

CHALMERS



Development of an ergonomic couch with a Cradle to Cradle design approach (for an activity based office environment)

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

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Master of Science Thesis PPUX05

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Abstract

The goal is to develop an ergonomic couch area that allows for people to work in as an addition/supplement to conventional workstations within an activity based working environment. Furthermore develop a selling product with market potential and sustainable development in the Cradle to Cradle mind-set.

It should be environmentally friendly by following the cradle to cradle design principles taking into consideration material choice, manufacturing, use, chemicals, coating, end life, disposal and recycling.

Fit into the companies brand by following the brand design queues and values. Provide for recognition as well as consistency with brand deliverables. It should express professionalism by both aesthetics and good working posture. It should fit into their market segment and focus area. It should have good market value by being realizable as well as feasible to produce.

It should also be comfortable to work with good ergonomics in mind providing for adequate posture while working with objects such as tablets, laptops and other various uses.

The project has resulted in four principles of how to solve the problem. The end goal is to build and test a main concept within the principles of activity based working with a future goal of achieving a Cradle to Cradle certification.

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1 INTRODUCTION

In this chapter a summary of the whole projects will be describe. The problems, purpose, scope and goal of the project will be describe and limitation of the project will be defined.

1.1 Background

There is a public increase in environmental awareness and as such companies are constantly improving their environmental affect to attract more customers. There is also a change in how people work in offices with more open and flexible offices. A large Swedish furniture manufacturer had the goal with this project to have activity based working combined with a cradle to cradle design approach to develop an ergonomic seating solution, while increase the environmental principles within the company and to create market value for a new soft seating product. A deeper environmental approach is in line with the company's goals of long-term environmental sustainability and their environmental declaration.

1.2 Problem area

In line with future needs the way we work in offices is moving towards activity based working where the work is spread throughout the office environment into different areas. This spreading of work tasks around spaces not developed with those tasks in mind creates strains on users when using laptops, tablets and other tasks originally intended for use with workstations. There is a lack of adjustability of the seating, proper support for laptops and writing surfaces. Users adapt awkward positions that cause strain as well as look unprofessional. There is a need for a product that increases the environmental awareness that is in line with the company's values.

1.3 Purpose

The aim of the project is to in cooperation with the company develop a couch solution that fits together with an activity based working environment to develop a couch concept as a basis for further prototype development and manufacturing.

Furthermore to look into how soft seating is used in an activity based working environment by taking into consideration how information technology such as laptops, tablets as well as typing documents, reading etc. fit into the working environment.

The aim is also to increase the environmental awareness within the company as well as bring forward a product that will increase awareness for the brand and its environmental approach through implementing a cradle to cradle design approach.

From the students perspective the aim is to increase the skills in product development, product design, and ergonomics as well as allow for independent work in a real life project.

1.4 Scope

This thesis project spans from initial literature study to developing basis for a prototype. The study will include the ergonomic situation of a couch and how it can be improved while remaining seated and working. This will be achieved through studying existing literature and assessing how users behave. It can also require virtual or physical models depicting different ways of achieving comfort to assess how well different concepts fulfill these requirements.

The literature study will also include how the soft seating might be used and in what context it may be relevant. This will require looking into what needs such a solution might require and what it needs to provide. This will then lead to finding a concept that can be used in the right way and in the right context.

The scope also includes environmental aspects, as the product needs to be developed for the future in mind with increased demands and responsibility regarding the environment. The new generated design should also be based on a Cradle to Cradle design process, which will require research into sustainability and material selection. This will also entitle looking into what criteria a Cradle to Cradle certification requires and to what extent this project should go in achieving those requirements. These aspects need to be considered during the early phases of concept generation without limiting creativity and the depth increase as the project moves further.

The company's brand and its values will also require looking at current products as well as competitors and existing solutions that fit the segment.

1.5 The Goal

The project goal is to have a soft seating concept with good ergonomics while performing different tasks and that fits into the company's vision and values. Another goal is to have a basis and recommendations towards a cradle to cradle certification. A goal is to successfully have applied cradle to cradle thinking for a soft seating product and finally having a foundation for prototype manufacturing.

The final impact goal would be a selling product with market potential that conveys the brand, values and vision. It should improve the working situation within an activity based office and make it more appealing to work desk-less.

1.6 Delimitations

Focus of the work will be centered on the development of a couch solution around which other non-detailed concepts might be centered in order to facilitate an activity based working environment.

Since the focus of the work will be several areas such as ergonomics, environmental aspects and aesthetic values in depth analyses in each of them cannot be handled in the timespan of

the project. Focus will lie in trying to find a seating solution for activity based working on which a cradle to cradle approach is applied.

There aren't any limitation to introducing new manufacturing methods to the company but preferable if they don't have to buy new machines.

In addition, as the company's products are delivered partly or even completely assembled, dimensions and weight of the product might be important to consider but detailed descriptions on final weight, construction and technical principles will be kept to a minimum.

1.7 Ambitions

The ambitions in the beginning of the project was to have a final concept with CAD-models and mock-ups with test results and a basis for making a working prototype together with the furniture manufacturer as well as having recommendations for developing towards and applying for a Cradle to Cradle certificate for the product. A complete report consists of researches about activity based office, ergonomic seating and working with computer and cradle to cradle as well as methods and process.

2 LITERATURE REVIEW

In this chapter the field of literature studies will be covered. First cradle to cradle will be described, what it stands for, its advantages and disadvantages over other methods, what it will bring and how it will be implemented in the project. Furthermore the principle of activity based offices will be described and the advantages of these. This chapter will also bring up the ergonomic considerations within office work, sitting and working with laptops, the problems, why it's important with good ergonomics and guidelines for how to achieve good ergonomics in these areas. The result of the review is presented below and will form the basis for the rest of the project.

2.1 Cradle to Cradle

To find the placement of Cradle to cradle (also referred to as C2C) in eco design and have a better understanding of how C2C is related to sustainable design, some general information of eco design and sustainable product development is needed. Eco efficiency and eco effectiveness as the two main path of sustainable design will be described and then C2C as the applicable tools in our project will be defined. Barriers for implementing C2C, the process of implementing cradle to cradle and its benefits.

2.1.1 Eco design

Eco design is a design method considering of environmental impact of products, which matches perfectly with sustainable design approaches. These methods try to assess life cycle of product to decrease the non-renewable energy and material consumption and eventually limit negative effects of products on nature. Three laws of sustainable product development as proposed by Nabil and Michael (2006):

1. Minimize material and energy usage
2. Maximize usage of expended resources
3. Minimize or eliminate the adverse impacts of waste and emissions.

(McDonough, Braungart, Anastas & Zimmerman, 2003) have defined a few principles to apply to green design in product development:

- Use non-hazardous material and energy inputs and outputs
- Make less waste rather than to clean it up
- Design products where materials are easy to separate and purify
- Maximize mass, energy, time and space efficiency during product design
- Design durable product which are easy to recycle, reuse and repair
- Use less diverse materials to make disassembly easier
- Use renewable available energy and material resources

Two strategies could be used to go apply sustainability and eco design in product development; Eco efficiency Eco versus eco effectiveness.

Eco efficiency

Eco efficiency is a task to reduce negative impact of human activities on the environment per unit of product or service (Bjørn, Hauschild, 2011). On the other words eco efficiency is a method to increase economic value of products and services with less impact on ecological systems (Braunga, McDonough & Bollinger, 2006).

The principal of the eco-efficiency concept can generally be understood as to get more values for products and services with less waste, less resource use or less toxicity. In term of material, Eco-efficiency can be described as the concepts of dematerialization, better resource productivity, less toxicity, raised recyclability (down cycling) and longer product lifetime. All of these theories based on linear; Cradle to grave material flow which is transformation of resources into waste and Earth through production and consumption. (Braunga, McDonough & Bollinger, 2006).

In linear systems of resource consumption, materials are used to manufacture a product and disposed by consumers at the end of a products lifestyle. In order to improve resource performance economy, reuse of material, energy and inputs have investigated in industries. Circular systems replaces linier systems which is end up life concept with refurbishment, moves towards the use of renewable energy, eliminates the use of toxic chemicals, to make possibility of reuse, and aims for the elimination of waste (Nasr & Thurston, 2006).

Circular systems is more beneficial than linear systems regarding to usage of material. Principles of Circular economy define as minimizing of material usage, maximizing the number of consecutive cycles, diversifying reuse across the value chain and finally increasing collection and redistribution efficiency while maintaining quality. In general circular economy could cause reduction in material usage and reduce the overall related labor and energy costs as well as carbon footprint during the entire supply chain (Foundation, 2010), (Nasr & Thurston, 2006).

LCA

Life cycle assessment is method to assessment the environmental influences attributable to the life cycle of a product, such as climate change, ozone damages, , acidification, toxicological stress on human health and ecosystems, the depletion of resources, water use, land use, and noise—and others (Rebitzer et al, 2004).

Life cycle assessment (LCA) is the most common methods to measure Eco efficiency. It corporates relevant resource uses and productions during the entire life cycle of a product or a Service, from raw materials to waste management (Bjørn & Hauschild, 2011).

As LCA is a liner method, it is not an appropriate approach for generating eco-effective products and processes and optimization in the context of cradle-to-cradle design (Braunga, McDonough & Bollinger, 2006).

Carbon foot print

Using carbon footprint, companies try to estimate their own impacts to global climate change. In contrast with LCA, carbon foot print focuses more on purchased energy to

produce a product and not the whole life cycle assessment (Matthews, Hendrickson & Weber, 2008).

Common tools for eco efficiency

Recycling, reuse and remanufacturing are some of common helpful tools to reduce the environmentally effect of product which is typically happens during manufacturing and disposal process. Reusing and remanufacturing are more valuable than recycling because of preserving the embodied energy inside the product itself (Bartlett, 2009). Other tools can be listed as:

- Design For Disassembly
- Down_cycling
- Hybrid Product
- Product Of Consumption
- Product Of Service
- Up_cycling

Eco Effectiveness

Eco-effectiveness developed on the model of effective regenerative productivity of natural systems. In nature, all inputs for one process come from for outputs of another process so concept of waste does not exist (Braunga, McDonough & Bollinger, 2006).

Compared to eco-efficiency that initiates in contrast with the idea of linear, cradle-to-grave material flow system, eco-effectiveness generates a set of strategies to make healthy, cradle-to-cradle material flow metabolisms ;Similar to internal processes of a living organism (Braunga, McDonough & Bollinger, 2006). Efficiency is described as “doing things the right way”, effectiveness means “doing the right things”. Industry assume as a fundamentally bad in eco efficiency while in eco effectiveness industry is totally presupposed good (Braunga, McDonough & Bollinger, 2006).

A stepwise strategy has been defined by Braungart and McDonough for businesses to transit from eco-efficiency to eco-effectiveness. Removal X-substances is the first step. In the next step educate people who are decision maker on eco design choices has been considered. Next step is classification of each element of product according to their toxicological and eco-toxicological characteristics to determine future required optimization. Afteward, Outcome from previous step is implemented. Last step encompasses a reinvention of the relationship of the product with the customer (Braunga, McDonough & Bollinger, 2006).

Balanced relationships between biological and technical metabolisms confirm raw material accessibility. While in technical metabolism, material reprocesses by companies lead to more economic activity, biological metabolism reprocess material in an ecological way which result to replacement of natural systems (Braunga, McDonough & Bollinger, 2006).

So many eco-analysis tools have been outline to assess product’s environmental effect concerning eco-toxicity and human health harmfulness. Life Cycle Analysis (LCA), Intelligent materials pooling, Cradle-to-Cradle (C2C) and Carbon Foot printing (CFP) are three most

common eco-analysis tools that can be used by companies to widely evaluate a product's environmental effect. (Prendeville, O'Conno & Palmer, 2010).

Eco effectiveness use a set of strategies like Cradle to Cradle design, intelligent materials pooling to develop a cyclical material flow metabolism. The purpose is to achieve zero emissions and use materials in a way that maintains or increases their value and productivity over time (Braunga, McDonough & Bollinger, 2006).

Intelligent materials pooling

Intelligent materials pooling is a structure for the management of eco-effective nutrient flow metabolisms. A *materials bank* supports ownership of technical nutrient chemicals and materials by leasing these elements to companies to be used in their products or services. Materials are recovered and returned to the materials bank after defined used period. All the information associated with these materials is managed by material bank to ensure of true *up-cycling* of the material (Braunga, McDonough & Bollinger, 2006).

2.1.2 Cradle to Cradle

Cradle-to-cradle design, suggests new design cycle model for entirely positive human designs. Using this design method, which is based on current solar income usage, make no toxic waste, use safe materials and on the idea that industries can clean air, land, and water instead of polluting. To achieve this goal, Cradle to Cradle identifies two metabolisms within which materials flow as healthy nutrients in a circular cycle.

Every element of a product should either be naturally biodegradable and return back to the soil or to be completely recyclable into an equally high quality material for later products (Bjørn & Hauschild, 2011). Material should turn into nutrients during a circular life cycle through one of two distinct metabolisms: the biological metabolism and the technical metabolism (Braunga, McDonough & Bollinger, 2006).

All materials that are safe for humans and nature like natural or plant based material and potentially synthetic matters like biopolymers can be counted as biological nutrients. Products made by biological nutrients are called as products of consumption and products made by technical nutrients are called products of service.

During a biological metabolism, material used by customers and also during the manufacturing process are extracted and returned to nature as a natural nutrient. Recovered materials can also be used in new products (Braunga, McDonough & Bollinger, 2006).

On the other hand, a technical metabolism may defined as an extraction of materials from used products with recovery, maintain and finally reuse of it in a new product life cycle (Braunga, McDonough & Bollinger, 2006).

Materials are evaluated concerning toxicity, energy use, recycling and reuse methods, and then classified as Red, Yellow or Green. Red shows highly toxicity of material; 'safe' material shows by Green and Yellow is in the middle. In condition of insufficient data of a material an

extra Orange category represents a material where insufficient data is available (Prendeville, O'Connor & Palmer, 2010).

2.1.3 Principles

Three fundamental principles of Cradle to Cradle are stated as: Waste Equals Food, Use Current Solar Income and Celebrate Diversity (Bjørn & Hauschild, 2011).

Waste Equals Food

Concept of Waste Equal Food originates from natural endless nutrient flow which output of every source could be an input for another source (Bjørn & Hauschild, 2011).

Use Current Solar Income

To run a C2C design flow, all energy must derive from of renewable energy sources like photovoltaic, geothermal, wind, hydro and biomass. As sun is an unlimited source of energy, as long as the quality of the energy meets the requirements, there quantity is not important (Bjørn & Hauschild, 2011).

Celebrate Diversity

Design products and systems using local environments, economies and cultures is key point of the last principle of C2C (Bjørn & Hauschild, 2011).

Over the past decade, cradle-to-cradle has transformed more and more from theory to practice. A new conception of materials and material flows that closed-loop material flow cycles are creating (McDonough, 2006).

2.1.4 Criticism against cradle to cradle

Measuring of the quantity of energy usage is one of the most important criticisms against Cradle to Cradle. C2C that emphasizes the use of solar income, which is very not likely to be fulfilled within the near future. C2C doesn't offer an alternative approach for solving energy usage with non-solar income energy sources (Bjørn & Hauschild, 2011).

Massive time needed to assessing the requested data (point out which data) for C2C is another barrier. C2C has also criticism towards the 'biological nutrients' which contain carbon compounds and also overwhelm lakes or rivers with nitrogen or phosphorous which may result toxicity to humans (Prendeville, O'Connor & Palmer, 2010).

Considering LCA as a tool focused approach to evaluate and improve the environmental performance, C2C defined as objective driven approach which guides activities to definite ends to forms and the necessary tools to evaluate progress toward those ends (Rossi, Charon, Wing & Ewell, 2006).

While LCA provide environmentally sustainable advice to for eco designers, C2C establish a definite set of criteria for designers. Based on these differences, LCA and Cradle to Cradle are in disagreement in number of critical points (Bjørn & Hauschild, 2011).

In conclusion, C2C based on the following definition:

- Human activities impact can be good, nourishing and healthy
- Materials and products should be designed as technical and biological nutrient or contain both
- C2C evaluates just qualities of current solar income as the energy recourses and not the quantities of used energy.
- C2C aims towards recovering the natural balance by adding nutrients (that are in shortage because of human activities) to the environment
- The material and products should be easy to recycle therefore technical and biological nutrients should not be mixed.
- As materials circulate in the technical or biological closed nutrient loop, C2C economic growth can occur at a high rate without any harm to the environment (Bjørn & Hauschild, 2011).

Using both tools (LCA and C2C) leads the design to have the positive image of a Cradle to Cradle design and not act worse than products of eco-efficient competitors by consuming more material (Bjørn & Hauschild, 2011).

2.1.5 Barriers

Several obstacles have been defined to implement cradle to cradle tools which were mentioned above. Limited demand for reused furniture and limited storage capacity which limits the capacity of industry to take back and store furniture for reuse are the two most important barriers. Other difficulties can be listed as:

- Difficulty on transportation of products back to the manufacturing, particularly if the manufacturer is not responsible for direct supply to customers
- Quality or technical problems due to inefficient transportation of old products
- Difficulty to detection of furniture types and models appropriate for remanufacturing
- New way of office design shift to more modular furniture to reduce waste
- Change in Technical work tools size like computer and printer therefore more need on small furniture rather than large one.
- Downturns economic situation leads to large discount on reused products so decrease total profitability of manufactures. (Bartlett, 2009)
- Extensive time investment to access the requisite data (Prendeville, O'Connor & Palmer, 2010)

2.1.6 MBDC

The principles of cradle to cradle exclusively manage by McDonough Braungart Design Chemistry (MBDC) which is a global sustainability consulting and product certification firm founded in 1995 by world-renowned architect William McDonough and chemist Dr. Michael Braungart. MBDC consults clients on leaving a 'positive footprint' on the planet (instead of reducing negative footprint) by implementing the Cradle to Cradle Framework. (MBDC)

Parameters for MBDC's materials assessment are according to (McDonough, Braungart, Anastas & Zimmerman, 2003) the following:

- Human health criteria like Reproductive toxicity, irritation of skin/mucous, sensitization and other relevant data (e.g., skin penetration potential, flammability, etc.)
- Ecological health criteria like bioaccumulation, climatic relevance, heavy metal content, persistence/biodegradation and other (water danger list, toxicity to soil organisms, etc.) (MBDC)

2.1.7 Certification Criteria

Five principles certification criteria are listed as Material Health, Material Reutilization, Renewable Energy Usage, Water Stewardship, and Social Responsibility. The product and manufacturing processes need to cover the criteria at that level in all five categories to get certification at a specific level.

	Silver level	Gold level	Platinum level
Material Health	In Cradle to Cradle design materials should be technical or biological nutrients. Through the certification process, entire supply chain should be analysed to outline every chemical in the product over 0.01% (or 100ppm). These chemicals are then assessed compared to human and environmental health criterias and granted a toxicity score of Red, Yellow, or Green. Green level of material have a little or even no risk associated with them and chosen for intentional use. Yellow label of materials contain small to moderate hazard and are applied for continued use if not a GREEN replacement is available. Red marked materials are the one with high hazard and risk and should be develop strategy for phase out. And finally gray ones show lacking data and are impossible to be characterized. (MBDC).		
Material Re use	Circular life cycle of materials is expected in higher levels of certification. (MBDC).		
Renewable Energy Use	The final energy usage of the product should be measured and characterize	The final assembly of the product should be use at least 50% renewable energy obtained across renewable certificates	all of the final assembly energy should be renewably powered and 50% of the entire energy footprint must be renewably powered
Water Stewardship	the company must publish water stewardship principles that guide operations	the company must conduct a self-assessment of the water use	the company must implement innovative water conservation and water discharge measures
Social Responsibility	the company must expose a corporate ethics or fair labor statement	the company must manage a self-assessment to collect data towards a third party social accreditation or certification	the company must complete a third party social responsibility certification

2.1.8 C2C Certification requirements

There are four levels of product certification: **Basic, Silver, Gold, Platinum**. In order to be certified at a certain level, a product must meet the minimum criteria for that level in all five criteria categories: Material Health, Material Reutilization, Renewable Energy Use, Water Stewardship, and Social Responsibility.

General Description of Certification Levels:

BASIC	<ul style="list-style-type: none"> -All chemicals in product identified down to 100ppm level (0.01%) -No PVC, chloroprene, or related chemical at any concentration -All materials and chemicals assessed for toxicity to human and environmental health -Strategy developed to optimize all remaining problematic chemicals -All materials defined as technical nutrients to be recycled or biological nutrients to be composted
SILVER	<ul style="list-style-type: none"> - All requirements met at BASIC level - Halogenated hydrocarbon content <100ppm - Toxic heavy metal content (Pb, Hg, Cd, Cr+6)< 100ppm - Material Reutilization score >=50 - Quantify the energy required for manufacturing (final assembly) - Characterize energy sources and develop strategy for including renewable energy - Adopt company wide water stewardship principles or guidelines
GOLD	<ul style="list-style-type: none"> - All requirements met at BASIC and SILVER levels - NO problematic chemicals (assessed by MBDC as RED) in product - Plan for product recovery and closing the loop - Material Reutilization score >=65 - Use renewable energy for 50% of manufacturing (final assembly) - Complete an audit to characterize and quantify water use - Complete an audit of corporate social responsibility practices
PLATINUM	<ul style="list-style-type: none"> - All requirements met at BASIC, SILVER & GOLD levels - Actively recovering products and closing the loop - Material Reutilization score >=80 - Use renewable energy for 100% of manufacturing (final assembly) and 50% of supply chain manufacturing - Implemented innovative measures to improve water conservation and water quality - Complete a third party social responsibility certification

2.1.9 Implementing C2C

Concentration on environmentally sound furniture is becoming more and more popular among furniture companies (Parikka-Alhola, 2008). Office furniture has a lifetime of 9-12 years (USA) and in Europe it ranges from 5 (Bartlett, 2009) to 10 years (Parikka-Alhola, 2008). Aesthetic or business decisions are the most common reasons to replacement of office furniture rather than being out of use and in most of cases, whole office are replaced rather than single units (Bartlett, 2009).

