adaptation and mechanical calculations. For example, it was deemed that the top of the frame surrounding the table top was not providing enough benefits to be preserved. Therefore its existent was questioned even though it was one of the factors that created a comprehensive design language to the concept. It was also deemed an obstacle for collaboration. This together with being deemed an unnecessary use of material from a sustainability and manufacturing aspect was cause for dismissal. This decision changed the entire expression of the product resulting in an extensive formal design development and a new approach to solving the technical aspect of the product. However, even though the development ended up with a radical change in the perception of the concept, the final result was such an improvement to the overall function of the concept that the change was not to be seen as negative.

12.4 SUMMATION

Finally, to reflect upon the overall appearance of the project process used, it was considered suitable for this type of project. Main focus was set on finding the problem, and since it was a need-driven project rather than technique-driven, the chosen process worked very well. This lead to a high priority of the earlier phases, with user studies and problem definition, resulting in a lower priority of the final steps such as the formal design. These prioritisations can be questioned, however since the deliverables was set to be a conceptual product, the final result reached a desired level and therefore the process fulfilled its purpose. However, if a similar project would be performed again having the knowledge gained, more resources would be set on verifying the final concept with the end users, involving them to a higher extent in the later part of the process. This would have been desired to confirm the assumed effect of the final concept.

Following, the project has provided deeper insights and understanding about how to make prioritisations during a project and how it affects the final result. Also, knowledgement and experience about having an intended customer and how to relate to their needs and interests has been an important part of this project, especially since there have been both a project initiator and an intended customer involved in this project. In conclusion, this project have provided valuable knowledge about how to use your resources in the best possible way, and to utilize the existing proficiencies in the best way to achieve a desired result.

13. CONCLUSION

The thesis has generated in a space efficient flexible concept product named Scrable that enhances collaboration at the open plan office environment, which was the purpose of project. Scrable is a product that allows movement in all directions and rotation around the horizontal and vertical axis. The Scrable is also built around a modular system that allows the purchaser to change the table surfaces to their own desires. The surfaces that are provided as options at this stage of the product development is pin board made out of material with silencing properties, whiteboard and different types of wood surfaces. The movement abilities together with the modularity of the product allowe it to provide all types of surfaces that are needed to enhance collaboration between users in an open office environment.

The ergonomic focus of the Scrable makes it user-friendly, adaptable to different human body measurements and coherent with Inergo's business model. It allows an adjustability between 650-1150 mm in a horizontal position permitting the product to fit and adapt to a large target group.

The position of the mechanical winch make it is easy to use and understand for first time users and minimise performance errors due to only permitting movement when the product is positioned in a horizontal position.

The design of the product is deemed to express a feeling of being stable, calm, confident, adaptable, collaborative, supportive and witty due to its thick frame construction, sterling base and divert functionality. Which was part of the goal of the project. The final product is a conceptual product that need further development and consideration regarding, technical aspects and manufacturing before being ready to launch.

The design together with the flexibility and functionality of the product is assumed to give value to Inergo as well as purchasers, and its users. It is deemed to fill a gap within the market of office furniture design since this problem has not been addressed in the same manner before.

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15. APPENDIX

Appendix 1
Questionnaire

At your office

1. For how many years have you been working? *

- [ ] 0-1
- [ ] 2-4
- [ ] 5-10
- [ ] 11+

2. How many different workplaces have you had? *

- [ ] 1
- [ ] 2
- [ ] 3
- [ ] 4
- [ ] 5+

3. What type of office environment do you work in right now? *

- [ ] Closed office room (only you in a room)
- [ ] Shared office room (2-3 people in one room)
- [ ] Open landscape office
- [ ] Flexible office (no individual desk)

4. Roughly how is your work divided during the office hours, try to estimate the percentage of time spent on each activity, the total should count for 100%

	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Individual work	○	○	○	○	○	○	○	○	○	○
Meetings	○	○	○	○	○	○	○	○	○	○
Teamwork	○	○	○	○	○	○	○	○	○	○
Other, please specify below	○	○	○	○	○	○	○	○	○	○

5. Is lack of workspace a problem at your office?

- [ ] Yes
- [ ] No

6. Have you ever had a need for a temporary workspace?

- [ ] Yes
- [ ] No

If Yes, please specify WHEN and WHAT type of space. If No move to question 7.

Why do you need this workspace?

Does this extra space exist at your office? If Yes, please describe it.

7. Why does there not exist a need for temporary workspace?

If Yes on question 6 you do not have to answer this question

8. Do you feel the workspace provided at your office suites your way of working?

9. What type of workspace would you like to have at your office?

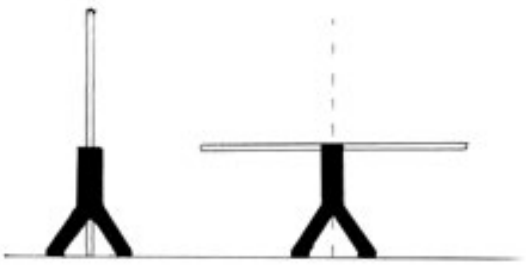
Additional comments

Thank you for participating!