Almost 1.2 million tones of office furniture are discarded annually in the EU, ending up mainly for incineration and for landfills. Over half of this is wooden material, over one-third consists of metal parts, and the rest includes plastics, textiles and other materials and parts. Implementation of the Cradle to Cradle design process which mainly means designing products made entirely from a combination of technical and biological nutrients is challenging (Rossi, Charon, Wing & Ewell, 2006).

Methods used by office furniture companies can be categorized as:

- Exchange the old product with another new remanufactured product or the same product. This method has been used in some companies such as Hermann Miller and Wilkhahn
- Design products for easy disassemble therefore possibility to onsite services like repair and renew which offer a considerable life extension of product
- Take back the used products so no extra resources are needed to enable removing, processing or reselling the old furniture (Bartlett, 2009).

Most common materials used as raw material in furniture industries are wood, metal and plastic. Highest environmental effects of furniture listed as chemical effect of material during manufacturing process and usage of product, enormous amount of waste generating, energy loss and material misuse (Parikka-Alhola, 2008).

Three core strategies to establish eco design in office furniture industries categorized as:

- Design products which are easy to disassemble and take part of recycle material. To ease separation and recycling materials are marked.
- Design for durability, maintenance and repair services, reuse, remanufacturing and leasing to have longer lifetime and therefore reduction office furniture consumption and waste
- Eliminate toxicity of materials by take consideration during design process (Parikka-Alhola, 2008).

2.3 Activity based office

This chapter describes what activity based office work is and compares it to other ways of looking at office work.

The work environment has changed during last 20 years. Work environments were more location specific with either owning space or long-term leasing in highly territorial space based on strong physical branding and formal structured interaction using physical space and mobile technology.

It seems that in future work spaces are going to be more like a network of locations with short-term leases, pay-as-you-go (Alliance/shared/hired space) based on varied internal and temporary brand expression and flexibility, connections, implementation speed using operating across virtual and physical space (Morrell et al., 2005).

Different types of layout can be used by different organizational structures. Interaction (the necessary amount of face-to-face communication to do work processes) and autonomy (the degree of individual choice regarding when, where and how work processes are undertaken) are two aspects of organizational structure that may help companies to find how they work today and how they may change in the future (Morrell et al., 2005).

Ergonomics working furniture has been found to have extensive positive influences on people's productivity, as well as on the reduction in the healthcare insurance payments for workplace. Also increasing has been shown on computer-based data entry and editing when normal workstations were replaced with improved workstations and ergonomic chairs. In addition, productivity has been increased by introduction of adjustable ergonomic chairs, wrist rests, and adjustable keyboard supports by 10%, as well as decrease injuries. With the introduction of height-adjustable titling keyboard trays up to 60% reductions of in the risk of musculo-skeletal injuries has been shown; whereas insurance costs for repetitive strain injuries diminished by 63% with the introduction (Morrell et al., 2005).

2.3.1 Implications

Different requirements of various kinds of users are being changed today's workplaces. Most of offices have been facilitated for sedentary office workers who prefer sit in a place and work. This can be described as the old way of looking at office work. Some changes need to match current working area with a more mobile work force. Some workers even attend their work office randomly and need new ways of communicating which in turn lead to more flexible offices (Greene, 2011).

Design a work place which covers just some part of four categorized workers and not all of them is challenging. Complex set of requirements need to be defined and just provide knowledge workers with open plan space, ergonomic furniture and the latest technology, the standard formula of the past decade is not enough (Greene, 2011).

On the other word, the new working place should have different facilities and places to meet requirements for all workers such as:

- Caves – flexible, partitioned areas for common use within an office.
- Commons – open plan meeting rooms to encourage spontaneous get-togethers.
- Cottaging – home workers gathering at a local work centre for interaction and access to technology.
- Guesting – organizations using one another's office space.
- Hot desking – desks being used by more than one worker.
- Just-in-time office – a work area available to everyone as needed. (Stocks, 1998)

An effective workplace should at the same time deal with the social, physical, and technical components of the work environment as well as financial considerations (Schriefer, 2005). Modern concept of the office are going to be a place to which people go there, spend the day working then travel home again. (Stocks, 1998) Modern workstations incorporate home offices, airports, workplace clubs, satellite offices, libraries, coffee shops and any wireless hot-spot. Wireless voice and data are making workers increasingly independent of a fixed location, even within the corporate office. (Schriefer, 2005) Flexible office was established around 20 years ago in Sweden. In new office design as movement is essential, all partitions have removed (Brunnberg, 2000). As worker are becoming more mobile, new ways of working, are changing the concept of one desk for one person (Microsoft UK). Research shows that although flexible office as cheaper solution for office design has established in a lot of working areas, it does not necessarily support all kinds of work and workers. Social workers how can use the same place that the other workers use, are more likely to work in flexible office (Brunnberg, 2000).

Activity based office as one of the most advanced concept of working area, has concentrated more than just saving space; based on three pillars of people, place and technology (Microsoft UK).

Activity based office is a working style that end on modern, flexible technology and that it is built more on tasks, activities and goals than the attendance in the and an inflexible private workplace. In the office you use it by creating different types of surfaces that will support the diverse needs of all the varied tasks that a job entails. You have the ability to vary the workplace furnishings in scale from individual workstations to large group / project table, it offers more opportunities to have access to both areas suitable for collaboration and areas / rooms that are drawn to when you're focused and you can also work with different audio zones, quieter, more lively areas. The activity-based office solves a lot of interference problems of the open offices. Office type should not be confused with flex office where it is more about saving space in organizations where there is low attendance at the workplace such as consulting businesses. (<http://www.mer.se>)

Exp: Interpolis, Tilburg, The Netherlands; Macquarie Group, Sydney, Australia; Microsoft, Amsterdam, The Netherlands (Microsoft UK)

Different from flex office?

Simply put, the activity-based office is a development of flex office, you do not have your own place of work in any of them but in the activity-based office takes more advantage of the opportunity to create many different types of workplaces and surfaces in order to best support the activity in question. The activity-based work can also be a good fit for businesses where you are inside a lot in the office but are variable in their approach.

In a flex office employees have not their own work but otherwise it differs often not from a typical open office in the design and sometimes it consists of private offices, where such employees of a consulting company can book a room when they are not sitting at a customer. (<http://www.mer.se>)

Different from the open office?

In the open office, I have my own workplace and the availability of some support functions such as chat rooms, sometimes slightly workroom and maybe an open forum. Many times it becomes a conflict between the need for collaboration and the need to focus because the surface is not sufficient to create solutions to the respective needs. In the open office sees mostly all work the same, regardless of need, for it to go to administer for local managers. (<http://www.mer.se>)

Problems and barriers

Not mere noise is a problem for workers. More than 50% surveyed said that their ability to perform their work was directly affected by people on the phone, people talking in nearby offices, and overhearing private conversations. Some companies with under-the-floor ventilation or air distribution systems may need under-the-floor acoustic septums installed to reduce the transfer of noise (including speech) through the floor plenum. Beside a specific type of abatement, there are also noise-masking, or sound-masking, “white noise” systems that can meet the Health Insurance Portability and Accountability Act (HIPAA) regulations for companies. And then there is also the ever-present concern over potential identity theft of private information.

Surveys from occupants in more than 200 buildings, including a naturally ventilated one, revealed too little air movement as the most common complaint among office workers. While many bring their own small fans to help, architects and designers have been working the problem with varying degrees of success. Most designers rely upon ASHRAE and ISO thermal environment standards, but a survey by researchers at the Centre for the Built Environment at UC–Berkeley reveals that people need more air movement, especially in warm and neutral temperatures. (Winston Churchill)

Customer satisfaction and responsiveness, Cost saving and operational efficiency (reduced churn costs), Mobility and flexibility, Sustainability and carbon reduction, Competitive advantage and differentiation, Brand awareness, Recruitment and retention of staff and Disaster recovery and contingency planning have been known as the benefits of new ways of working (Microsoft UK).

2.4 Ergonomics

Since it is important with adequate comfort to be able to work within an office environment the field of ergonomics is very important for this project. This chapter will involve ergonomics while seated and issues related to computer work. What comfort is, how it is perceived, what effects comfort has and how it can be evaluated as well as the importance of posture. The subject of office work will be looked into as well as portable computer usage. Furthermore how inclusive design might affect the outcome and hazards of sitting improperly and finally characteristics of chair design.

2.4.1 Comfort

Haslegrave and Pheasant (2006) explain that all seats become uncomfortable over time, and depending on the seat this may come sooner or later. They describe seat comfort as an interaction of seat -, task- and user-characteristics. Kee and Karkowski (2002) add by explaining that the indication of pain shows a mismatch between task and person, needing a redesign. Carcone and Kier (2007) relate that a less restrictive chair that allows for postural variation is perceived as more comfortable. Groenesteijn, Vink, Looze and Krause (2009) describe discomfort as based on association of pain, tiredness, soreness and numbness while comfort is describes as a feeling of relaxation and wellbeing. When discomfort is present, the presence of comfort becomes secondary. They further describe that in order for a product to be comfortable, it needs to look comfortable at first sight, be comfortable during short use and remain so even after long-term use. Kee and Karkowski (2002) explain that discomfort is associated with biomechanical factors such as joint angles, muscle contractions, pressure distribution that over time produce pain, muscle soreness, numbness, or stiffness. This shows regardless of the how it is defined the reduction of discomfort is important; as Kee and Karkowski (2002) explain that by reducing perceived discomfort reduce the risk of musculoskeletal disorders. They also explain that assessing postural discomfort in any given posture is an important first step for improving the work environment.

The task of a working seat, office seat and an easy chair differ considerably, therefore it might be important to consider what an activity based office seat solution should provide support for. How would that kind of seat functions differ from the other types of seats?

Haslegrave and Pheasant (2006) explain that easy chairs function is to allow for relaxation, resting, perhaps reading, and watching television or conversation. Perhaps these aspects are applicable for an activity based office solution, as well as provide support for working with papers, computers and other tasks. Perhaps it would be applicable to combine aspects from different types of seats and look into the requirements of each and how they can be combines into one solution. Groenesteijn, Vink, Looze and Krause (2009) explain that different types of office jobs have different job activities and therefore a different behaviour in chair use. Therefore it would be better to perform tests with chairs in different tasks with adjustability.

“a chair is not an isolated object, but needs to be considered as an integrated component in a complex work environment” as cited in Groenesteijn, Vink, Looze and Krause (2009).

Groenesteijn, et al. (2012) also support this by saying that office chairs need to facilitate office workers and their jobs. However this includes a variety of tasks. This would mean that in that in the context of this project, a couch solution would also need to incorporate a wide variety of tasks.

2.4.2 Posture

Haslegrave and Pheasant (2006) describe posture as something a person adopts while performing tasks. How a posture is restricted depends on the connections between the user and the task, either physical or visual. If the dimensional match is inadequate short- and long-term consequences may ensue. To maintain a posture in space a person has to exert a constant muscle force, which is called static work. Static work restricts the flow of nutrition to the muscles causing waste products to accumulate, causing fatigue (Haslegrave and Pheasant, 2006; Grandjean and Hünting, 1977). This causes discomfort that over time increases until an unbearable pain forces a person to change posture. If static work is repeated often and for long periods of time it will cause chronic pains, musculoskeletal disorders and changes in muscles, tendons, joints and ligaments (Grandjean and Hünting, 1977). By making small movements the body protects itself from postural stress, therefore it's important to allow for change in posture to increase comfort especially for longer periods of time (Haslegrave and Pheasant, 2006). A study by Kee and Karkowski (2002) showed that comfort is significantly affected by joint motion, size of the motion and which joint it is. The study also showed that in sitting the hip joint was the most stressful followed by the shoulders, lower back, wrist and ankle, neck while the elbow had the smallest level of discomfort.

While sitting the spine often takes a flexed position that poses tension in the supporting structure of the spine. While the muscles may be relaxed this position causes pressure on the intervertebral discs. In order for the spine to have an erect posture while sitting a person has to use the back muscles, which enacts a static load. Haslegrave and Pheasant (2006) therefore suggest when designing a seat the lumbar region needs support to keep its natural position by having a reclined sitting position, that isn't too low or deep. The angle of a backrest and the amount of lumbar support directly affects how a seat supports the trunk. Haslegrave and Pheasant (2006) however point out that while working a person often has to take a forward posture and will therefore lose the support of a backrest. This causes a problem of how to enable work while seated in a reclined position.

However in Carcone's and Kier's (2007) study where users were allowed to choose the thickness of lumbar support showed that a less forcing posture was more comfortable over a longer period of time than the “ergonomically correct one” since it was less restrictive.

2.4.3 Office work

According to Groenesteijn, et al. (2012) 47% of the employees in the EU perform some kind of white-collar work and as the amount of workers increase so does the importance of keeping them productive, comfortable and free of injuries.

Since the ergonomic conditions depend on what tasks are performed it would be good to look into the different uses that might come into play while designing for an activity based office. Haslegrave and Pheasant (2006) describe that office work can be divided into either paper- or screen-based work. Furthermore there are other categories as well such as telephone, computer, meetings, visitors, writing, diverse manual deskwork, breaks and resting. Since each of these pose different user scenarios it will be important to consider how these areas might affect the conditions under which a potential concept might be used in and what it needs to provide support for to get a correct seat-, task- and user-characteristics.

While typing the shoulders, neck, trunk muscles and arms are subjected to static loads while maintaining the stability of the body. Also using a mouse causes static loads on the muscles in the arm in a higher degree (Haslegrave and Pheasant, 2006). This emphasizes the importance of having a relaxed posture and maintaining a posture that is close to the neutral to achieve the least amount of muscle and postural exertion.

According to Groenesteijn, et al. (2012) the muscular load from differ between tasks while sitting. During paper work the shoulder region is mostly affected, while operating a computer mouse the lower arms are activated and telephoning often lead to extreme spine postures. Computer work showed the most difference related to other tasks as it showed a lower intensity of physical activity in all body parts due to an upright posture. This showed that computer work was the most static task between conversation, telephoning and desk work. Conversation showed the most backwards inclination and the highest activity of the head, legs and spine extension. Groenesteijn, et al. (2012) found that the reclined posture during conversation was preferred over the restrictive postures of computer and desk work. They explain that preferred postures are often the more reclines postures as they impose increased support by the backrest, however these amount to only 15% of the work postures in white-collar workers. This amounts to a possibility in a soft seating solution that would offer a reclined working posture during computer and office work as there aren't restrictions of how close a working surface can be to the user.

Haslegrave and Pheasant (2006) impose a few principles for office work:

- For writing a surface should be around 75mm above elbow height in a standard upright sitting posture.
- For computer work the shoulders should be relaxed with arms hanging at the sides, forearms horizontal and wrists in a neutral position. The keyboard surface should be close to the sitting elbow height; the range of which should accommodate a 5th percentile female to a 95th percentile male.
- For an upright sitting position a person should have the feet flat on the floor, a 90° angle between the thighs and the calves. The height should preferable be 50mm

below a user's popliteal height, in a fixed seat height this should at least be for a 5th percentile female.

Portable computers

Since the introduction of the portable computer the use has evolved from initial temporary work to more and more being used as a main tool for computer work (Haslegrave and Pheasant, 2006; Straker, Jones and Miller, 1997; Wyatt, Todd and Verbick, 2006). Since portable computers aren't originally designed with ergonomics in mind users adopt awkward postures, which will in time cause discomfort and eventually injury (Haslegrave and Pheasant, 2006). This wouldn't be a problem if a laptop wasn't used in high frequency and duration but considering flexible or activity based offices the importance of portable computing devices such as laptops and tablets increases as main tools over traditional workstations. Since the start of this century notebooks and laptops have increased in popularity amongst "on-the-go, space-conscious, computer users". They are replacing the more bulky desktop computers in offices and homes, increasing the occurrence of bad postures while computing (Wyatt, Todd and Verbick, 2006).

Wyatt, Todd and Verbick (2006) report that amongst college students repetitive strain injuries such as carpal tunnel syndrome and tendonitis has increased, as it used to mostly affect adults working with computer work.

Laptop computers apart from traditional desktop computers can be used in a various type of ways: lounge areas, airports, outdoors, cars, bed, couch and schools. The biggest problem would be to have an adequate surface on which to place the computer on. Straker, Jones and Miller (1997) point out that with the variation in humans, it's impossible to have a good posture without having at least a few features adjustable. Haslegrave and Pheasant (2006) explain that from the three contact areas; seat, floor and workspace, at least two should be adjustable to allow for anthropometric variation. However even with the possibility of adjusting seats users are also less likely to adjust them or making sure they use a proper posture. According to Haslegrave and Pheasant (2006) laptop computers have more inclined head postures and neck flexion and most likely flexed curvature of the spine than working with desktop computers. Starker, Jones and Miller (1997) add to this explaining the alternative would be increased shoulder and elbow flexion to reach a higher keyboard.

The problems are according to Haslegrave and Pheasant (2006) the height and position of the screen and the legibility of the screen from different angles. Wyatt, Todd and Verbick (2006) support this by adding that portable computers are ergonomically incorrect due to having the keyboard attached to the monitor making it impossible to correctly position both.

Use with portable computers often limits a user to use a built in touchpad which restricts movement and further calls for poor postures. An external mouse would solve such problems and would allow for more flexibility in posture. It would therefore make sense to have enough workspace surfaces to allow use of external input devices and other tools such as document holders. It is recommended that an L-curved surface should be used to allow for forearm support while using input devices (Haslegrave and Pheasant, 2006).

A study by Berkhout, Henriksson-Larsén and Bongers (2004) showed that by using a laptop station that improved the posture while using laptops increased productivity by an average of 17%, decreased the mechanical load by an average of 24% and an average of 17% smaller discomfort when compared to just using a laptop computer. The study points out the importance of adjustable tools while doing VDT work and by providing proper working areas a better productivity can be achieved as well as less long term injuries.

Therefore in a solution towards this kind of environment it's more important to allow for adequate use of computing devices while remaining seated in product that traditionally isn't made for such use.

2.4.4 Inclusive design

Design for all means to incorporate all possible users including disabled and handicapped in the design of products and services. It is "design for human diversity, social inclusion and equality" (Paulsson, 2006). A part of this view is the inclusive design approach, which is part of a framework to understand the needs of a diverse user group. Hoskins, Waller and Clarkson (2010) describe inclusive design as understanding diversity in the population and the importance of it in design. With design for all one might think the goal is to develop products and services for the whole population, while inclusive design offers a sensible and realistic approach to addressing diversity. Hoskins, Waller and Clarkson (2010) describe that a population can be described as a sequence of states that all are on during their lives. By thinking like this products can be developed to provide a better experience for more people in more states/situations. Haigh (1993) describe that people begin to change in their 30s and 40s with a varying level of ageing depending on the individual and that it would make sense to include these as well as the able bodied to ensure a greater return and reach.

The entire population can be visualized by the user pyramid, which represents all possible users. The lower part of the pyramid consists of normal able bodied and slightly disabled users. The middle part represents users that are in need of technical aids to function normally while the top represents users with severe disabilities, whom require advanced technical aids and personal assistance. By designing towards the upper part of the pyramid a wider user group will be included. Sometimes the onset of universal design can be to work towards the requirements of specific users as aids for these. However it may also be attractive for many other users as well (Paulsson, 2006).

Hoskins, Waller and Clarkson (2010) describe that there often is a focus on single disabilities, however it is more often that there is a co-occurrence of minor disabilities amongst elderly. Hoskins, Waller and Clarkson (2010) further describe that only 5,3% have a severe ability loss, 13,2 % have a moderate ability loss and 81,5% are able bodied. Only 0,9% of the population have a single severe ability loss.

However while considering design for all in this context of a seating solution it might be important to limit the inclusive scope. The severely disabled users might not be plausibly incorporated into the user group due to the impact it might have in the widespread acknowledgement of the product in a workplace environment. Hoskins, Waller and Clarkson

(2010) describe that the needs of those with severe disabilities can only be met through assistive technology. Therefore the aim is to increase the reach of mainstream products while maintaining commercial viability by not compromising the needs of those at the bottom of the pyramid. This could mean to those in the middle segments that features can be added to include them.

However there is a balance between adding features and having too much complexity in a product. Hoskins, Waller and Clarkson (2010) also argue that it might be useful to use boundary cases in personas to identify possibilities. This can help finding solutions that might benefit many and increase the reach in the user pyramid. The conclusion would be that by extending existing market segments a more inclusive design can be achieved.

Of course inclusive design doesn't only incorporate the disabled but also social, economic, gender, culture, lifestyle and age factors as well. The difference between inclusive vs. non-inclusive design principles can be described as (Paulsson, 2006):

- Concern with meaning and context vs. with style and ornaments
- Participative vs. non-participative
- Human oriented vs. corporate or institution oriented
- Client re-defined to include users vs. owner as exclusive client
- Low cost vs. high cost
- Grassroots approach vs. top-down approach
- Democratic vs. authoritarian
- Seeking to change design attitudes vs. accepting current design attitudes
- Use appropriate technology vs. high technology
- Use alternative development process vs. corporate controlled process
- Heterogeneity vs. Homogeneity.

The seven principles of universal design are according to Paulsson (2006) the following:

1. Should be usable to people with diverse abilities
2. Incorporate user preferences and abilities of a wide user range
3. Easy to understand and use
4. Information should be communicated effectively regardless of ambient conditions or user's abilities
5. Low tolerance of error
6. The design should require low physical effort
7. Appropriate size regardless of user's size, reach, posture or mobility.

2.4.5 Personal Space

Haslegrave and Pheasant (2006) describe personal space as a portable territory that surrounds us and influences our interaction with people. This personal space is described as four zones; intimate (<450mm), personal (450<1200mm), social (1200<3500mm) and public (>3500). This might be important to consider depending on the context in which and what the work is in a seating solution.

2.4.6 Hazards of work

The feeling of pins-and-needles, sore back, blurry vision and hurting wrists and fingers are common symptoms of workers within the technology field. These are signs of that an injury is close by and often signs of long term damage (Wyatt, Todd and Verbick, 2006). Wyatt, Todd and Verbick (2006) report that repetitive strain injuries gradually develop over time and become noticeable after weeks or months of use with a computer. These are caused by repetitive motion and improper postures of the hand causing strain to muscles, tendons, nerves and joints. They add that these problems can happen even during low frequency and duration. An example is that a man that used a computer a couple of hours per day never more than 40 minutes at a time developed so severe problems that he wasn't able to use a magazine.

According to Wyatt, Todd and Verbick (2006) common areas of discomfort are: neck, head, eyes, hands, hips, wrists, legs, knees, feet and ankles.

Wyatt, Todd and Verbick (2006) report that there is a lack of awareness related to visual ergonomics involving visual display units. So called computer vision syndrome (CVS) has become a concern as more use computers for everyday tasks. CVS is caused by sitting too close to the screen, working for too long without resting, wearing improper glasses, bad or too much lighting and bad quality computer screens. These conditions cause strain on the eyes and aggravate vision problems even further. The results from eye strain can be blurred vision, eyestrain, headaches, light sensitivity, double vision and difficulty focusing.

Wyatt, Todd and Verbick (2006) explain that common problems with computer work are related to headaches and neck pain. These are often caused by improper positioning of the screen which in turn requires more neck flexion in order to view it properly. Problems can also be caused by alternating extreme postures while answering phones or assisting customers.

Haslegrave and Pheasant (2006) argue that sitting for long periods of time isn't healthy. Other than causing discomfort, bad circulation through pressure to soft tissue can cause oedema or even blood clotting in the lower legs. There have been cases of sudden death attributed to excessive computer sitting. This emphasizes the importance of avoiding pressure spots and allowing users to vary posture while seated for longer periods of time. They conclude that comfort could be seen as an absence of discomfort i.e. warning signs of imminent damage.

According to Haslegrave and Pheasant (2006) it is widely known that repetitive and prolonged screen based keyboard or mouse work may result in musculoskeletal injury. It is recommended that screen-based work should be alternated with other types of work and breaks as to get a variation of working tasks and rest between working intervals. They continue that breaks should be taken that allow workers to flex and move away from the workstation. Micro pauses are also recommended as they allow muscles to relax and release the static load caused by prolonged static work. So if work cannot be broken up into various tasks, micro breaks and longer breaks should be introduced to allow for relaxing. Wyatt,

Todd and Verbick (2006) explain that repetitive strain injuries such as tenosynovitis and carpal tunnel syndrome have been seen increasing amongst college age and younger students. This could be explained as more and more are using computers in the academic, personal and recreational purposes. Pain in elbows, upper arms and shoulders are also common ailments amongst computer users. Tennis elbow (Wyatt, Todd and Verbick, 2006) and mouse arm are commonly named injuries associated with computer work related to keyboard and mouse positioning.

A bad working posture while working with a computer without proper back support can be the cause for major back pain. Culprits are often improperly adjusted seats, bad lumbar support, dangling feet, nonadjustable seats and reaching for keyboard or mouse (Wyatt, Todd and Verbick, 2006).

However viewing this in context while working in lounge type furniture that is comfortable a person might believe that injury isn't possible and thusly stay seated for longer periods of time without break. Wyatt, Todd and Verbick (2006) explain that in initial stages there might only be slight body aches and fatigue that goes away once removed from the task. As the injuries progress in severity so does the pain until it lasts long after the work has ended. This can only be adverted by promoting awareness; however such considerations are outside of the scope of this project.

Haslegrave and Pheasant (2006) conclude that the two main risk factors for keyboard injury is:

- Prolonged periods of work in a restrictive posture, with little or no interruptions
- Degree of musculoskeletal loading from static loading due to working posture.

2.4.7 Chair ergonomics

Furniture obviously plays a significant role in the workspace ergonomics and can be a major factor in preventing musculoskeletal injury if ergonomic principles are applied correctly in the right context.

The positions in how a user adopts a computing posture are vital for the overall comfort and risk of injury. Wyatt, Todd and Verbick (2006) explain that the best way to work with a computer is to use appropriate furniture and those workstations should support the user with adjustable desks, chairs and footrests. As seats are the largest contact surface consideration into the different elements with specific ergonomic requirements will give insight into that that specific support needs to provide during different circumstances.

Seat

A seat is the surface that the fleshy part of the buttocks and lower this is in contact with while seated. The main function is to distribute the pressure from the body weight unto as big surface as possible. Groenesteijn, Vink, Looze and Krause (2009) state that pressure

linearly relates to seat comfort. According to Haslegrave and Pheasant (2006) a seat should follow a few general guidelines:

- Be firm rather than soft so not to bottom when a heavy user sits on it
- Materials should be porous enough to enable breathing
- When compressed be relatively flat rather than excessively shaped.

However rounded edges may be important to avoid pressure hotspots. Groenesteijn, Vink, Looze and Krause (2009) explain that seat cushioning is important either due to inducing “re-sitting” or just being more comfortable over longer time periods. They also explain that a flat seat creates better anthropometric spread since it fits a broader spread of users.

When considering the depth of a seat it is important to think about that users will be able to reach the back of the seat so to get adequate back support without causing pressure on the knees and calves. Haslegrave and Pheasant (2006) recommend using a woman’s 5th percentile buttock-popliteal length as a reference for seat depth as to include as many as possible.

According to Haslegrave and Pheasant (2006) a seat only needs to provide a width that is 25 mm shorter on either side to provide adequate support, however with armrests it should at least fit a 95th percentile woman’s hip breadth adding clothing since women in general have wider hips than men.

Seat height is important for the perception of comfort as it affects the way you sit. According to Haslegrave and Pheasant (2006) a high seat causes pressure on the soft tissue on the lower side of the thighs causing lowered circulation. This in the long run causes discomfort, numbness etc. If a seat is too low the spine takes a flexed position, as well as makes it harder to sit and stand up, which is important to consider for elderly people. If a seat is too high smaller people tend to sit on the front edge of a seat, which was the case for smaller people who tend to have pain in the knees (Grandjean and Hünting, 1977). In conclusion a seat with the popliteal height of a 5th percentile woman would be adequate to make sure the amount of pressure on soft tissue is decreased (Haslegrave and Pheasant, 2006). It can however be important to have a higher seat depending on its inclination, depth and angle so to enable easy sitting and standing when considering taller people and elderly.

Backrest

As the amount of back support increase as the more area that is in contact with the back the higher the backrest is the more effective the support will be. Groenesteijn, Vink, Looze and Krause (2009) state that in order for muscles to relax and the spine to remain unloaded the backrest should be inclined backwards. They also state that allowing for mobility and resting against a backrest can reduce discomfort and pain. Haslegrave and Pheasant (2006) distinguish three types of backrests, low-, medium-, and high-level. While high-level rests provide support for the entire back and head, it is important to consider the sitting height of a 95th percentile man as an upper value. The medium-level backrests support up to the shoulder area of the back. A common measurement is the 95th percentile man sitting

shoulder height (roughly 650mm for full shoulder support, 500mm for overall backrest support). Groenesteijn, Vink, Looze and Krause (2009) explain that different levels of backrest support relates to different comfort levels while performing different tasks and that therefore it is important to have varying levels of backwards inclination either in fixed or dynamic backrests.

The low-level backrest only provides support for the lumbar and lower-back area to provide for movement of arms. However when considering a soft seating solution a low backrest may not be applicable as a high level of support is desired.

As previously described it's important to keep the natural curvature of the spine. Thus the backrest should have a curvature that follows the spine and maintains its natural curvature without restricting movement. It should also be adjustable in height as to match the midpoint of lumbar support to match a person's own back (Haslegrave and Pheasant, 2006). A study by Carcone and Kier (2007) showed that a smaller lumbar support was preferred over more restrictive ones since it allowed for more variation. The thicker supports gave the feeling of being pushed forward even though they gave better lordosis over the small pad. Haslegrave and Pheasant (2006) point out that the individual variation is considerable and a variable support may be essential to provide adequate comfort for a wide area of users. Also a clearance between the seat surface and backrest will allow room for buttocks to make sure that all reach the backrest and get the maximum amount of support. It is also important to leave clearance for shoulders in high- and medium-level backrests so that the lumbar region will get adequate support. The scapular support should be at least 6cm behind the lumbar support (Haslegrave and Pheasant, 2006).

The larger the angle of the backrest the more weight of the body is supported; this also improves lordosis i.e. the curvature of the spine. However as pointed out by Haslegrave and Pheasant (2006) an increased angle also drives the buttocks forward causing a sliding sensation. This can be hindered through adequate seat tilt, friction material in upholstery or by exerting muscle force to counteract the sliding. A tilting of the seat will also enable good contact with the backrest.

When considering easy chairs Haslegrave and Pheasant (2006) recommend that a backrest angle should be as much as 136° to allow for resting. This is with a seat of a seat angle of 20° to 26° and a seat-backrest angle of 105° to 110°. Seat tilt of 10° and a rake for 120° for reading and watching television. Considering elderly a rake larger than 110° may cause problems while sitting and standing. In this category a high backrest is essential to provide adequate support. To provide a headrest train seats for instance have a 10° angle for the headrest. Groenesteijn, Vink, Looze and Krause (2009) explain that an angle of 105° is best for driving since a larger angle would give too much head flexion and that the same reasoning would be given to seat design. A 120° would be comfortable for reading purposes as a book might be positioned in such a way that head flexion is avoided giving a relaxed position with low postural loading.

Carcone and Kier (2007) suggest that a lumbar support of 3 cm would be enough to provide adequate lordosis while also allowing for movement, increasing the feeling of comfort.

Armrests

Armrests also have an important function for sitting down and rising. Armrests are good for supporting a posture, allow a relaxed position for the shoulder and neck and also make it easier for elderly to rise and sit down. Armrests decrease the static load posed on the muscles in the arm, neck and shoulder area. Armrests should preferably be lower than the sitting elbow height to allow for a relaxed posture rather than giving raised shoulders. Unless armrests are well padded they shouldn't support the bony parts of the forearm. A recommendation is to at least have an armrest length of 200 mm, and not too long as to hinder a work surface from getting too close to the user. However this is a recommendation for workspace seats to get close enough to tables.

Work surface

Wyatt, Todd and Verbick (2006) explain that the desk is in many cases the first thing thought about when designing a computer workspace. It needs to be wide and deep enough to fit a computer and its accessories. The surface needs also to be adjustable as to allow for as many as possible to fit it to their needs or be in an appropriate height for the majority of users. Wyatt, Todd and Verbick (2006) explain that the ideal keyboard should be tilted, which can be interpreted as the work surface on which the keyboard or computer is placed should be tilted as to lower the stress on the hands. And have an "L" shaped surface to enable it to get close to the body and provide more support for the arms.

Vision

Haslegrave and Pheasant (2006) describe the vision is an important aspect to consider since it affects the position of the head and neck. While standing the sight will naturally assume a slight downward angle of 10° to 15° from the horizontal. The sight can further move down to 30° without the head moving causing strain on the head and neck muscles. However since slight flexion is allowed for short time durations it can be extended by another 15° to a total of 45° below the horizontal. However an angle over 30° isn't preferable since it causes high strain and muscle fatigue. A general consensus is that a screen should be slightly placed under eye level so that the most important part of the screen is placed at 0° to 15°. The visual comfort also depends on the distance to any visual display units (VDU). As a general guideline the minimum distance should be 500 mm to any object, however a distance further than 750 mm would be more preferable.

2.4.8 Ageing population

Holden, Fernie and Lonau (1988) state that that an ageing population requires considerations related to sitting. The more active participants require a chair that facilitates ingress and egress, while the more immobile ones require supportive chairs. Ease of ingress and egress was ranked one of the top features for chairs amongst elderly. According to Holden, Fernie and Lonau (1988) space under the seat should be allowed to enable users to place the centre of gravity closer to the body making egress easier. A minimum of three inches (~7,5 cm) or more is needed for elderly due to decreased mobility and strength.

Holden, Fernie and Lonau (1988) continue that seat rake is also important to consider, as a reclined seat is harder to egress from, especially for elderly with decreased thoracic strength and balance. A contoured seat is needed to distribute pressure, however it's hard to fit for a wide user base. Therefore a slightly contoured seat is a necessary compromise. The seat must allow for movement by being wide enough, avoid sharp corners and not be too soft. A soft seat doesn't control posture and positioning and doesn't distribute pressure well enough, which is important for elderly. The cover should be easy to clean, secure and allow for breathing. The seat must be deep enough to allow elderly to properly make contact with the back without causing pressure on the knee area.

Armrests are important for enabling ingress and egress from a seat. The armrest should be as high as possible to provide support for the manoeuvre. For arthritic users the armrests should protrude from the front of the seat. The ideal armrest should be in a slope as to provide upper body support while sitting and assistance for ingress and egress. A person resting has the forearms in a 30-60 degree inwards angle, therefore only a portion of an armrest is used to support the arm. This causes pressure hotspots and increases the importance of providing a soft support without sharp edges (Holden, Fernie and Lonau, 1988).

Some guidelines for an aging population that might be relevant for this project (Haigh, 1993):

- Eliminate irrelevant information
- Use appropriate size of text
- Combine upper and lowercase symbols for readability
- Maximize contrast between symbols and background
- Combine type and graphics when possible
- Use non reflective surfaces
- Use contrasting colours
- Minimize ambient sound produced by the product or environment
- Size that is easy to grip with one hand
- Not small enough to be buried
- Not large enough not to be gripped
- Shape so that it fits well in the hand
- Texture that is easy to grip and hold onto.

2.4.9 Additions

Haslegrave and Pheasant (2006) recommend adding 25mm for men and 45 mm for women to all dimensions in public places and semiformal occasions due to shoes worn, in normal shoes this is 25 +- 5 mm. This will impose importance in the seat height and thigh clearance during sitting.

Secular trend is that the general stature increases with 10 mm every decade; this imposes an addition to old values for stature (Hazelgrave and Pheasant, 2006).

Another addition is the ageing workforce factor. Only young people shouldn't be considered when designing seating etc. Since the population is gradually getting older more and more needs to be design for the older population. Height decreases with age and this is an important factor to consider when selecting anthropometric data not to exclude de older users. People start to shrink after the age of 40, women shrinking faster than men (Hazelgrave and Pheasant, 2006).

2.4.10 Assessing comfort

As stated earlier in the field of seating it is important for a seat to be comfortable. The question rises while developing a seat how then to assess the comfort to ensure that the end result actually is comfortable. Kee and Lee (2011) describe methods for assessing postural stress as biomechanical, physiological and psychophysical methods. Kee and Lee (2011) explain that reducing discomfort may decrease the risk, since discomfort and musculoskeletal disorders are known to be related to the exposure to biomechanical load. Haslegrave and Pheasant (2006) explain that a fitting trial is a method for experimentation to find possible design solutions and are described as psychosocial experiments in which subjects make subjective judgments of objects or events. Kee and Lee (2011) found in their review that subjective measures were more effective than time consuming objective methods to evaluate postural stress. Methods like Borg's CR10 scale discomfort levels were easily obtained without interrupting the worker.

A fitting trial consists of an adjustable-mock up that subjects can use to perform tasks and make realistic judgements on comfort. In the trial the mock-up can be adjusted to fit a subject's comfortable range and evaluated. Through this kind of testing for instance a "too low" or "too high" position can be defined (Haslegrave and Pheasant, 2006).

Haslegrave and Pheasant (2006) explain that in order to access discomfort it is necessary to sit in it for a period of time from 5 to 30 minutes, however can be as long as 3 hours. They point out that to access comfort between seats it can be as short as a few minutes. This would mean that either longer or comparing tests would be needed in order to assess comfort in an eventual concept.

Haslegrave and Pheasant (2006) describe the procedure of a fitting trial as:

- Making a mock-up of the workplace with adjustability of all represented features being evaluated
- Including simulation of the task to be performed
- Selecting a sample of subjects representing the relevant characteristics
- Decide the order of presentation of the features
- Determine the range of testing
- Determine the interval between settings
- Each component should be set in the intervals
- At each interval subjects are asked to perform the task
- Determine which needs to be adjustable or fixed
- Determine best compromise
- Evaluate the final design solution in the right context and with the actual users.

2.5 Product Communication

It's widely known that the appearance of physical products strongly influences the behavioral responses in consumers. These responses strongly relate to the perceived attributes that a product communicates through visual information. This denotes the importance of appearance since consumers often just don't buy a product but the entertainment, experience and identity it provides (Clarkson, Crilly and Moultrie, 2004). According to Clarkson, Crilly, Good and Matravers (2008) consumers engage with products forming their own meaning that influence how they feel and behave based on form and function. Design is a way of communicating (Clarkson, Crilly and Moultrie, 2004; Clarkson, Crilly, Good and Matravers, 2008).

A consumer's interpretation of a product is mainly formed through the consumer product interaction since consumers seldom have access to the designer. The communication that the designer wants to convey has to go through the product, which acts as a medium for this communication (Clarkson, Crilly and Moultrie, 2004) The cognitive response to product appearance can be described by aesthetic impression, semantic interpretation and symbolic association (Clarkson, Crilly and Moultrie, 2004).

2.5.1 Aesthetic impression

How a product appears to a consumer is important when considering the product-consumer relation. An object may be attractive, elegant or beautiful and if a user finds it pleasing the likelihood of positive reaction increase. Aesthetics refers to the product aesthetics which relates to what signals the product presents and aesthetic experience that relates to the cognitive response to those signals, i.e. how pleasing it may be. Aesthetic impression is that what results from the perception of attractiveness (Clarkson, Crilly and Moultrie, 2004).

There is a school of thought that there are certain shapes that are inherently attractive; lines, proportions, colours etc. Examples of this are the golden section and gestalt rules that include symmetry, proximity, similarity and so on. This line of thinking relates to objective aesthetics. Subjective aesthetics on the other hand relates to that depending on different factors what is considered aesthetic changes and therefore there cannot be any universal aesthetic principles (Clarkson, Crilly and Moultrie, 2004).

Clarkson, Crilly and Moultrie (2004) also mention that in order for something to have positive aesthetics it needs a balance between information (novelty and contrast) and concinnity (order and sense). These stem from the objective qualities and subjective experiences.

2.5.2 Semantic interpretation

According to Clarkson, Crilly and Moultrie (2004) semantic interpretation relates to what the product says about its function, use and qualities. Products are in some way used and thus require practical qualities such as function, efficiency, and ergonomics to facilitate use. Semantic interpretation is then the relation and evaluation of the utility and perceived

qualities of the design. Clarkson, Crilly and Moultrie (2004) continue that in order to consider semantic interpretation three stages are needed:

- Establishing the character that the product should communicate
- Listing of the attributes that the product should express
- Searching for how these attributes can be manifested and projected through shapes, material, texture and color.

Chen and You (2006) mean that by following conventions understood by the users to apply icons, symbols and metaphors in the product design and that the designer through designing product's appearance and interface assists users in understanding the products they use.

2.5.3 Semantic functions

Clarkson, Crilly and Moultrie (2004) describe Mönö's way of seeing semantic interpretation from a semiotic perspective (meaning of symbols). This means a product communicates its qualities through four semantic functions:

- Description, how the appearance describes its purpose and use
- Expression, what properties it shows such as density, stability, weight and so on
- Exhortation, how it gives feedback to the users by indicating appropriate actions such as power lights
- Identification, the origins and where the product originates through logotypes, name, model etc.

They continue that these functions are interconnected; a product may show its use through form but identifies the actions through text and labels. For example a knob for a stereo indicates turning but the labels show what functions the action elicits.

2.5.4 Affordance

Affordance is similar to Mönö's semantic functions in the way that affordance describes how a product's visual presentation assists a user in seeing how the product should be used. According to Chen and You (2006) there is a difference between affordance and a semantic interpretation of an object. Affordance relates to the action capabilities of objects while product semantics relate more to the meaning constructed in users' minds based on the information received. According to Norman (2002) it refers to the perceived and actual properties of an object that determine how the object can be used. A chair affords support for a person and therefore affords sitting. Affordance provides a user with information on how objects can be used and other possible uses. If affordances are considered well in the use of objects then no instructions are needed. Norman means that when simple objects need instructions, labels or text the design has failed.

When possible affordances haven't been considered objects might be used for different uses than firstly thought of, such as bus stops that were vandalized; glass was smashed, wood was carved. Norman means that the planners were trapped by the affordance of the materials that allowed for such actions. Chen and You (2006) mean that affordance can be

actualized through adopting ergonomic and anthropometric data to the product and that the role of the designer is to manipulate physical properties to regulate user behavior.

2.5.5 Constraints

Norman (2002) explains that constraints restrict the possible amount of actions towards an object, the way it's used, put together, moved or manipulated. These natural constraints are physical restrictions that limit action and come naturally to any human. Norman (2002) also states that there are also cultural constraints put there to limit the acceptable social behavior in societies. These cultural constraints are learned and limit action in a wide area of circumstances.