Appendix 2
Repertory grid

Stable	☐	☐	☐	☐	☐	Wobbly
Confident	☐	☐	☐	☐	☐	Shy
Serious	☐	☐	☐	☐	☐	Witty
Independent	☐	☐	☐	☐	☐	Collaborative
Fix	☐	☐	☐	☐	☐	Adaptable
Ignorant	☐	☐	☐	☐	☐	Supportive
Calm	☐	☐	☐	☐	☐	Excited
Expensive	☐	☐	☐	☐	☐	Cheap
Easy	☐	☐	☐	☐	☐	Complicated
Office	☐	☐	☐	☐	☐	Home

1



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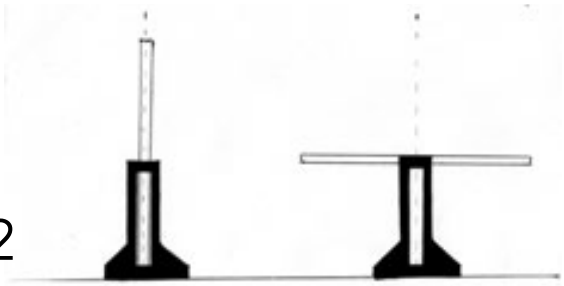

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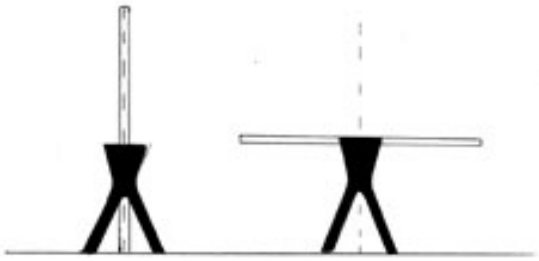

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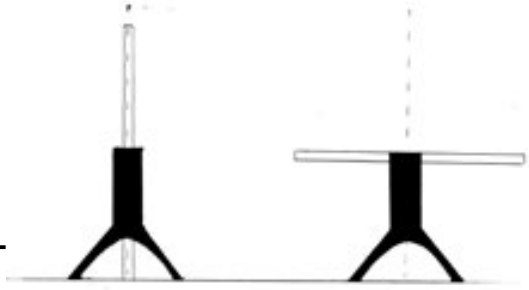

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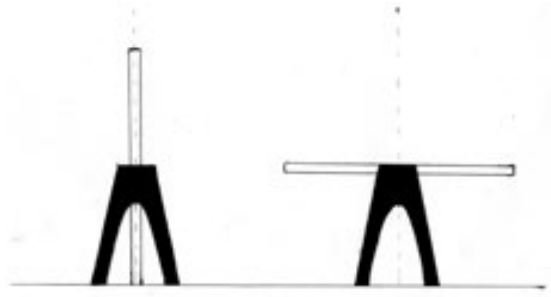

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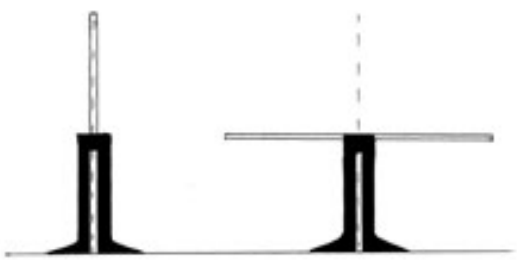
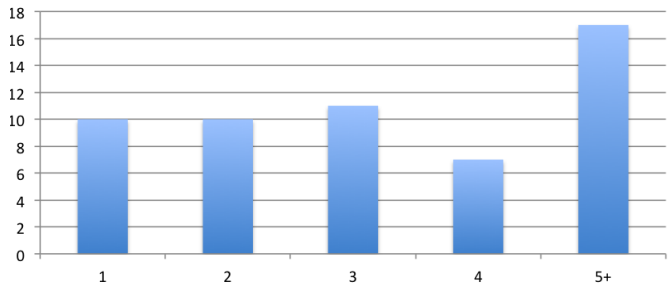