2.5.6 Mapping

Mapping refers to the relationship between things by using physical analogies and cultural standards to lead to immediate understanding. Examples can be lights with corresponding buttons next to them, spatial analogy to control movement up, down, left to right. Mapping also relates to the perception and natural grouping or patterns of objects, controls and feedback. If there exists good mapping an object will immediately show what it does or to what it relates to. Bad mapping can lead to confusion, errors and mistakes (Norman, 2002).

2.5.7 Symbolic association

What a product says about its owner or user, the social significance attached to a product is what symbolic association is about. Clarkson, Crilly and Moultrie (2004) describe it as there exist symbolic meaning to objects. This is achieved that there are cultural agreements to the meaning of objects and that consumers communicate their identity through them. Instead of a product communicating about itself this is about what it symbolizes about its user or owner. They describe self-expressive symbolism as products allow the expression of one's personality and categorical symbolism as expression of group membership of social position and status. They also mean that symbolic meaning is culturally defined and the identities that products provide therefore depend on the cultural context in which they are used in. These associations depend on historical standards and social conventions to give context. Therefore it is up to the designer to correctly translate symbolism into products to give them correct meaning through the use of for instance mood boards (Clarkson, Crilly and Moultrie, 2004).

2.5.8 Responses

According to Clarkson, Crilly and Moultrie (2004) there are five categories of emotional responses (affect) that can be elicited from products: aesthetic, social, surprise, instrumental and interest. These stem from how they affect the consumer, from usefulness, attraction to disgust and amazement. These emotions result from the perception and the aesthetic impressions, semantic interpretations and symbolic associations. The behavior may then be either approach or avoid depending on how interested or disinterested a consumer may be. Also a consumer's background, culture, experience, gender, location and social status influence the reaction depending on the context they provide in which a product is used. It is within this context the message is interpreted.

3 ANALYSIS

3.1 Competitor analysis

As the company that this project is made in cooperation with isn't presented and described in much detail it was chosen that the competitor analysis should be kept short. Therefore it lists only a few examples of what is out there in terms of activity based office solutions that fit the description and soft seating.

To get a grasp of what is out there many different areas were looked into. There was a need to see what is out there considering design, colours and design language, what type of areas are utilized, how lounge areas look like, different informal meeting areas, cooperative areas and solutions for activity based areas. Another aspect was ergonomic products, how they look and improve ergonomics. Finally Cradle 2 Cradle products in what materials they use, how they use them and their designs.

Furniture companies

Steelcase has "Node" as a classroom seating that is an interesting combination of work and sitting in one. It feels modern, fresh and uses mobility in an interesting way. Steelcase also has an interesting soft seating solution called Migration by Brayton international that incorporates mobility, work surfaces and seating. The project group however felt that it feels dated but has a few good points to it.

Interesting options also relate to modularity such as EFG's Hippione and Materia's Le Mur and Monolog that have similar feelings but utilize modularity well.

Other companies that were interesting to look into are Herman Miller, Kinnarps, Materia, Allsteel and Edsbyn amongst others.

Nala patient chair by Brandrud had an interesting approach to ergonomics and soft seating. Other items looked into were laptop stands, chair keyboard supports, adjustable computer seats etc.

To list a few examples of interesting activity based work offices or similar one can look into Google's offices that have interesting options for working and relaxing and doing different activities in. Another example is Alcatel-Lucent that has 450 workers and only 250 workstations. Also Microsoft Netherlands has an interesting approach to the subject.

To see what furniture is available in the C2C aspect the C2C website offered a list of certified products that are available. Many of these utilize materials in interesting ways. Amongst the C2C certified products are many office chairs by Ahrend that feel modern. As well as many by Steelcase that incorporate C2C well. These are available at <http://www.c2ccertified.org/products/registry> (Website has changed since the work was done).

3.2 Company

This chapter gives a short description of the company's environmental work and goals.

The company is a large office furniture manufacturer in Sweden that produces a wide range of furniture from soft seating to desk chairs and desks. They produce most of the furniture and deliver them to customers fully assembled.

3.2.1 Environmental work

The company has a long history of promoting socially and environmentally responsible use of the world's forests. They also have a long relationship with IUCN – International Union for Conservation of Nature, which is the world's oldest and largest global environment network.

They are also active in WWF Sweden GFTN (Forest and Trade Network). This cooperation includes them undertaking in and setting targets and make plans for handling and purchase of wood and raw materials to ensure they come from a responsible source.

They have joined the national collection and recycling program for packaging (REPA).

3.2.2 Environmental goals

The company has an ambition to maximize the degree of energy and material recycling to minimize waste. They make monthly return reports in order to achieve a disposal-free industry. They also try to reduce the transportation needs of furniture between locations and have a goal to deliver directly to customers in order to reduce the environmental emissions.

They have also set goals on fabric utilization in order to minimize the waste during sewing. They set a goal of 80% utilization which they met. They are making efforts to increase it even further.

They have also made efforts to remove CMHR (combustion modified high resilient) foam from their upholstery materials, which are based on melamine and chlorated phosphates. They were replaced with HR (high resilience) foam that contains no flame retardants but is equally effective. They have also their own production of upholstery materials based on MDI and polyol and use water-based release agents. Water replaced freons as an blowing agent.

They have also set goals of not exceeding 10 tons of VOC (volatile organic compounds) even if their production increases in the future.

3.2.3 Materials

Wood in form of fiberboards, solid wood, veneer and laminates represents the company's largest renewable material source. Wood materials are mostly used in table tops, storage units and seating. They expect their suppliers to comply to forestry management standards

and have a goal to increase their use of FSC-certified wood. Laminate suppliers meet the demands of E1 norm for formaldehyde and use a glue free from it.

Metal is mostly used in frames, chair mechanics and components in soft seating. They make sure the metals are recycled and powder coated with a material with low environmental impact.

The use of plastics is quite small relative to wood and metals. They try to label all plastic components to ease recycling and separation. They try not to use PVC or phthalates in their plastics.

Fabrics and leathers are used mostly in covers. Synthetic fabrics have the same requirements as plastics. Flame retardants using brominated or polybrominated elements and chromic tanning aren't used in their processes. Most fabrics are labeled to EU ecolabel or Ökotex. They have one of the toughest fabric demands in Sweden today.

Packaging materials are recycled and the excess is used in energy production at the company.

3.2.4 Energy

Excess waste from production, packaging and so on are used as fuel for energy to heat the factories. Fuel briquettes are their main fuel source for heating, which are made from waste and worn packaging from their factories. Their machinery uses energy from the national grid, some of which is green-energy that is made from hydroelectric or wind power.

Water consumption is measured each year and they try to use it sparingly. The water is taken from the local public water supply.

3.2.5 Emissions

The company's trucks run on environmental diesel to reduce the impact they have. They catalog the emissions from:

- Air emissions from production, such as carbon dioxide, nitrogen, particles, sulphur and solvents.
- Transport emissions, carbon dioxide, particles, sulphur, and rubber residues from tyres
- Noise from factories and transport
- Furniture, such as worktables, storage units, desk chairs, chairs, easy chairs and sofas, screen walls and accessories
- Water from sanitary requirements, processes and cleaning
- Waste and hazardous waste in the form of oil residues, lacquer residues, ash and other waste for disposal.

3.2.6 Chemicals

Chemical substances listed in Swedens Chemical Agency's database of restricted materials are not used in their products. If they are present they are to be phased out as quickly as possible. If the material is present in Swedush Chemicals Agency's prioritization guide (PRIO) they are assessed. IF a material is hazardous to health or the environment they must be phased out. Materials that are to be used are included with their environmental classification in their databases.

The company hasn't used chrome in their products other than screws, fittings and hinges since 1997.

Lacquers are used for surface treatment. They are UV-hardening, solvent free, acrylate lacquers. They meet the demands of the Nordic Swan and are therefore considered to meet some of the highest demands on the market today.

Powder coating is done using high molecular weight epoxy or polyester resin. Attempts to reduce the amounts of coating used have been made with new machinery and types of powder.

Solvent-free hot-melted adhesives and water-based glues are used that contain no VOC's.

Metal cleaners are used to clean metal parts for painting. As some of these contain toxic substances that are non-biodegradable they are disposed of safely. Cutting fluids are also collected and disposed of for the same reasons.

Freon is present in cooling systems for the factories. The most harmful, CFC's are not used at their factories.

3.2.7 Values

The company presents itself by a few core values that are important for them. Amongst these are:

Forward-thinking where they try to develop and see opportunities. Creative, daring and different and do what no one else has done. They strive to be better.

Independent where they have their own knowledge and be proud of their profession and develop as persons.

Honesty and humility, where they strive to be open in their communication and be respectful towards all. They comply with laws and regulations and keep what they promise.

They strive to be responsible, thrifty with resources and carry operations in such a way that they are sustainable. They want to find the source of problems and long-term solutions.

5 METHODS

In this chapter the methods that were chosen to be used in the project are presented as to what they are, the outcome of them and how the results may be used.

5.1 Users

It is important to understanding who the users are and what they need in order to have a successful design. Therefore there is a need for a detailed description of user's attributes, a so-called user profile to make it easier to understand them. This is also done to know whom the product is developed for, to whom to recruit for usability tests etc. The user profile should contain demographic data, skills, education, age, occupation and more. Users aren't only the ones that directly interact with the product but others as well such as: the managers of the end users, purchasers, users who use the competitor's products. The users should be categorized into primary, secondary and tertiary users. These range from those that use the product daily to those that are affected by it in a system basis. However even if these all are possible users, requirement activities might not be needed with the secondary or tertiary users, they should however be known (Baxter and Courage, 2005).

User requirements are what a product should have from a user's perspective. User-centered design refers to the approach of adopting a product to the user and not the other way around. This is achieved by applying techniques throughout a product development process that are focused at the user (Baxter and Courage, 2005). According to Baxter and Courage (2005) there are three principles to user-centered design:

- Early focus on users and tasks
- Empirical measurements of product usage
- Iterative design.

This means that through structured and systematic collection of user's requirements a superior product is achieved. Test and evaluation iterations of prototypes then ensure that the end product meet requirements. User-centered principles are incorporated by clarifying usability objectives, performing user studies such as interviews or focus groups, usability tests during development and collect feedback from the end users (Baxter and Courage, 2005).

User requirements allow project members to see in which direction a project should go by determining what functions a product should incorporate. It's important to talk to the user in order to know their tasks, goals, skills and in what context they might use a product. A number of techniques such as interviews, surveys, focus groups, group task analysis, card sorting and field studies are all methods for gathering user requirements for different circumstances (Baxter and Courage, 2005).

To make any changes in a product the most important task is recognizing the users who interact with the product in different level. Four different kinds of users that can be

identified: Primary users, secondary users, side users and co-users as described by (Boghart et al, 2009);

Primary users

A primary user is a person who uses the product for its main purpose.

Secondary users

A secondary user uses the product in some way, but not for its main purpose.

Side users

Side users are affected by the product, but they do not actually interact with it.

Co-users

Collaborate with primary or secondary users, but are not interacting directly with the product.

5.1.1 Interviews

Interview techniques are one of the most commonly used user requirement techniques. It's a qualitative technique to obtain detailed information that other techniques might not entail. By doing several interview of a task a holistic view can be achieved through combining the individual opinions of multiple users. Interviews may gather detailed information concerning challenges users face and are great conduits for innovation (Baxter and Courage, 2005).

Before doing an interview there is a need to know about the product in question, potential users of that product and what the objective outcome should be. It is important to form interview questions with the outcome in mind as to not wander and get information about topics that are irrelevant. There are three types of interviews, open ended, structured and semi-structured interviews. Open-ended interviews allow the interviewees to freely answer questions while structured only allows for selection between answers. An unstructured interview gives the most qualitative answers as it provides a rich data, is flexible, allows for follow up questions and when the results are unknown, i.e. probing for innovation. A recommendation is to interview six to ten participants of each user group, however if a user group is fairly homogenous fewer participants might be enough (Baxter and Courage, 2005). Baxter and Courage (2005) explain that in an unstructured interview talking points are defines but the interviewee decides how deep into each subject they want to go. They continue that the pros are getting rich data, ability to follow up on questions, flexibility and useful if the expected answers are unknown. The cons are that it is difficult to analyze, follow up questions aren't consistent, some might delve in a particular area for too long making covering all points hard and quiet participants may not give rich answers.

After an interview it's important to go through the information and later analyse the data before forgetting the acquired information. The data can be analysed through categorizing methods, affinity diagrams or qualitative analysis tools (Baxter and Courage, 2005).

Probing

Probing is a method of digging deeper during interviews to get additional information if a trigger is identified. According to Baxter and Courage (2005) by identifying markers in interviews the interviewer can probe for more detailed rich information from the participants. If a marker is seen the interviewer can ask a follow-up question to dig deeper. Examples of follow up questions are according to Baxter and Courage (2005):

- What are you trying to do? Instead of asking: Are you trying to ____?
- Did you find the product easy or difficult to use? Instead of saying: Did you find the product easy to use?
- Are there any changes you would make to ____ to make it easier to use? Instead of saying: If we changed ____ to ____ do you think that it would be easier to use?

5.1.2 Focus group

Baxter and Courage (2005) explain that focus groups are an excellent way of getting different points of view in a short period of time. They explain that participants are brought together to discuss topics proposed by a moderator and are excellent ways of collecting many points of view on a topic. They also explain that by having several participants it can simulate ideas and encourage participants to talk about topics that in single interviews wouldn't bring up.

According to Baxter and Courage (2005) focus groups are useful in any stages of a process to get initial requirements, understand results from surveys or identify why user understanding is poor and so on. Another possibility could be to evaluate concepts or product models in a later stage in the process before doing detailed design.

Baxter and Courage (2005) focus group process is in short:

1. Identify the questions that need answers
2. Identify and recruit users
3. Prepare activity materials, location, incentives, etc.
4. Do the focus group, record and store data
5. Analyse the data and interpret the findings.

Baxter and Courage (2005) explain that a focus group session is held by introducing the participants to the task and go through the session. After which the discussion is held, during which the moderator has to make sure that the conversation flows, wanted questions are answered and so on. They also explain that there needs to be a note-taker, and recorder to enable the moderator to freely concentrate on allowing the discussion to flow. After the focus group the information needs to be analysed with appropriate methods and then conveyed to the appropriate stakeholder.

5.1.3 Affinity diagram

Affinity diagram is a method based on Jiro Kawakita's KJ-diagram and is a method that collects large amounts of data into manageable chunks. It is one of the most useful methods

for managing qualitative data from interview responses, focus groups, field studies etc. It can also be used to group characteristics when building personas or analysing usability tests. In this method individual data is written down and then grouped together in themes or trends in the data (Baxter and Courage, 2005).

According to Baxter and Courage (2005) the affinity diagram is a good method for sharing results, add structure, breaking down issues into broader categories, identifying issues that affect multiple areas, responding to broader scale problems rather than individual ones for a holistic solution, getting innovation and getting an team agreement on an issue.

Affinity diagram is the best method for analysing qualitative data as it looks for patterns and themes. The results should then be used to build on personas and scenarios further to improve them. Activities that can be based on the findings should be identified and recommendations for the next step should be put together (Baxter and Courage, 2005).

5.1.4 Persona

Personas are there to fill in the blanks between the facts to create a user. A persona is a fictional typical individual based on the user profile are there to represent the group of end users in order to keep them in focus during development. The benefit it shat developers are able to feel a connection with the target group, which might be hard to do with statistical facts. Personas also encourage developers to think about the same user instead of each having their own vision of who the user is. It also makes it easier to target the user profile with a few main targets, instead of trying to make it for everyone. There should be at least one persona per user type, preferably three main personas for the main user group. The persona should contain identity, photo, goals and tasks, skills, education, requirements, expectations, relationships and more in order to fully represent a user and be a believable character (Baxter and Courage, 2005).

“personas will help you, your team, and your organization become more user focused.”
(Adlin and Pruitt, 2010).

5.1.5 Scenario

Scenarios are stories of how the fictional characters behave and complete tasks or behave in a situation. These stories give life to the user and enable the designers to see if the product meets the user’s needs. Scenarios help in determining the functionality of a product so that users will want to use it. Scenarios should contain the setting of where it is done, the actors present, objectives and goals that are to be achieved, the sequence of events and what the results are. The focus should be on the primary tasks a user might do, if there is time secondary tasks might be included (Baxter and Courage, 2005).

The idea is according to Baxter and Courage (2005) that before any user requirements activities are performed these should be done even if there might be lacking information for them. As information is gathered from the activities these are then fed back into the user profiles, personas and scenarios in order to complete them.

5.2 The natural step process

The natural step process is based on system thinking that each step of the system affects the other parts. It helps organizations to understand and fit sustainable thinking into their planning. The process is part of the framework for strategic sustainable development. In this framework an organization should follow a strategic process such as the ABCD method to apply the framework. The framework is a model for planning complex systems towards sustainable development. The framework is tried and tested for creating lasting plans for transformative change in organizations (Thenaturalstep, 2012).

This can fit the project by providing a tool for visioning the ideal future that we should strive towards, in line with Cradle 2 Cradle thinking. Also it's a way of envisioning the steps for the company to reach that goal in line with Cradle 2 cradle goals.

5.2.1 ABCD - method

The A-B-C-D is a process of applying the natural step framework in an organization. It's based on back casting from sustainability principles. Each letter represents a step in the method. This method continuously assesses whether actions strive towards the envisioned future, it provides new design parameters that drive innovation, it incorporates organizational learning into the process and it doesn't limit by considering only what is available today as the forecast but as a step towards the future (Thenaturalstep, 2012).

A = Awareness and Visioning

The first step consists of creating a common understanding about sustainability and creating a vision for that organization for a sustainable future. The principles of sustainability should be incorporated for living in balance with nature. During this step the organization is encouraged to set ambitious goals where radical changes may be necessary. Here is when the organization envisions the service that they provide independent of any one product. By doing this a wave innovation can be set in motion and releases the organization from limitations (Thenaturalstep, 2012).

B = Baseline Mapping

In this stage the four sustainability principles are used to conduct a gap analysis of an organization's activities to see how they are lacking in context to the sustainability principles. Here products and services are looked at, energy, capital and human resources. It also considers the mentality and culture of the organization on how to induce change. Here issues are established, their implications and assets that can be changed (Thenaturalstep, 2012).

C = Creative Solutions

Here potential solutions for the issues highlighted in step B are created through brainstorming. The organization looks backwards from the vision on how they can solve the problems, called back casting. With this in mind each activity should then strive towards the shared vision (Thenaturalstep, 2012).

D = Deciding on priorities

Here the organization prioritizes the activities that would move the organization forward the fastest, while optimizing flexibility as well as economic and ecological returns. Here step-by-step implementation of activities can be useful for doing incremental changes that provide steppingstones for further improvement (Thenaturalstep, 2012).

7 PROCESS

This chapter describes the things that were done within the project excluding the literature review done in the beginning.

7.1 Stakeholders

Meetings with stakeholders within the company were held at a few occasions. They resulted in gathering of how they wished the company values to be presented within the product, what it should incorporate.

Initial meeting was with a few of the main stakeholders consisted of describing what they wanted and what we had planned with our work. Later meetings were had with different heads of departments and went into what they do and what tips they had. These departments included environmental, soft seating, office chairs and desks, prototype department, test and validation etc.

A meeting was held with a head of design that brought insight into their design language, how it should be presented and what their vision and values are.

There were many stakeholders that each had their own wish of what should be the focus and what should be included in the project. There often pulls to focus on different items making it hard to choose focus and how each of them should be implemented.

Visit to factories

A visit was made to two of the company's factories that manufacturers office furniture and one that manufacturers soft seating. The visits showed their manufacturing process of table tops, cabinets, use of laminates and wood. How they are constructed, glued, assembled and finally packaged into transports and shipped. The second factory had the soft seating manufacturing. It showed the process of cutting fabrics, sewing the upholstery covers, assembly of frames and upholstery, moulding of seat cushions and packaging of finished parts and furniture. A visit was also made to their prototype facility that showed how they make prototypes and what is needed for making one.

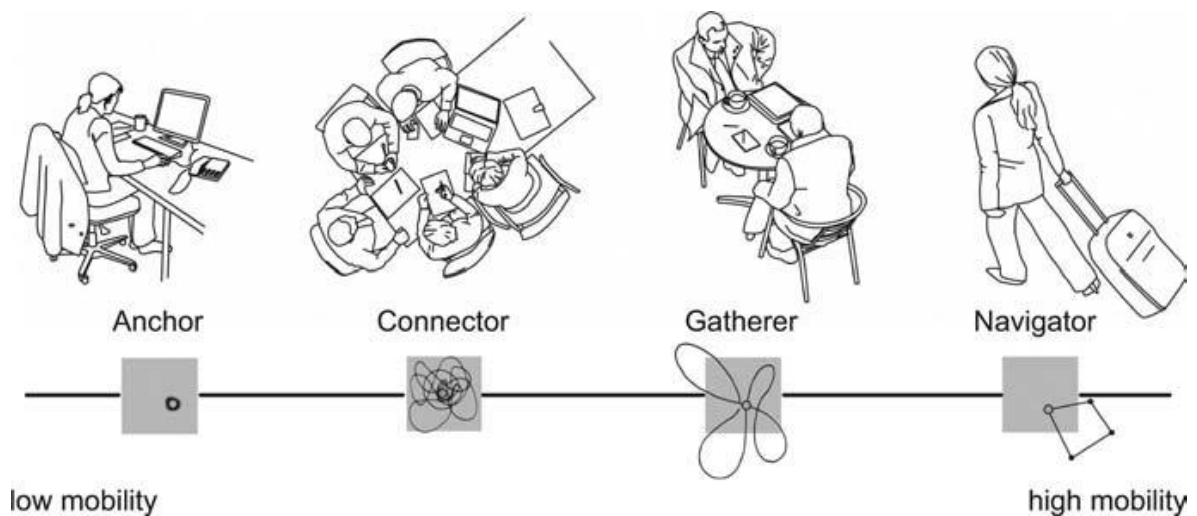
The company also has a display where they show off their different furniture lines and arrangements to show for customers. These gave a good inspiration of how they view their furniture to be used and in what context.

These visits gave insight into how their assembly process is done and how they package their furniture for delivery to customers. The visits also showed the consideration they take into material use, safety, efficient assembly amongst other things.

7.2 Identifying the user

To start with, a user basis was needed to be identified to whom the product should be aimed at. Applying traditional thinking with sedentary office workers that use desktop computers as their main work station wouldn't meet the requirements which this project had. This required identifying a way of looking at workers depending on computer usage, mobility or other reasons.

During the literature study a way of looking at workers with four main types of knowledge worker defined by their level of mobility from low to high. These four categories represent knowledge workers sufficiently different from each other in respect to their communication and mobility (Greene, 2011) (Image xx.).



The different user types visualized by the level of mobility. The box represents the office.

The Anchor

The Anchor is the mostly sitting office worker, someone who is mostly found at their desk in office. The Anchor can enjoy doing desk based tasks within the organization which means limited movement around the workstation (Greene, 2011).

Not long ago, office furniture has been focused mainly on this way of working and most of needs for comfort have been met with ergonomic desks and chairs. The Anchor usually does not have comfortable relationship on open plan space within which they are usually situated. The majority of their tasks need concentration so they often find noisy environments hard to work (Greene, 2011).

The Connector

The Connector typically spend half of their time in different places like meeting rooms, cafe or at colleagues' desks. They leave their jacket over the back of their chair and are gone – and they may be mistaken for not doing any work at all. For example: R&D manager of an industrial company (Greene, 2011).

Over the past ten years there has been more concentration of the social aspects of work, with the emphasis of office design transferring to be more communicative and collaborative, fit more with the Connector. But it seems that the design of these areas has been more focused on computer as the only tool a knowledge worker really needs, whether they are collaborating or not (Greene, 2011).

The Gatherer

The Gatherers are workers whom spend around half the week away from the office at different appointments and have many relationships not in the office. The Gatherer can be located at client or customer offices, at other sites or third space places like cafe's or members clubs. They are expected to have local travel to do business and bring information and critical new relationships so the office still remains a main place to work (Greene, 2011).

The Gatherer use mobile and wireless technologies provided in office to collect, handle and review information on their own or face-to-face with relevant colleagues. They are most likely to work on a shared desk or hot desk instead of their own desk but still need to have spaces to good concentration and collaboration. Large benefits in terms of space utilization and is cost efficient can be taken but the weak hot-desks designing has meant that many Gatherers simply take work home in the laptop bag (Greene, 2011).

The Navigator

The fourth typology includes knowledge worker who not often work in the office and are visitors to their own office in some extend. Contractor, the nomad and needs access to a space where they can sit down and use their laptop. This group is increasing day by day but still managers have least information about their needs and are find it hard to provide facilities for them. Navigators often have political responsibility and critical international concerns (Greene, 2011)

The wireless generation

As an addition to the user types identified from the literature a fifth one was added to complement them and add a more modern approach with use of wireless technology and office less work. The idea was to gather possible extra uses or just to get more innovation into the product. As an addition this user base has more of a focus on public spaces, cafes, rent offices, libraries, school areas and working from home giving further possible locations for a product.

7.3 Interviews

Interviews were chosen as an appropriate method of collecting information on users' habits during work. According to Baxter and Courage (2005) interviews are a good method for getting information on current usage in depth and getting a holistic view. The outcome of the interviews is represented in the affinity diagram results as well as the personas and requirements list.

Following the process suggested by Baxter and Courage (2005) appropriate users were first identified as described by the amount of mobility in their working tasks; anchor, connector, gatherer, navigator and added to these was wireless generation.

Secondly the purpose of the interview was discussed and the outcomes it should bring. The results were agreed upon to be getting user requirements that can be implemented into the requirements list to complement existing ones and make sure no important aspects were forgotten. Also the outcome would be getting information that can be used to create personas and scenarios to be used later in the product development phase. Questions were directed to receive information on work, working tasks, areas for work, travel habits, use of soft seating, what would be required of a soft seating product to work from and concerning their opinion of environmental branding and reuse of products.

With the purpose defines an open-ended interview structure was chosen as to allow for in depth analysis and flexibility.

By checking the Baxter and Courage (2005) “To Choose Telephone Versus in-Person” the method of interviewing was chosen to be telephone interviews due to difference in user base and type of users chosen making it hard to and time consuming to get participants for face to face interviews. Also questions weren’t depending on sitting in a certain location, interview didn’t require showing anything in particular, no physical requirements were used and there was a need for rapid data collection as time was short.

The affinity diagram method was selected to gather the large amount of data and to organize it. Initial brainstorming within the project group collected interview questions, which resulted in a large amount of questions. After sorting and using only the most important topics an amount of questions suitable for a single interview session was obtained. The question slightly differed between the different users types as to not delve into matters not concerning the users’ different types of work. Using the guidelines from Baxter and Courage (2005) “Dos and don’ts in question wording” the questions were changed to be clearer.

Baxter and Courage (2005) recommend using six to ten participants of each user type; however explain that this number depends on many factors such as diversity within the user types and when similar answers begin to appear. The aim was to have up to six users in the main user types, and up to three in the secondary users.

Interview advertisements for finding users were put up in areas with office rental areas, office coffee shops, public areas such as libraries and schools. However these advertisements didn’t render any replies at all. A more direct recruitment method was needed and contacts were used to find appropriate users in each user type. Also a Facebook group called “Jobbsällskap” (work companionship) that is aimed at collecting people who work in public areas was used to recruit users in the wireless generation user base.

The recruitment resulted in a total of 12 participants over the different user types;

- Anchors, 3 participants

- Connectors, 2 participants
- Gatherers, 2 participants
- Navigators, 2 participants
- Wireless generation, 3 participants.

The amount of interviewees was decided to be enough due to the diverse and rich information obtained from the participants and also that there was a shortage of time to do more interviews. The participants were interviewed for in average one hour each through the phone using question worksheets. At first interviews were more or less tied to the question worksheets while, as the latter ones were more or less like normal conversations regarding the topic and the question document used as a guidelines as not to forget anything. Participants were in general talkative and happily talked about their experiences and opinions regarding work. During the interviews it was noticed that many didn't have a working situation only belonging to one user type description, which required some adding of questions and probing at times outside of the specified question worksheets. Answers were then written down during the interview for later analysis.

7.3.1 Focus group

The aim of the focus group was to get the students perspective on the work they do and form a discussion into activity based working and different working situations. The main goal was to get comments, opinions, ideas and such to be used in the affinity diagram but also interesting topics that might spur ideas. The results from the focus group were added to the results of the affinity diagram.

The focus group was prepared using the guidelines of Baxter and Courage (2005).

An advert was placed out at school premises about a focus group to get interest from students a week prior to the date of the focus group. A group room was booked and incentives consisting of cupcakes and coffee decided upon. However the advertisement didn't render any replies, which later required in person recruitment amongst Industrial design Engineering and Technical Design students at Chalmers University of Technology. The recruitment rendered five participants for the focus group held at school premises.

The purpose of the focus group was presented together with a description of activity based office work and what kind of users there are in offices and why students were of interest. A more detailed description of the topics can be found in appendix 2. The focus group took roughly an hour after which the students were presented with coffee and a cupcake for their trouble. The discussion was transcribed during the interview and recorded if further analysis was needed. The results were later used in the affinity diagram method.

7.3.2 Analysis



After each user had been interviewed and the focus group was held the data was gathered and sorted as described by the affinity diagram method in chapter 5.1.3. The comments were divided between the project group members and then sorted with post-its into different categories after which the group discussed the topics and did further grouping and sorting. A complete list of the results from the affinity diagram can be found in appendix 3. The topics can be summarized as:

- **Easy to adjust**, about having visible, logical, obvious features/handles
- **How to visualize ergonomic/comfort**, having parts or functions that clearly indicate movement or adjustability
- **Level of adjustment**, what parts should be adjustable
- **Work tasks/activities**, what kind of tasks they do during work
- **Characteristics/feelings**, feeling of the environment
- **Storage**, place for items
- **Work surface**, space for items needed for work
- **Extra value**, things that would add value
- **Concentrating**, preference during concentrating work
- **Relaxing**, preference during relaxing tasks
- **Privacy**, what is needed to provide privacy needed for work
- **Semi-privacy**, provide enough privacy for work while maintaining contact
- **Meetings**, required to conduct formal meetings
- **Areas for work**, places users liked to work in
- **Lounge**, formal relaxed meetings.

After the final sorting and grouping the topics were written down and further requirements were ascertained from these topics and comments within them forming user requirements in chapter 6.x. The results from the interviews were also used in completing personas and scenarios from real user behavior during the type of work the different user types perform.

7.3.3 Personas & Scenarios

Temporary personas were created as per guidance by Adlin and Pruitt (2010) prior to doing any interviews or focus groups. These brief skeletons of users were created as to shortly describe the different personas based on the defined user types described by Greene and Myerson (20xx) with the addition of the wireless generation. These were prioritized by the importance they have to the project and the context in which they are main-, secondary and tertiary users. These were then developed further in more rich detail to provide richer personas bases. The results from the interviews and focus group were then used to further improve and develop the personas to fit the real users in more detail and to make them more believable. Scenarios in combination with the personas were created to further give them more credibility as well as depict the real life scenarios of the users interviewed. This process resulted in the final personas and their accompanying scenarios in chapter 6.1.

7.4 Fitting trial

The complete task description of the fitting trial can be found in Appendix 4. The fitting trial is to be done when a final concept is found and ergonomic testing is needed to access it regarding comfort and ability to support work related tasks.

Fitting trial guideline as theory suggest by (Haslegrave and Pheasant, 2006).

- **Mock-up constructed with an adjustable range to features being evaluated.**
- **Simulate tasks intended to be done in the seat.**
 - Working with computer
 - Having accessories for the computer, mouse etc.
 - Reading and writing
 - Taking notes and writing on computer
 - Reading notes and typing on computer
 - Decide if to compare to other solutions
 - Time of evaluation.
- **Select relevant sample of users**
 - Short person to evaluate seating height
 - Large person to test fit etc.
 - Tall person for height and backrest
 - Small person for armrests and such
- **Decide order of presenting the feature**
 - Present for work purpose and then move to seat. Adjustable height and angle to make better to work close to the body. Seat for comfortable working. Feel for work.
- **Range of testing**
 - Test comfort
 - How they like to work in the seat
 - How they like the size of the work area
 - What needs improvement and change?
 - Is the seat inclination enough?
 - Is the seat shape comfortable?
 - Does it allow for movement?
 - How are the armrest?

- **Set in intervals**
 - Backrest 90 – 120.
 - Fixed seat inclination of 3 degrees.
 - Table height around sitting elbow height.
 - Table angle 0 to 15 degrees.
 - Fixed seat height at 43 cm middle of cushion. 47
 - 5 cm to top front edge.
 - Fixed armrest height of 62 cm from the floor. 21 cm approx. sitting position.
 - Fixed backrest shape and lumbar support. Formed through testing.
- **Test in intervals**
 - Each subject can set the table in the height and angle they prefer since it will have a variable setting, not fixed.
 - Determine the interval for backrest inclination that will be comfortable.
 - Inquire on armrest height of 21 cm.
 - Seat height might be evaluated quickly. Preset height.
- **Determine which needs to be adjustable or fixed.**
 - Worksurface – adjustable
 - Backrest – adjustable
 - Seat height – Fixed
 - Armrest height – Fixed
- **Determine best compromise**
- **Evaluate the final design solution in the right context and with the actual users.**

8 IDENTIFICATION OF NEEDS & REQUIREMENTS

In this chapter the results from the literature review, interviews, are presented. These are divided into personas and scenarios for guiding concept generation, user requirements from the affinity diagram, cradle to cradle material requirements and a full specification of all collected requirements.

8.1 Personas & Scenarios

The results from the interviews, focus group, affinity diagram and production of personas and scenarios resulted in an in-depth description of the main user types to increase the insight as well as aid in concept generation. The main personas are the connectors, gatherers and navigators. While the secondary users are the anchors and the wireless generation. Following are the descriptions of the five different personas.

8.1.1 Anchor

John Fields is an engineer at a medium sized manufacturing company. He is 28 years old and engaged since three years. He's been working at the company for the last 2.5 years but got his current position six months ago. Has since a few years back been interested in motorcycles and recently received his license. He enjoys hanging with his friends and goes to the gym regularly. He studied for an engineering degree for three years. He thinks it is important to think about the environment but as long as it isn't a compromise.

John's position is to take care of smaller development projects, he does the technical part of the projects which includes doing CAD work, make sure manufacturing know what they are doing and do changes when new versions or changes are needed. Sometimes he visits different manufacturers to get feedback and report on their projects.

The office he works in is an open office environment with 30 to 40 workers in the same area. They are combined in clusters and separated by small walls between them. There are meeting rooms and smaller shared areas in the office such as lunchroom and resting room.

He usually takes his car to work where he arrives at 8.30. He usually gets a cup of coffee and talks to his coworkers before heading to his office area where he works for the most part of the day. At the start of the day John attends the morning meeting where they talk about the agenda of the day, progress and changes.

On his desk he keeps a lot of things but tries to keep it tidy and organized. For work he mostly answers calls, prepares documents and mainly does CAD work. He also prepares, attends and transcribes during meetings that are held a few times a month. In the mornings he likes to go through his emails and plan for the day while having a cup of coffee. He usually has a lot of email to go through. A part of his time is spent on reading and writing documents on the computer if it's a meeting transcripts or a quarterly report. He's often disturbed by the noise around him, which makes it harder for him to concentrate on writing.

It may be random telephone chatter from a nearby colleague, laughing or just normal or private conversation. He often takes his music player to phase out any distractions while typing, but since he has to take calls he often has to take them out to use the headset. He sometimes experiences neck and back pain while working in the same position every day. He has started to shift between standing and sitting positions to get variation. However he feels that he needs to sit down when he needs to concentrate. He also tries to walk to the printer and other things every time he needs to in order to get more variation. He also gets mentally tired from staring at the screen all day. He is also using a mouse and track pad and shifts between them to change posture; he has also learned more short commands to reduce the amount of small movements with the hand. He likes his current setup but his headrest is disgusting as the previous user used a lot of hair gel.

He usually leaves his office area to get a cup of coffee, print or scan papers, chat with a colleague at times or to attend meetings. At times he has discussions with coworkers about different issues or other work-related matters. Twice a week he needs to discuss different projects with co-workers in which he needs to show cad models, images or other things. Most of the time this is done at someone's desk. However most of the time he just stands up and talks with the colleague it involves. He thinks he spends 50% of his time on concentrated work and the rest with some kind of cooperative tasks. For lunch he goes to the Cafeteria where he either has his brought lunch or buys something from the nearby restaurant.

John hopes to have an area more suited for reading, writing and concentrated cad work that also offers privacy and relaxation. He would like to be able to take calls without disturbing others while also having the possibility to take notes. "Would be good to be able to discuss and relate over things that come up during work".

8.1.2 Connector

Anders Frihamn is a 35-year-old manager at an industrial company in Sweden. He's currently living together with his partner Lena whom he recently had a daughter with. He's a very busy man and often has to work late hours and hurries home whenever he can. He is interested in sports and tries to go to the gym at least a couple of times a week. He used to play soccer but hasn't had time for it since a few years.

He gets to work around 8 in the morning and often don't have time to sit down for long before he has to run off. Usually he tries to trough emails and see if there are new issues to address. He gathers progress of different projects and throws a quick run-through with everybody in his team before he heads off. Many times he goes to coworkers to discuss issues that have come up. He often has to mediate between design and manufacturing to ensure that everybody understands each other. He meets with the different heads of the company about future ideas, how they fit into the plan and progress of ongoing projects. He presents ideas and gives a run-through of a fitting approach, shares ideas and tries to manage resource allocation. He has daily meetings with his team to go through design pitches and ideas in teams or one on one. He often has to run around with his computer under the arm to bring it to meetings and to work on. Visual aids are used a lot and he often

uses whiteboards or desktops as tools for these means. Sticky notes are excellent for gathering ideas during brainstorming sessions. At times important guests or clients come to visit and therefore its important to provide a area for them to access as well as to talk about work and other related subjects or an design they have an interest in.

He enjoys the freedom that the activity based office provides. It has great spaces for talking, meetings, sharing of ideas between members of his team and areas to spread out if needed for activities. He enjoys the dedicated phone booths and privacy settings for concentrated work when he has need for I and meetings for when he has to work with others.

Since he is so busy he often has to take meetings during breaks, therefore he likes the coffee area for relaxation while discussing or just having a nice talk.

He often misses a good area to talk privately and share ideas or just to go through a pitch with one of his coworkers, heads or guests. He’s also feeling a little stressed at times and sometimes wants somewhere to take a break where it’s more quiet and easy to work before running off to some other meeting.

8.1.3 Gatherer

Elise is a 45-year-old married woman with two teenage children whom still live at home. Her husband Thomas works as a teacher at a local school. Elise works as a purchase manager, which means that she has to travel a lot from her main office to suppliers and other offices that may in many cases be located in other cities. She gets to meet new people, has flexible working hours and has a good salary, which she enjoys. She has since she was young been interested in outdoor activities, hiking and such and in recent years developed an interest in interior decoration and old houses.

She commutes at least 1.5 hours each day to and from work, which often requires travel to clients, customers, suppliers and between the different offices within the company. She constantly has to have contact with suppliers and its required of her to be social and “happy” every day regardless of her mood. She might have to spend a day or two somewhere and travel back the next. She doesn’t like how the traveling affects her time to workout, have time for her children and husband who often has to take care of everything at home. A laptop is almost necessary for everything in her work and she still uses a briefcase since a lot of the information she gets is in paper form. Elise also uses her smartphone more and more since it is faster too look up numbers, addresses, directions on the telephone than pulling up her portable computer each time. She has to travel between clients and the office to bring back specifications and needs from the customers to the relevant coworkers and employees. She often has presentations, factory visits, negotiations, shows reports, prices and so on. She usually has to sit wherever there is space, often the conference rooms after meetings to catch up on work and go through notes. She sometimes has it hard to charge her computer as the outlets might be sparsely placed. And as she is short she often has trouble sitting in deeper sofas and lounge furniture and therefore tends not to favor them on trips. An observation she has done is that conference rooms are often boring and cluttered.

She usually starts the day by car and has telephone meetings while driving and waits in the car until the telephone meeting is finished. On arrival she takes a cup of coffee and either walks around checking her employees or sits somewhere going through her emails and plan of the day before heading to the first meeting of the day. At the office she uses a shared “hot desk”, which she usually uses for short periods of time. She likes the workstation seat since she can adjust the height to fit her easily. Her time at the office is riddled with meetings throughout the day between which she usually has 15 or so minutes to work on other things.

Many times she has to go through the information she has gathered from clients which requires concentration and time for herself. Therefore she works from home many times, as she doesn't want to be disturbed and can't fit all work within a normal working day. At home she is also more comfortable and has her own space. She enjoys using her couch with the extra wide armrests to use a wireless mouse on or use the kitchen for a more upright sitting position and to be close to her family.

She often needs a space for concentrating and collaboration with colleagues. She estimates that 20% of her time goes to working by herself the rest involves other people. She often has face-to-face discussions with relevant colleagues and suppliers about opportunities and needs. Even if she has to work by herself she likes having people around her, but not too close. She sometimes finds many areas to overhearing and with too much insight and therefore searches for quiet private spaces to have sensitive phone calls or meetings with suppliers that others cannot hear or to work on negotiations or sensitive documents.

She would like a place where people cannot walk behind her so that she can keep tabs on them. “If people walk behind you don't want to show documents. Or that you are fine tuning a power point with sensitive information for people to see.”

She thinks functionality and comfort is important also that there is a safe atmosphere around you that is cozy without insight. She thinks a couch would only be good for working short times, showing suppliers something, coworker discussions or have short presentations or share information rather than to use a conference room for that. However only if the couches are not like home couches, which are too soft and deep and the tables are often too low.

8.1.4 The Navigator

Andrea is 51 years old currently married since 17 years and the mother of two now adult children who recently finished their gymnasium and started University educations. She speaks three languages fluently and enjoys traveling to different countries. She and her husband frequently travel to France where they since 10 years even have a summer home. Her language skills come in handy in her work due to her traveling. The traveling was her main reason to choose the job she currently has as a sales director. She has a bachelor's degree and many years of experience at the company where she started at sales before moving up to her prior job as department head. One of the main problems she had was the

sedentary type of work she had to do at the sales department. She wanted more movement and traveling and decided to put her knowledge of the assortment and love of travel to use.

In her job she frequently travels to customers, architects, and retailers and so on to try and get their products to a wider market and present new products and improvements as they come. She spends in average 3-4 days a week traveling. Her work requires good knowledge of their assortment and the market as well as computer skills as it requires a lot of writing reports and making presentations for customers and so on. As she travels a lot she has to utilize whatever time she has to spare to use for work in hotel, airport and clients' lounges. In the hotels she sometimes sits in the hotel room where they usually have a desk and a chair. She however often feels they are uncomfortable and therefore either uses the bed or goes down to the hotel lobby to work from there. She often likes the movement and activity in more public areas, which gives her work more dynamic however sometimes she needs more privacy while working with sensitive materials that others cannot see. Nice areas are the half high sitting areas in some lobbies where you can hotspot and work or eat a snack or cup of coffee. At airports she often does work in cafés wherever she can get a seat or close to the gate in airport chairs.