Appendix 3
Requirement specification

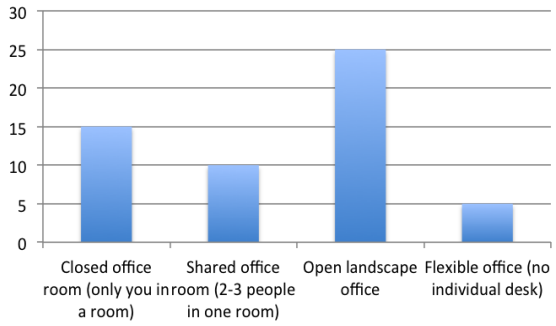
REQUIREMENT SPECIFICATION						
Industrial Design Engineering, Chalmers University of Technology						
Project: "Office Furniture Design to Improve Collaboration - The development of a space efficient workstation to enhance flexibility."						
Issued by: Cecilia Edlund and Elin Fouganthine						
Created: 2014-03-18		Modified: ongoing				
	Criterion no:	Criterion	Weighting	F/L	Method of verification	Reference
Usage						
	1	Be installed with no more than 3 steps (simple use)	5	L		
	2	Be installed with no more than 5 steps (advanced use).	5	L		
	3	Be understood by first time user after 20 seconds.	5	L		
	4	Installation should not take more than 30 seconds.	5	L		
	5	Easy to move (manageable by one person).	5	F		
	6	Be used by the 5th and 95th percentile of employees.	5	L		
Geometry						
	7	Fit through a regular door opening (800x2100mm).	5	L		
	8	Adapted to fit average sealing height in upright position. (minimum allowed sealing height 2,7m).	5	L		
	9	Abutting face 1000x1200mm.	5	L		
	10	Stroke length 500mm.	5	F		
Ergonomics						
	11	The amount of force required for moving/folding is to be no larger than 100 N.	5	L		
	12	Enable table heigh from 650-1150mm.	5	F		
	13	Minimum vertical reach length 1850mm.	5	L		
	14	Minimum horizontal reach length 620mm.	5	L		
Safety						
	15	Enable fixed positions in space.	5	F		
	16	Should not tip over with a load of 120kg.	5	L		
	17	No risk for unwanted folding.	5	F		
	18	Minimize risk for pinch injury.	4	-		
	19	User errors must not result in injury.	5	F		
Branding						
	20	Match current product range of Inergo.	2	-		
Environment						
	21	Minimise use of material.	3	L		
	22	Minimise the number of materials.	3	L		
Capacity						
	23	Optimise the relationship between horizontal and vertical worksurface.	4	-		
	24	Bare a load of minimum 120 kg.	5	L		
Additional						

Appendix 4
Compilation of the survey result

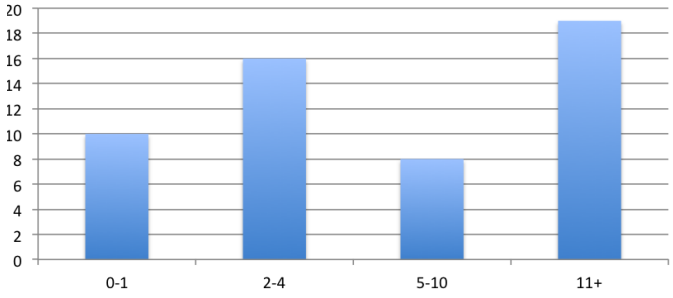
How many different workplaces have you had?

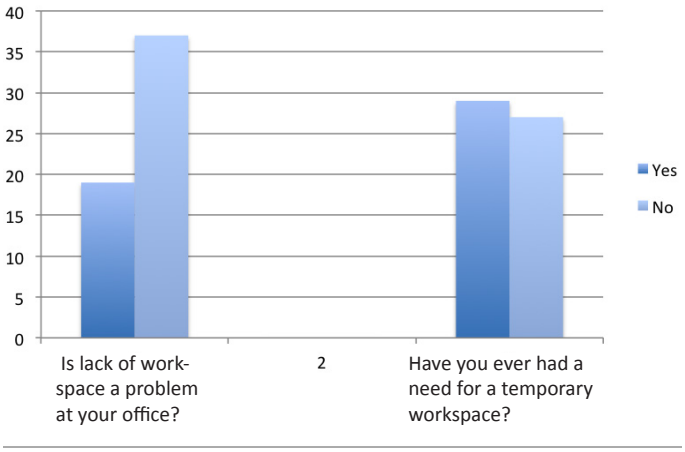


What type of office environment do you work in right now?

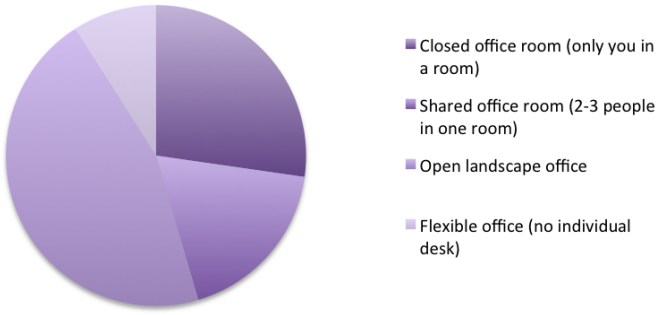


For how many years have you been working

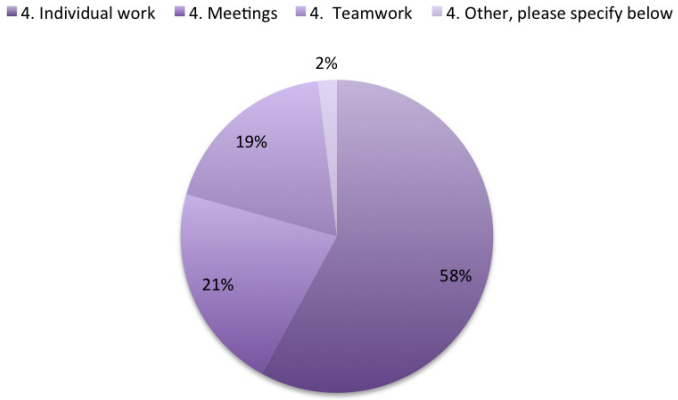




Roughly how is your work divided during the office hour?



Percentage of work..



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