At customers' offices she often spends most of her time in conference rooms or small meeting rooms where she often works for a while before the next meeting. Now and again she might have access to a desk. She often has a bag with her computer and other items in which she has to carry everywhere she goes and often has problems with electric outlets. During short trips it's often a small computer bag but for longer ones she may have to carry luggage wherever she does. Often she places it by her feet if she has to, too much hassle to hand it in. Another note that she has noticed that she never stays in one area for long before having to go to meetings or other activities in her work. It is the same in lobbies and cafés as she never stays more than a couple of hours.

The laptop and wireless Internet are her most valuable tools; she also has to spend a lot of time on tele-conferences and phone meetings so she often has to use her hands free. She estimates that a total of 25% of her time goes to preparatory work such as making presentations and such and the rest is in meetings of different kinds not including the traveling she does.

At the main office she has to review the gathered data, but sees it only as a node in her network. She often doesn't feel welcome at the office since many who aren't in her department don't know who she is, however whenever she is there she needs to be comfortable and ready to do her work from the start.

She doesn't like sitting in arm chairs as they don't have the same ergonomic as work chairs. She however likes using them during personal meetings with different parties and for more relaxed work at times. She feels that she would need somewhere better to put her computer and support for her arms than normal couches afford. She has also noticed that those who wear suits often don't like couches as the suits get wrinkled and many sit on the edge of the seat. She often likes the aesthetics in many hotel lounges and the feeling they have. She enjoys eating out during business trips and often chooses finer restaurants.

Asked whether she felt welcome, one highly qualified Navigator told us: No, it's generally, who is that consultant over there? (Greene, 2011)

8.1.5 Wireless generation

Stefan considers himself as a hip young entrepreneur. He recently finished her three years at the university and decided to continue with his own company that he started during his student years. He works mainly from home since he didn't need an office as he works alone. He thinks it's lonely as he lives by himself so he might spend the whole day alone and the home is full of distractions that kept him from focusing on work. He later then heard about a group that come together to work, share and talk. He thought it would be a great opportunity to do some networking, get more experience and meet new interesting people to make work life more fun.

Now when he feels the need he'll contact the others in the workgroup and they convey somewhere to work together. They talk, have coffee, work, share knowledge and experience, contacts and so on. He has also started to rent office space in a rent office in the town where he can go whenever he feels like to work, have meetings and discussions in a more professional setting.

Stefan starts his day by taking a walk outside to feel that he is going to work even if he is at home. He has made himself an office area with a cheap office chair and desk that he uses. The mornings usually start by reading emails from clients he might be working for at the moment and planning what he shall do during the day and when. Most of his work is text based; writing guides, manuals and such for clients. That also means that he has to read a lot of instructions, drawings, notes and other documents as preparation but also work with pictures and taking photographs. Since he started in the work company group he tries to plan in different settings and booking meetings with others to work with. He tries to at least be away from home two days a week. Usually he tries to do most of the heavy stuff early in the morning and after lunch tries to focus more on reading and doing lighter activities for the day. During heavy parts of the work he has to have more space for papers and notes, spread them out to get a full overview over things while reading mostly doesn't require a lot of extra space and can be done elsewhere.

When Stefan goes out to cafés he often finds himself sitting at a coffee table with his laptop reading and typing or calling contacts for providing services and the like. He plans it so that he won't have to need a lot of space for his documents and such. When he sits there with company they try to plan their efforts to coincide with each other. He often tries to plan in to have discussions to get input on ideas. He enjoys the company of others during work to talk and have coffee but it can also be troublesome at times.

The rent office areas are a nice addition to his home workplace and cafés and other public areas. He is considering moving to the rent office on a more permanent note to get more out of work in the future. He has the same structure of the day with the exception of company and the input from others for his work. He usually uses the private work areas for focusing and writing and sometimes changes his setting to softer seating to work from. The

major downside is that he can't spread out and have as much documents as he has at home so it can't replace it completely. The positive is that he can have business meetings while working in a formal setting and work more focused without the distractions as it would be at home.

He likes large cafés with less people in them and less clutter. He thinks it hard to work comfortable at times since sitting with a laptop on a normal chair isn't the most ideal position. He uses lounge or armchairs if they are available and tries to optimize his sitting as much as he can by using pillows and other things. He doesn't like people walking behind him so he chooses corners or sitting with his back against the walls to make sure he has his space. Sometimes it is a problem if someone sits too close or talks with him if he wants to work and focus on it. Also sometimes it is hard to find electrical outlets at many areas and they have to choose places that have those regardless if they are comfortable or not, however more cafés loan power strips if you sit in a group. Sometimes the normal coffee shop chatter gets too loud and affects his concentration but he doesn't expect it to be quiet either. The attitude of the shop may sometimes be a problem if they pull up laptops and work for longer periods of time, since some do not want that. Wi-Fi access is important and that prices aren't too high so they can stay there long periods of time without it being too expensive or having trouble with mobile internet access. Another important factor is having proper lighting since some cafés try to have a cozy setting which usually means poor lighting.

"I don't choose to work there for it to be silent or have privacy. I choose it for the company and to have that setting."

8.2 User requirements

The user requirements seen in appendix 5 were defined from the results of the affinity diagram method. These were set into these categories: Ergonomics, handling, working tasks and activities, storage, privacy, aesthetics and features. Listed below are the problems related to those different areas described by the users. See appendix 5 for the requirement list.

Ergonomics

The users in general commented on existing products and how they weren't good for working in due to sitting too slumped backwards, cushions being too soft, sitting too deep and hard to get up from. Also in combination with laptops where users often had to have them in the lap which makes the computers hot, the other alternative would be using coffee tables or similar items that required them to take a forward sitting posture, which decreases comfort significantly. The most important aspects were that users need good support for the body and a surface to place the computer on that allows it to be placed close to the body. However since a couch normally isn't used for working for long time periods it should be quick and easy to adjust any parts or users wouldn't bother doing any of the adjustments.

Handling

For many users the problems were that couches normally aren't adjustable which would require that it should be really easy to adjust, easy to see that it is adjustable, what can be

adjusted, how it is performed and how the adjustment happens. Many preferred that there were fewer functions to make it easier to directly know how to adjust instead of trying different functions and that the chair easily reverted to a default setting since many wouldn't bother to adjust if they were to use it for a short period of time.

Working tasks

Since many of the interviewees working task differed from each other and was in different fields of work there was a wide variation of needs to be considered. The anchors had working tasks that required special considerations and equipment therefore the focus was on more general tasks. Reading or writing on a computer or notepads, surfing the internet/intranet, reading and writing emails were common tasks that many performed each day. Many on the go users did a lot of preparing for presentations, administrative work and transcribed notes on the computer in various places and often missed electricity, privacy and good comfort while working. Some had also started to use tablets and smartphones daily as a substitute to slow bulky portable computers to just read emails and texts. There were also comments on using different accessories such as wireless mice, 3D visualization joysticks, chargers for phones, headsets and such, which will require space. One pattern seen was that users due to their daily routines never stayed in a location for more than 2,5 to 3 hours before going on breaks, meetings or other activities. The Connectors, Navigators and Gatherers often only sat in one place for 10 to 30 minutes before having to run off to a different meeting.

Working activities

The different types of users had very dissimilar activities, which they performed during work and how big part of their work these activities were. The anchors did contemplating work as a large part of their working day, which places a big emphasis on good workstation ergonomics to reduce static loads. The more mobile users had a larger emphasis on cooperation, meetings of different kind and had a larger change in work areas, situations and locations throughout their day that place entirely different needs on seating solutions. The main users estimated that they had a work divide of 20 – 35 % contemplating work and 80-65% as cooperative work. The cooperative work consisted of informal meetings with a few participants, sharing of ideas or discussions, having presentations, formal meetings, welcoming or visiting customers and so on. They also spent a lot of time on trips and worked from hotel lobbies, cafés and so on. This places a need for a more formal soft seating area to conduct work related meetings, discussions, sharing of work with up to around four participants but also for personal contemplating work.

Storage

It became apparent during the interviews that many of the mobile interviewees were more or less dependent on portable computers and having them with at all times. This means that they have bags, chargers and papers wherever they might go and when stay seated in an area have to store them temporary, most of the time at their feet, next to them on the seat or on tables. Even if some had personal storage they still had to carry the items they need for work. They also had a need to have a stow away area for papers, telephones and other

supplies and accessories during work and electric cables that otherwise take up space on the floor or seats.

Privacy

Many considered it important during contemplating/ concentrating work that they needed more privacy but few wanted complete privacy. Those that worked stationary preferred having close access to colleagues to be able to converse and ask if needed and if they required privacy they used headphones to “close out” distractions.

Many also mentioned if they choose to work from soft seating areas, lounge areas, cafés it was for the activity and movement there to give inspiration, change of environment and also the closeness to people. They didn’t choose those settings to get away or have complete privacy. However if they used those areas for work they wanted to create distance either by creating boundaries, having the possibility to screen off, be shielded from the back, not having anyone next to them, not sharing a table surface or wanted a way to show that they shouldn’t be disturbed. This aspect can be described as a concept of semi-privacy.

They also talked about having the possibility to cooperate and work together and then screen off or separate themselves to work alone and then communicate if they needed or wanted to. Also during situations where cooperation was need they preferred a solution that allowed them to face each other and not sit parallel to each other in a soft seating product.

Aesthetics

The interviewees’ main concern regarding the aesthetics of couches was that normal couches aren’t suitable for working neither in comfort nor looks. A couch meant for work needs to have an appearance that indicates it as well. Also as couches normally aren’t ergonomic or adjustable it wouldn’t be easy to see or understand that at first sight with a normal soft seating product. It would have to clearly indicate in shape or controls that perhaps this item is better suitable ergonomically to work in. Many also expressed the need for fresh colours and appearance that indices a modern at work appearance without being too flashy as a more neutral appearance was what they expected at or during work.

Considering “for work” users prefer upright sitting, large work surfaces and often searched for a seat and table as an area for concentrated work. However since a workstation seat and table would therefore be more suitable for longer work the focus would be for more short-term usage. However still interesting to think about the “table and workstation seat” appearance.

Features

Other aspects that were commented on were how dirty surfaces become especially headrests since many use hair gel and such items stressing the need for easy to clean or replaceable fabrics. Also as more and more accessories require electricity this is a must in a product aimed at supporting a modern way of working and because many choose certain areas just because it had access to electricity.

8.3 Cradle to Cradle requirements

The requirements belonging to more to the technical side of the project were gathered mainly from the literature review of Cradle to Cradle and belonging subjects.

A list of general basic requirements has been defined by MBCD to start with moving toward cradle to cradle approaches.

- All chemicals in product identified down to 100ppm level (0.01%)
- No PVC, chloroprene, or related chemical at any concentration
- All materials and chemicals assessed for toxicity to human and environmental health
- Strategy developed to optimize all remaining problematic chemicals
- All materials defined as technical nutrients to be recycled or biological nutrients to be composted.

More specific about implementation of cradle to cradle in furniture industries, numbers of actions have been taken by different companies. Using certified wood from ‘sustainable forest’, using recyclable plastic parts and metal, using non-toxic additives on material, using proper water emission for wet process like panel materials or textile materials and finally appropriate air emissions (Parikka-Alhola, 2008).

8.4 Ergonomic requirements

8.4.1 Preliminary measurements for sitting

<p>Sitting height 5th percentile woman popliteal height 401 mm, absolute minimum. Higher for elderly. Maybe + 3 – 5 cm</p> <p>Sitting depth 5th percentile woman Buttock-popliteal length, 427 mm 50th percentile male –“- 495 mm Test not deeper than 43 cm. Might be too shallow?</p> <p>Sitting height body 5th percentile woman shoulder sitting height, 526 mm 95th percentile male shoulder sitting height, 661 mm. Test with height between 40 and 43 cm? Sitting height erect (on top of head) 5th percentile woman erect, 834 mm 95th percentile man erect, 1004 mm</p>	<p>Elbow sitting height 5th percentile woman elbow sitting height, 194 mm 95th percentile male sitting height 285 mm 50th woman 237 mm 50th male 239 mm</p> <p>Hip breadth 95th percentile woman hip breadth, 466mm.</p> <p>Knee height - table clearance knee 5th percentile woman 470,96mm 95th percentile man, 605,26 mm</p> <p>Thigh clearance – sitting table clearance 95th male 184 mm.</p> <p>Shoulder breadth – bideltoid 95th percentile male – 520,57mm</p> <p>Eye height sitting 95th percentile male – 878,36 m</p>
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8.5 Company demands

The most important defined prerequisites from the company were encompassing their design values and guidelines. Authentic and expressive designs with multisensory, interactive and behavioural scheme are defined as some of their design guidelines. Modular but still coherent goals are also good to be considered. Efficient use of material and manufacturing process also try to use less toxic material which are preferably reusable are other directions of theirs which should be reflected. Ergonomic aspects of the design like few statements, multi sensation and interactive ergonomic functions need to be reflected.

A set of requirements have been defined from aesthetic point of the view. More Scandinavian than continental design like lots of light wood pieces, fresh and bright colours, simplicity should be thought about. The design should be differentiate from other parts of their line-up and competitors and reflect authentic heritage. The final design could be not easy to break or make dirty, services marketing product, designed for all, crafted, details at correct level. Different way of misusing the product should be contemplated. The product could be able to reset after each use for the next user. Design and quality values are supposed to be expressed in the design.

8.6 Requirements specification

The specifications were collected from the literature study into ergonomics, cradle to cradle and its process as well as activity based offices and office work. Stakeholders within the company as well as company guidelines and traits were used as stakeholder requirements. The user requirements from the interviews were also put into the requirements specification. The complete specification can be seen in Appendix 5.

Based on the requirements and all above information the main function of the product can be summarized in short by that it should:

- Provide seating
- Provide semi privacy
- Provide small storage
- Provide a working surface
- Provide for/enable private work
- Provide for meeting
- Allow for a good sitting posture
- Support the use of portable computers or similar devices

It should also

- Express Scandinavian design values
- Reflect authenticity

Although these headlines don't reflect all of the requirements they give a good summary of what is required from the results later on. To get a holistic view of the requirements again see Appendix 5.

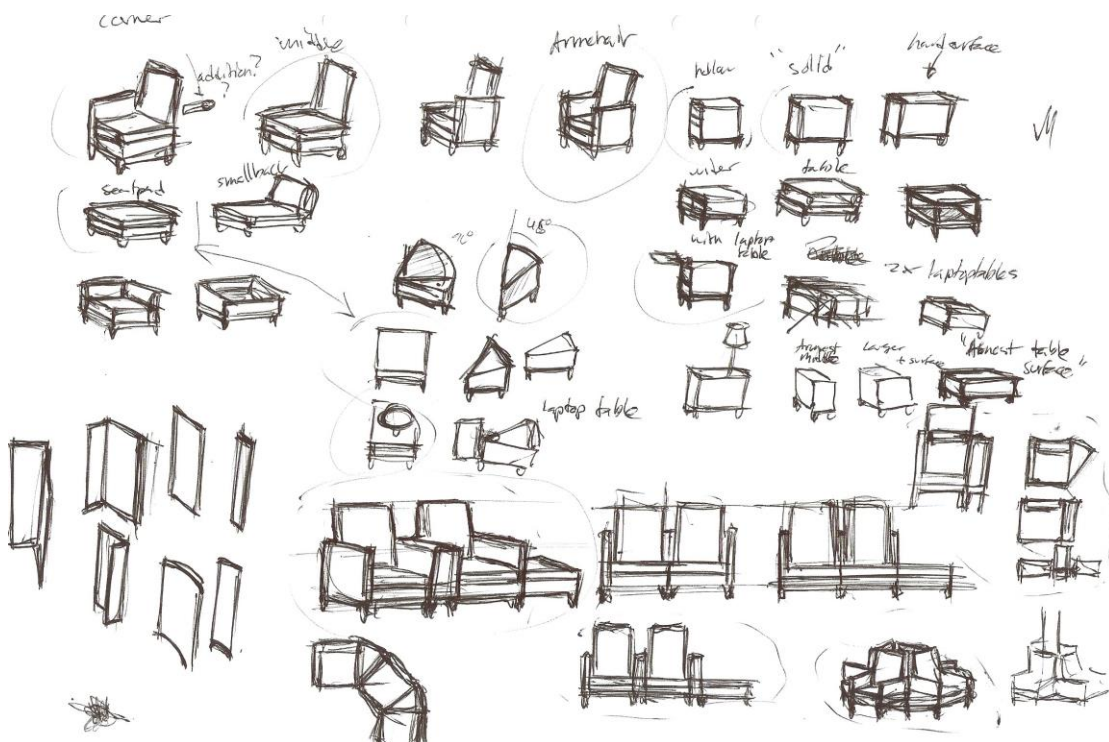
10 CONCEPT GENERATION

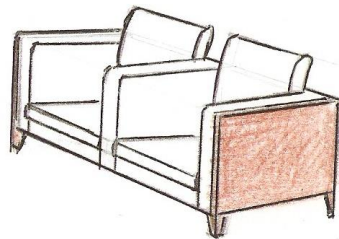
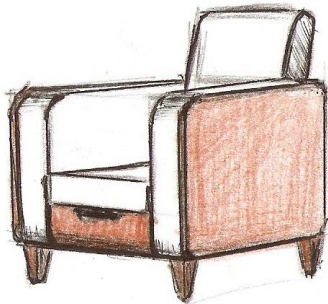
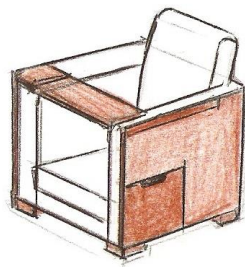
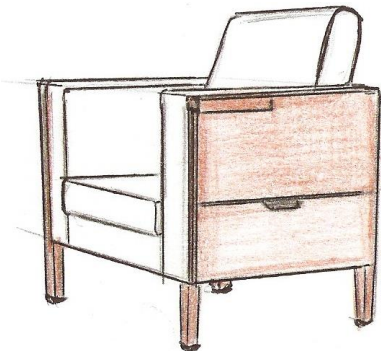
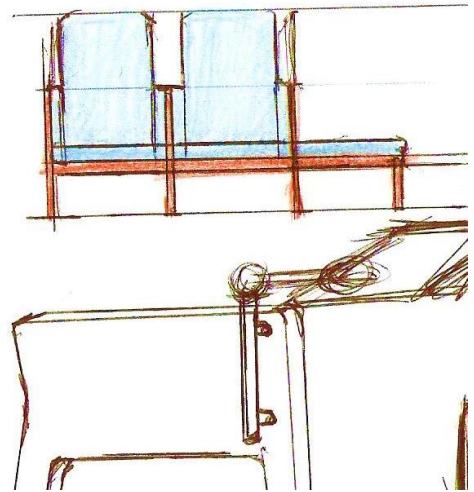
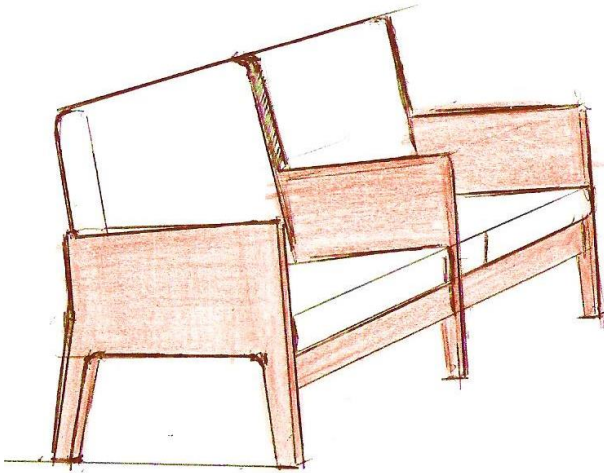
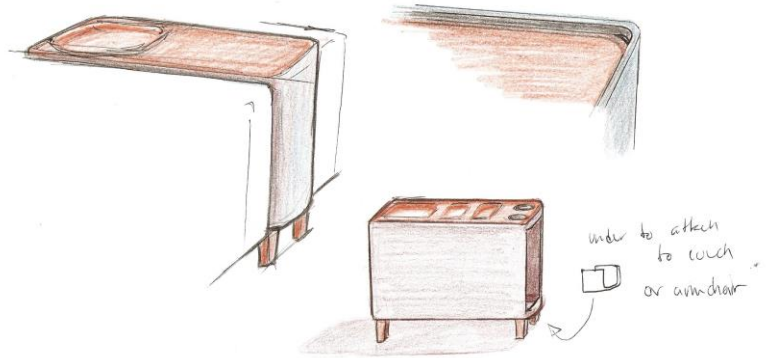
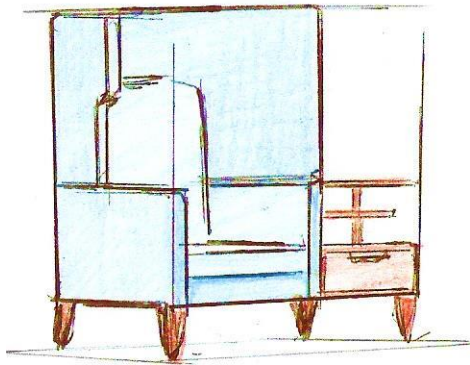
Concept generation started with looking at existing solutions that caters to portable computer use, soft seating, work space soft seating, what large office furniture distributors offer and what kind of soft seating products are available in the cradle 2 cradle segment. As the interviews and personas also hint at storage, work surface and other features these were also looked upon to see what kind of solutions are out there both as concepts or real products.

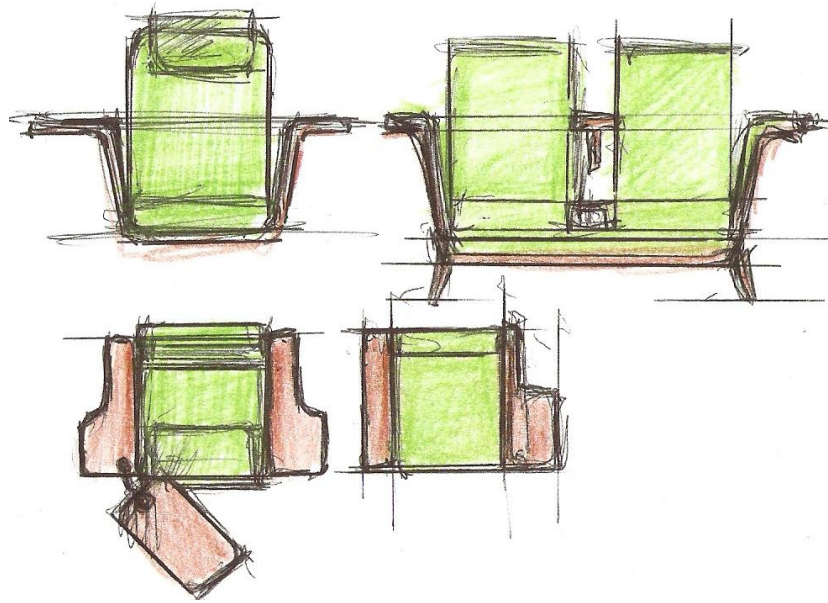
These different segments together with demands from the company were used to create mood boards and inspirational boards that were used to direct the feeling and mood of concepts. In this early stage the focus wasn't on specific manufacturing methods but on the overall solutions, ideas and ways to solve the problems.

The main aim of this stage was creating a new functional solution to provide soft seating that has better ergonomics while working with a portable computer. Aspects such as to provides privacy while working as well as possibilities for cooperation were also accounted for. Basic solution should also present a space to be used as a place to store items users usually have with them such as cameras, mobile phones, bags and papers.

Several varieties of concepts were created ranging from portable modular concepts to a stable unit that needs a permanent installation.







10.1 First evaluation

First evaluations of basic concepts were done on all concepts based on creativity and innovativeness. This evaluation consisted of quickly listing interesting aspects, positive and negative comments. Those that passed were grouped and discussed further. The concepts are eventually sketched on further evaluated more. Those that passed were then selected for further concept generation. This early on the main focus wasn't to have much focus on the environmental aspects for the sake of idea generation.

10.2 Further development

During this stage of development more thought was put into details based on requirements aimed at fitting chosen concepts with main functions of the project. Thinking about detailed design or even exact ergonomic solutions were not the purpose at this stage. On the other hand all the needed requirements should be thought about but not in detail. At the end of this stage the expectation was to have a couple of concepts that gave two new solutions that played emphasis on different requirements and aspects of what was wanted.

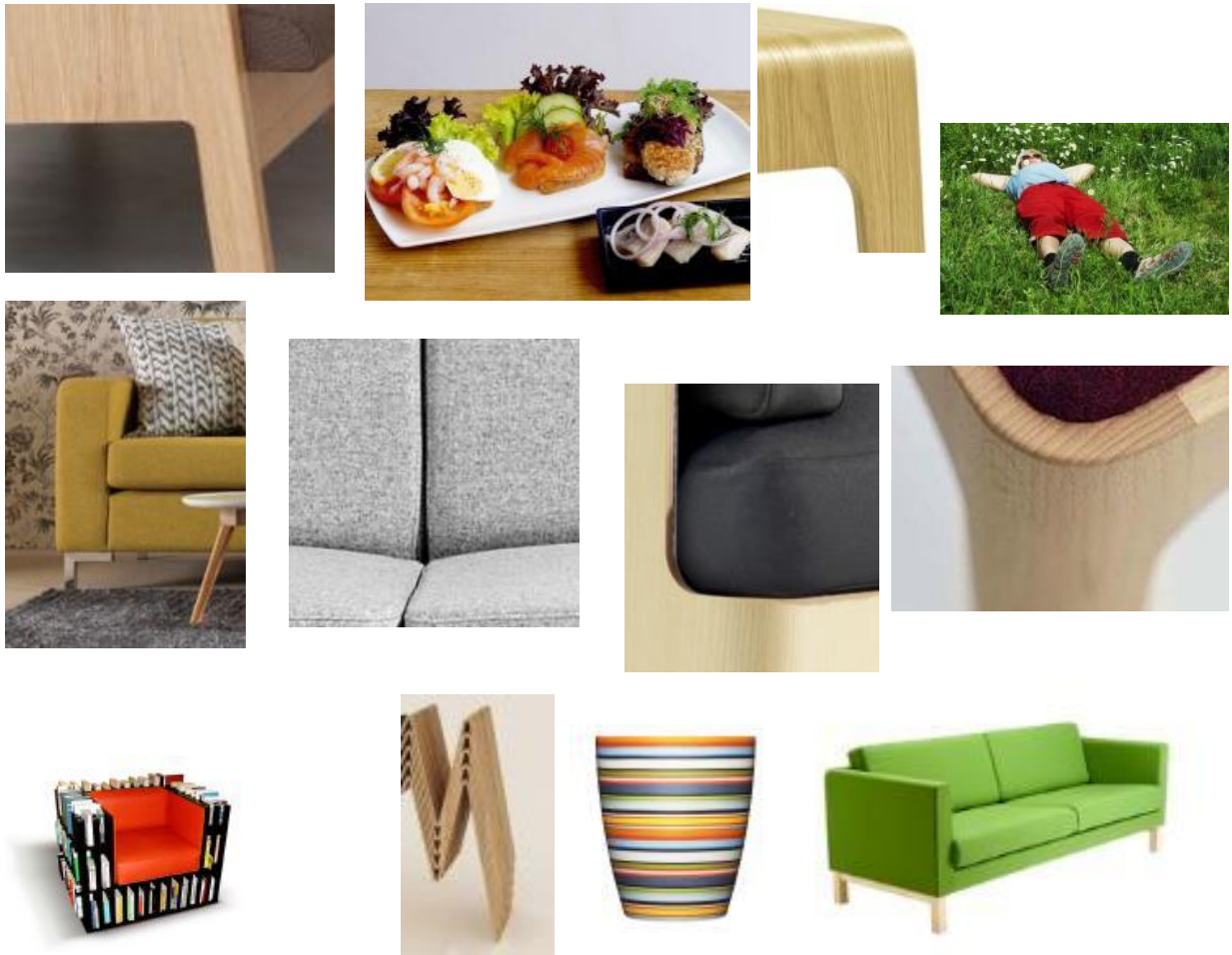
11 FINAL SOLUTIONS

In this chapter the results of the concept generation phase that meet the requirements set on the design and intended usage of the product for the activity based office environment concept are presented. These four concept directions are the result of different concept generation and selection phases in the project. They have been weighed and selected as good examples of areas or solutions that will meet the requirements of providing for an active working environment within an office or other possible working areas. Note that these are examples of how to solve the problems and not set concepts. The purpose of doing it this way was to have a discussion of which direction would interest the company the most for further development and what kind of traits they valued the most.

These examples are divided into two conventional and two unconventional concepts. The concepts are presented in a neutral way with little design elements to emphasize that they are mostly examples of how to solve the problem. The two concept categories are as described divided; the conventional concepts are based on conventional design cues for soft seating while the unconventional concepts try to think outside of the box by providing for more flexibility and free thinking in the shapes and usage of space.

The list below gives a short summary on the differences between the two directions and list their strengths compared to each other.

	Concept	Positive list	Negative list
Conventional concepts	Aflex	<ul style="list-style-type: none"> Familiar look so more guaranty for the market Modularity 	<ul style="list-style-type: none"> Familiar look which might affect marketing of the current similar product More complex way of repair and maintenance compared to existing products
	Basa	<ul style="list-style-type: none"> Layout design Wider area of use 	
Unconventional concepts	Helja	<ul style="list-style-type: none"> New so people talk about it Modularity Layout design 	<ul style="list-style-type: none"> limit area of usage of some designed parts More space might be needed to be used
	Araa	<ul style="list-style-type: none"> More privacy Wide area of use Stronger emphasis on group work 	



11.1 Conventional concepts

The conventional concepts are closer to the current range of products of the company. They should be closer to home, feel a part of the current line-up while providing a more exiting and new approach to their approach of activity based office work. They incorporate solutions to meet the requirements of the users depending on their need. They offer a range of solutions in different ways that meet the customers' demands.

Modularity is one of the keywords for these concepts by adding functions depending on need and the possibility to change or adapt areas for usage. Both have Scandinavian design cues, linking it more closely to one of the best-selling soft seating products from the company's portfolio. Modularity being one of the key features these concepts provides and supports a wide area of use.

Aesthetics

The idea behind the conventional concepts is not to stray too much from the aesthetics one might encounter within a modern Scandinavian office environment but at the same time set a more relaxed setting and relate more to Scandinavian domestic furniture design. The idea is to have a product that will with the already existing product range by adopting similar

cues and fit within the same environment and settings but also providing for different or specialized usage compared to ordinary soft seating.

The cues that were adopted by these concept examples are as described in the requirements specification in appendix 6: Scandinavian, quality, authentic, contemporary, crafted and so on.

The feeling for these concepts was set by the moodboard above, which is used to set the feeling for these concepts as they do not have a set design. The tone shows a more slightly domestic feeling compared to traditional office spaces as activity based offices tend to try to strive for a more “homey” feeling. Colours should be fresh somewhat vibrant with different textures and fabrics. The use of wood is preferred to give a natural warm and soft feeling and to associate more with the environment. They should be comfy and give a more relaxed setting to either work in or take a break. However the seating shouldn’t be too soft looking or soft for that matter as it should also invite the user to choose the product to work in which requires firmer stuffing than traditional soft seating provide.

Usage

On a side note but still relating to aesthetics is the need to show the functions in a manner that users immediately understand how the product works. Levers and controls should be easily visible and accessible even from a seated position. A user should see what functions the seating provides while approaching the product but also how they can be used while in the product. This can be achieved in many ways and both of the concepts have a slightly different way of providing this.

How the user sees how the product should be used is approached in a somewhat similar way in both concepts. Areas have different “attachments” or parts that indicate the type of usage that might be performed in each area, being either a table surface for laptops, adjacent storage areas or surfaces for papers, coffee cups or mobile phones and so on.

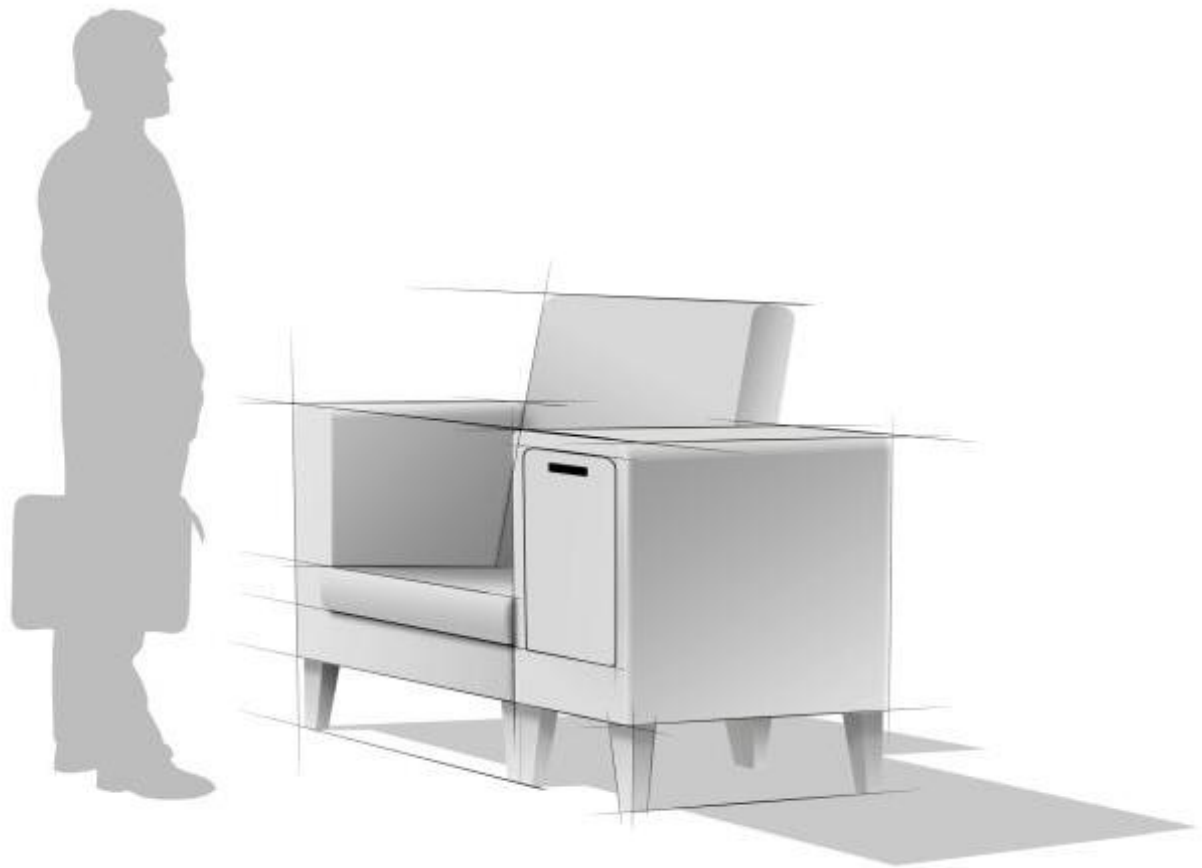
Materials

Other than for purely aesthetic reasons the materials should in this project have an environmental reasoning and meaning behind them. The conventional concepts while trying not to stray too far from soft seating, approach a “use familiar types of materials that are adapted to cradle to cradle standards”. This means that wood that is used should adopt a FSC standard and selected wood suppliers should be used as per the requirements of the C2C certificates. This means no hybrid materials and environmentally friendly/ compostable glue should be used in for instance plywood.

Fitting and any metal components should be easily removed and made from recyclable metals that have no or little by-products as per C2C standards and fit into the technological lifecycle of materials

Fabrics that meet C2C standards should be used that strive to remove toxicity and aim for a complete biological lifecycle so that they can be composted together with the wooden components.

Regarding other possible materials should also fit into the C2C lifecycle being it either biological or technological.



11.1.1 Aflex

Aflex is the first example concept presented. The name is an acronym for “arbete flexibelt” which in Swedish means to work in a flexible way. The concept main feature is by having different modules for building work areas giving it a flexible and varied area of application within different office settings and especially for the varied need of flexible offices.

Modularity

The aspect of modularity within this concept is its main strength. The idea is that it can provide different modules or parts that have different functions attached to them. By combining these different modules the customers can build areas/ add functions that meet their needs.





The building of areas

The Aflex consists of an seat section module and an storage armrest module that together offer a place to sit and offer quick and easy storage for bags and an armrest/ support surface to place papers or items.

These different modules can be extended to provide table surfaces for laptop computers or papers, open storage for newspapers or magazines or visible spaces for bags, table surfaces that combine seat modules with a work area and larger support surfaces.

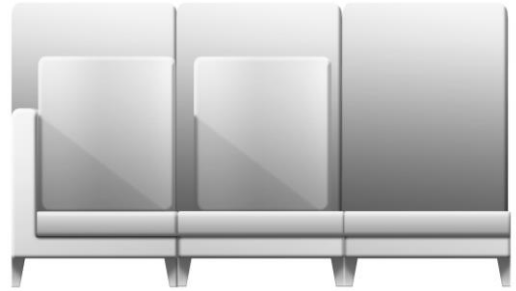
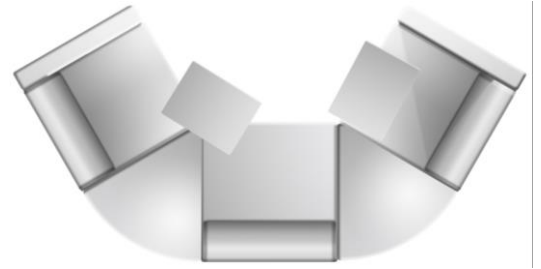
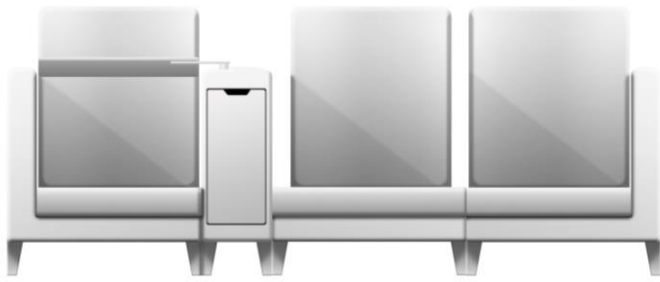
The aspect of privacy can also be incorporated with wall modules that attach to soft seating parts and placing them together give walled off sections that can be extended. These types of areas would be ideal for semi-private work, meetings or phone calls. They might also provide privacy islands in a larger public domain.

Flexibility

By providing for the option of having different modules the customers can adapt and build their own solutions giving them an incentive. It also gives them the possibility to include more modules or move them around if the need changes and still have an office that has a consistent interior.

The types of solutions that adapt a more domestic appearance could also fit more informal settings such as libraries, lobbies etc. that require different spaces for reading, computer work, laptop work and so on. With a modular system these areas may have a consistent interior with a large assortment of working solutions.







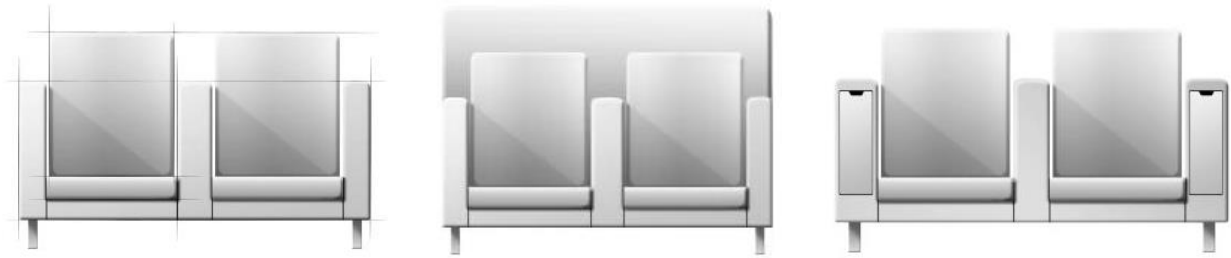
11.1.2 Basa

Basa which is an acronym for “Bas arbeta” which loosely translates from Swedish to Base of work or Base work refers to a more durable or permanent solution compared to the Aflex concept in the sense of how it’s constructed. In many ways similar in principle as the Aflex concept with the exemption that these modules are built together and not changeable in the same degree.

Line of soft seating

The Basa concept consists of that there should be a line of furniture that fit into the Basa category with different pieces of furniture that have functions that cater to different needs. Different variants of similar base units or furniture groups give a large option for customers to choose from that each have a similar design features, design ques and appearance that fit together. Customers may have the option to change some aspects to the furniture during ordering adding functions to the furniture to further meet their needs. If the customers require new pieces they can add to their existing line with the same design language.

A soft seating couch for instance could consist of two seating areas with armrest in-between each seat to provide extra space and support for work. Another model could have the addition of a screen for privacy while still being a single unit. A third option could be a two seat couch with storage in the ends and extra armrests in-between. This could be further added by having models with table surfaces, support surfaces for papers, open storage for magazines, pamphlets and so on.



Built in functions

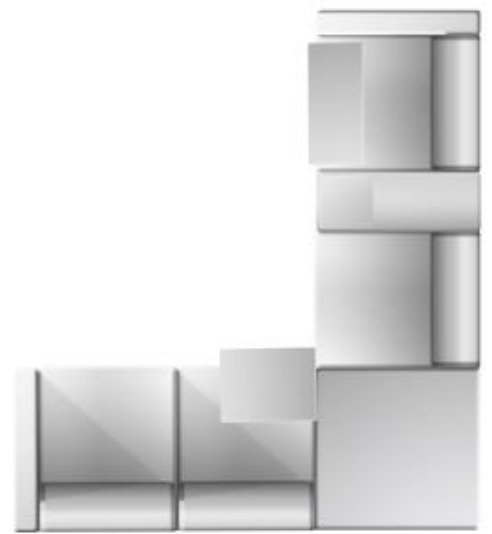
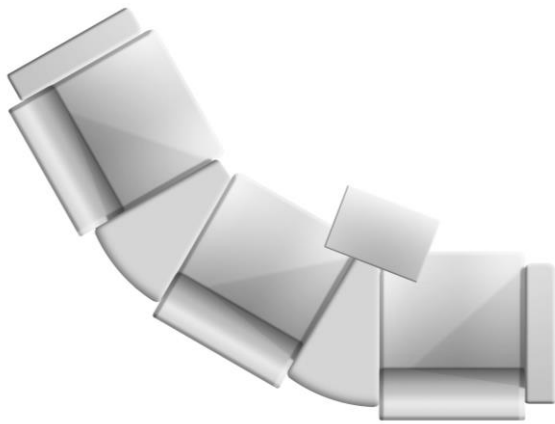
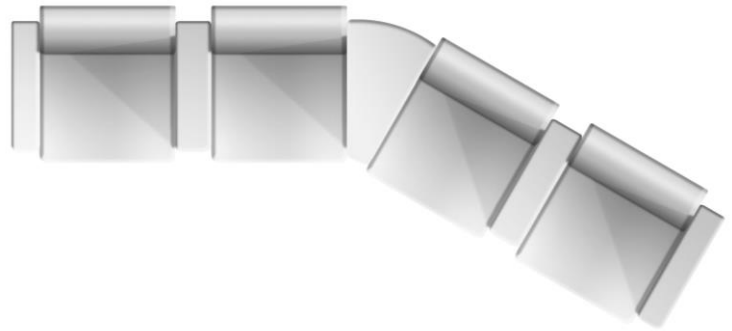
Another idea with the Basa line is to incorporate different utilities within the furniture. The meaning with this kind of “hidden” functions is to give a uniform appearance to the line and give a more aesthetic appeal to them. A benefit is that this also gives an indication of when a furniture is in use or unoccupied even when the occupant might have gone away for a short duration.

A table surfaces can be pulled out from the furniture to provide a work surface for a portable computer or to write on. The user can pull out table surface, drawers or electric outlets from within the furniture and when not in use they are hidden and appear like normal furniture.



To work in

A more abstract aspect of the Basa solution is that it should have an appearance that relates a feeling of work furniture. The design language should in the sense of the furniture line in appearance, ergonomics and work surfaces and functions signal its intended use to users in offices or public areas. Previously mentioned aspects such as an upright sitting posture with harder stuffing can separate this line of furniture from ordinary soft seating couches that are used in lounge areas. Which In a sense might signal relaxation instead of work.



11.2 Unconventional concepts

The two concepts that have been named as unconventional concepts have been based on more freedom of thinking relative to soft seating solutions. Main idea is founded on simple aesthetic and technical design and try to have as modular as possible design to give more options for customers. The concepts both have seating, portable detached working surfaces, stand or screen to provide semi privacy, a big centred table for meetings, storage options and areas to accommodate meetings. Unconventional designs aimed to provide personal privacy and social communication without need of so much relocation. On the other words, these concepts try to give fast and easy way of switching between personal private usage and social usage.



The use of wood and a Scandinavian design cues are more heavily promoted in these design solutions. They are also aimed to promote a more widespread and free approach towards cradle to cradle in the sense of how to use natural materials in the furniture. The hope is to use new ways of assembling and using wood in soft seating compared to how the company does today.

Seat functions must be clear in their use and designed for visibly as part of the designs. This would help users to easier understand functions as well as aid with repair and maintenance.

Aesthetics

Simple construction, modularity, use of soft curves, variation in arrangement and lightweight materials are important aspects of these two concepts. They should signal a sustainable, enduring, authentic/ natural, clean and simple solution that feels lightweight.

The images set the tone for the unconventional solutions in a way to promote exiting solutions that might not follow conventional paths related to soft seating. They achieve to create new ways to achieve a more homey office feeling suitable for an activity based office surrounding. The use of wood is here in the same way as with the conventional concepts used to promote a natural warm soft feeling and associate with the environment. Compared to the conventional solutions the fabrics, padding and seat shape have a somewhat firmer but still comfortable style to promote work activity rather than rest or relaxation.

To step forward the cradle-to-cradle design it has been tried to make the whole complete design with less variation of detail component. It means that one aspect of unconventional concepts is try to use repetitive simple pattern to make a more complex pattern which leads to have less variation of tool making and manufacturing process.

Usage

The unconventional solutions have a more varied use that offers more modularity in the context of building an area suitable for work. They emphasize modules or parts that can be combined to be used in primarily group activities while having the option to be standalone units. The accompanying solutions for privacy, table surfaces etc. can be used in unison and shared by many or giving extended work surfaces for standalone use. These concepts are intended to create work areas within activity based offices that cater for group activities such as meetings, group work, discussions and so on. They can also allow for personal use where more privacy is wanted or the users prefer to be more focused on their work.

Screening walls

The unconventional line heavily incorporates the use of screens to focus more on the need for “semi privacy” described earlier in the report. This “semi privacy” can be described as the need to feel isolated from a larger room to be able to focus more on a certain task. To have the feeling of being screened off when in fact others will be able to see you and you if you want can see them. In the unconventional line this is achieved by screening walls with gaps or bars in them to allow for light to pass through. These might even have the possibility to be closed like window blinds. These walls can be combined to form screened off areas with grouped seating and table surfaces creating rooms within rooms. Or used in lines to screen off parts of rooms or divide rooms into sections with different uses.

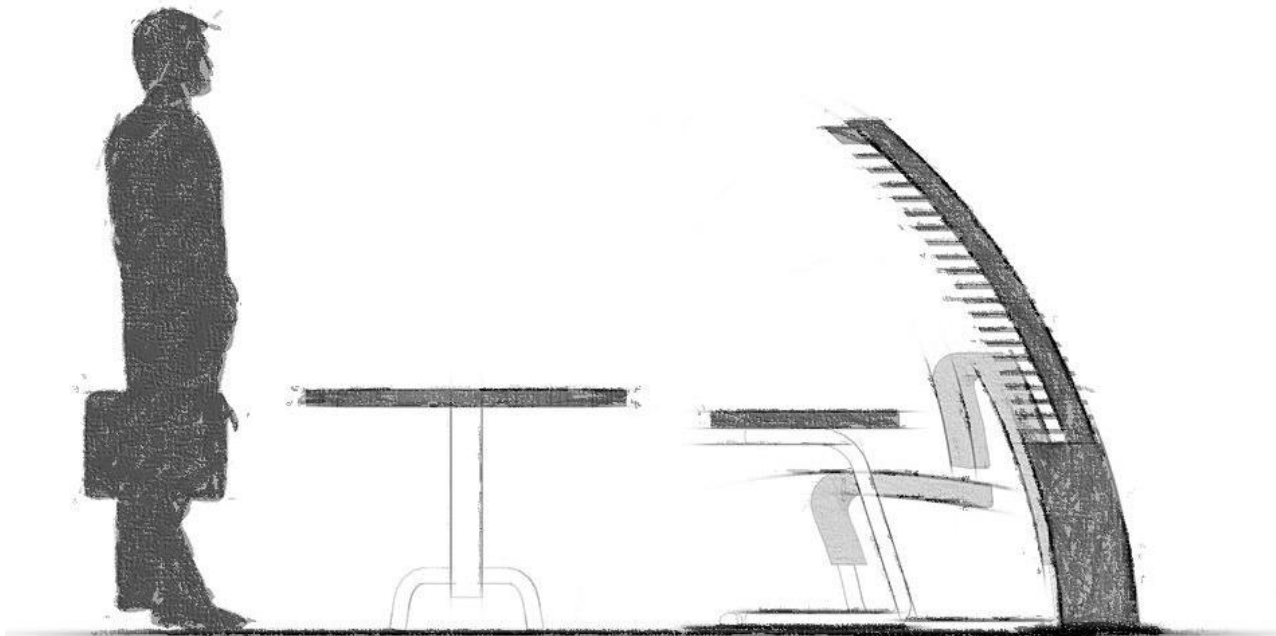
Materials

The material use in these concepts should to a higher degree conform to cradle to cradle guidelines compared to the conventional approach. While the conventional solutions incorporate solutions and materials that are used as before but steps taken to go for more environmentally sustainable options these unconventional try to opt for new and interesting

ways to solve material usage. These solutions should be less familiar and more interesting with new materials, pure non hybrid reusable materials and FSC certified wood.

Fitting and any metal components should like be easily removed and made from recyclable metals that have no or little by-products as per C2C standards and fit into the technological lifecycle of materials.

Fabrics that meet C2C standards should be used that aim for a complete biological lifecycle. Regarding other possible materials should also fit into the C2C lifecycle being it either biological or technological. Material inside the seating is kind of natural material like feather.

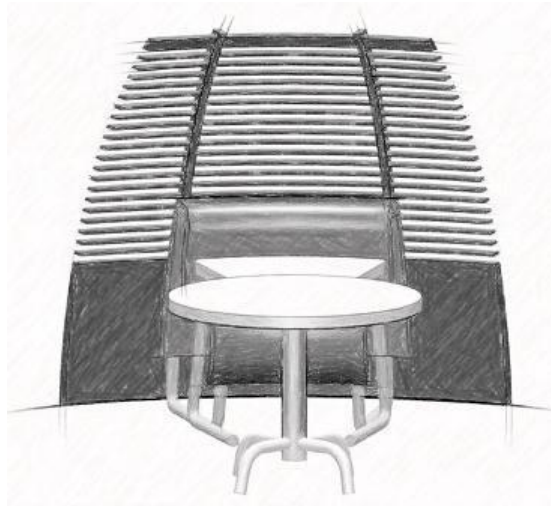
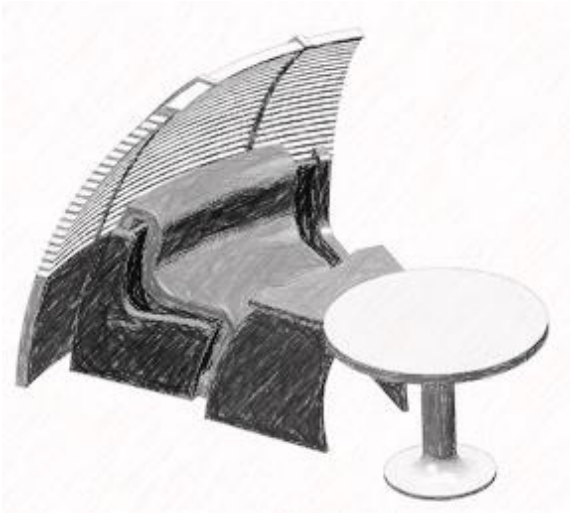


11.2.1 Helja

Helja means “Sun” in Persian and points to the main principle of the Helja concept direction with a light feeling allowing for light to travel and a more sleek appearance.

Most important aspects of Helja are modularity, lightweight and arrangement possibilities to fit customer’s needs. The working combines a wooden table surface with tube legs that provide stability while being lightweight enough to be moved by the users. As the working desk is not attached to the seating solution, it can be used in other places if needed adding more flexibility to the arrangement. The height of working desk is lower than the table in the centre so it gives possibility to put it under the meeting table when a meeting runs. It gives the user more freedom to use other seats but still have possibility to have a proper surface to work on. The screening wall provides the earlier mentioned “semi privacy”, giving users enough privacy while not being completely shielded from the environment. While lacking closed off storage the Helja offers open and airy areas underneath the seating and table surfaces that can be used for bags and other items. This more open and airy option makes Helja suitable for public areas.

Depending on the need, number of units could be set in an environment. Using four of them a nice place would be created which offers a place that is good to private and group work at the same place.

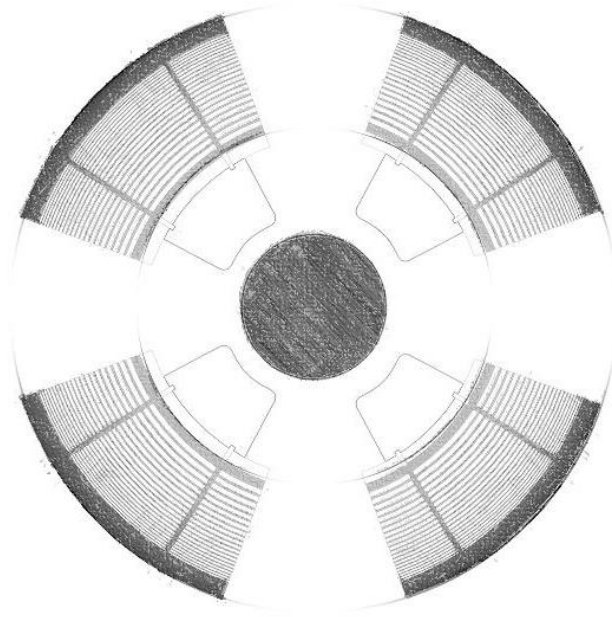


Light

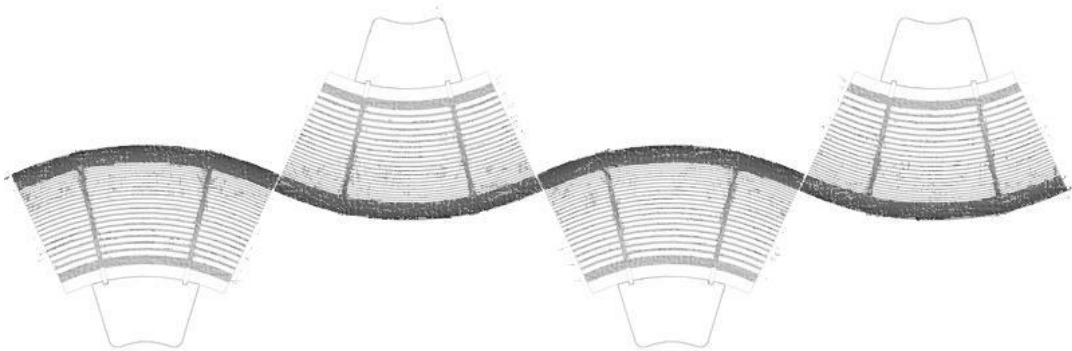
As the Helja solution relies on a tube design for sturdiness and wood for screens and table tops it creates a lightweight solution that is both airy and easy to move. Aluminium is a highly suitable option as a recyclable or reusable material for the framework combined with sleek wooden panels and surfaces.

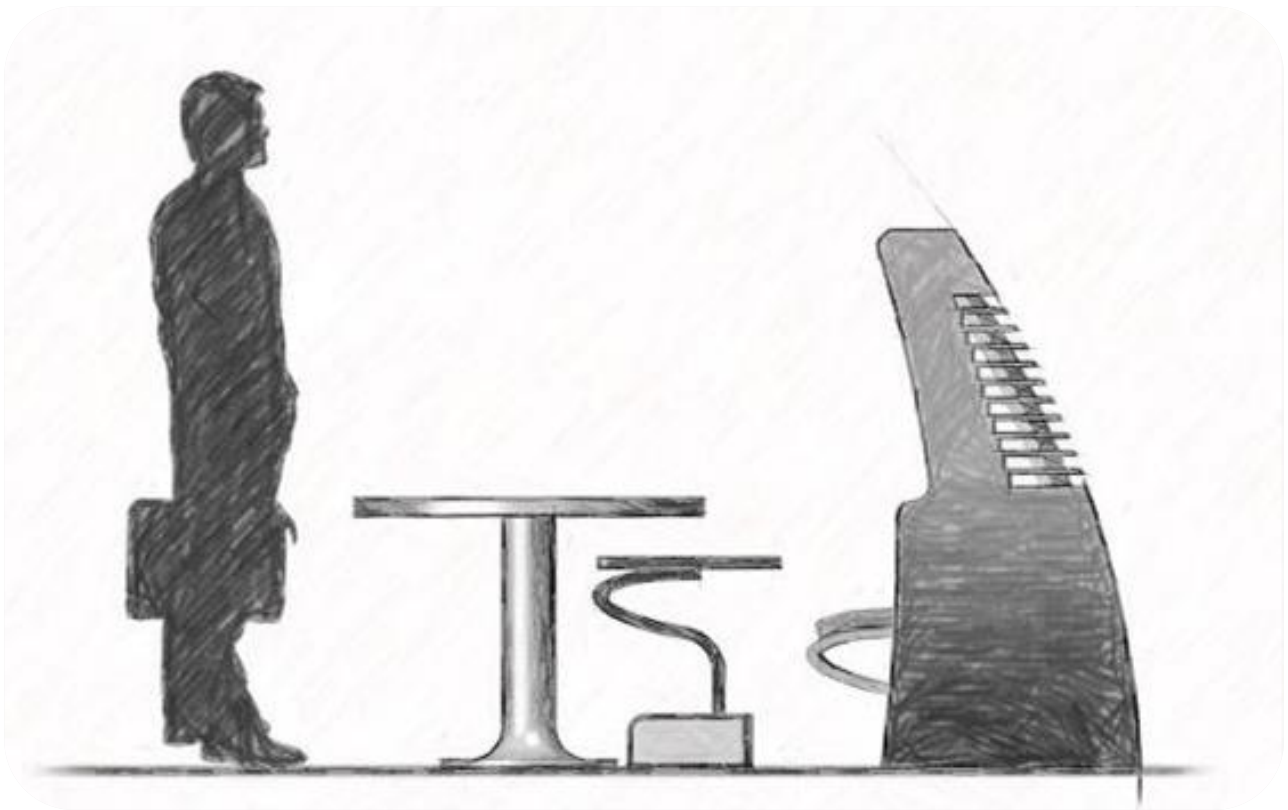
Flexible layout

One of the strong suits of the unconventional solutions is their flexibility in creating interesting layout options for larger areas to accommodate a wide area of use in both the activity based office environment as well as public spaces such as libraries or lobbies. In large areas the use of screens and layout options can be combined to create walled off areas for group activities or areas suitable for standalone work. Creating rooms within rooms that give users an area to be more focused compared to traditional lounge areas with soft seating.



Picture from the top, reminds roundness and centrality of the sun as a source of life. While this arrangement make it easier to have group activities set units in a line can provide even more privacy to stand alone work.





11.2.2 Araa

Araa means “Good arrangement of things” in Persian and refers to the more stable arrangement of the components and feeling of the concept. Each unit of the arrangement should have a distinct design giving them the ability to stand-alone but combined they should give a larger better picture. This concept has the same principle thinking of the first unconventional concept. Something that is specifies this Araa from Helja is trying to use wood as much as possible. Another specification of Araa is giving possibility to have even more modularity compare with Helja.

Scandinavian look

Using wood as the main material, design of the items should reflect a Scandinavian feeling and design. For years, wood has been the main material in Scandinavian design. Other Scandinavian design cues like simplicity and clarity can be presented by easy to seen functions as well as not complicated elements. It brings forward the elements of Bright and sharp colours as a Scandinavian specification can be present in the cushion’s fabric. Light green, bright red and blue can be some of the colours that match well with the design aspects.

Cozy

Compared to Helja, this concept gives more privacy for standalone work. While it incorporates the same principle of “semi privacy” this solution should have a more enclosing feeling to feel cozier and provide for more privacy. The users should feel more screened off o be able to relax more even in larger open areas of public spaces or office areas. While not requiring a closed off room or area they can sit in this space surrounded by screen walls on



the sides and light coming from the back with the option to screen it off even more. Compare to Helja, those two sides stands provide crozier place to seat and work. Users can still have possibility to communicate but have more privacy if they choose so.

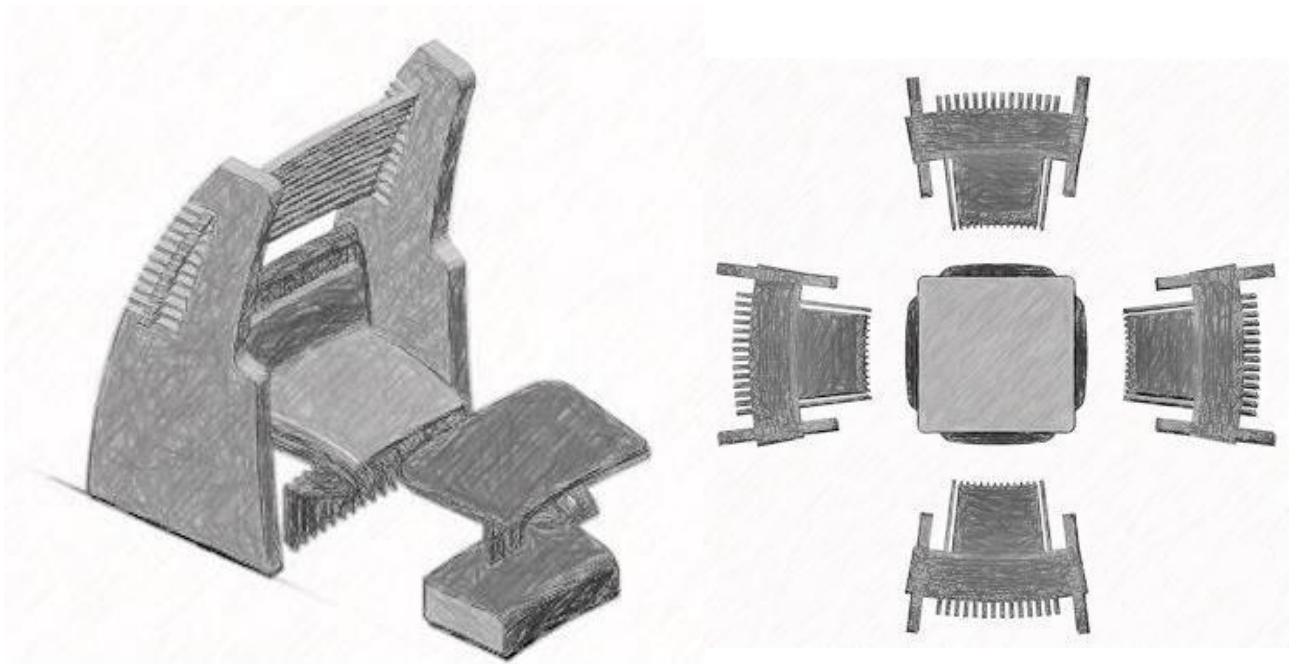
Light

Both Araa and Helja have lightness as a one of the design characteristic. Solid wood is heavy by itself but it has been tried to use small solid woods with gap between. This specification can be seen even visually so the user receive the message of lightness when see the product. Lightness of the design is not in contrast with the stability of it. The design should give enough feeling of stability while present the feeling of lightness. It is why small solid woods with gap have combined with bigger solid surface to expose both feeling.

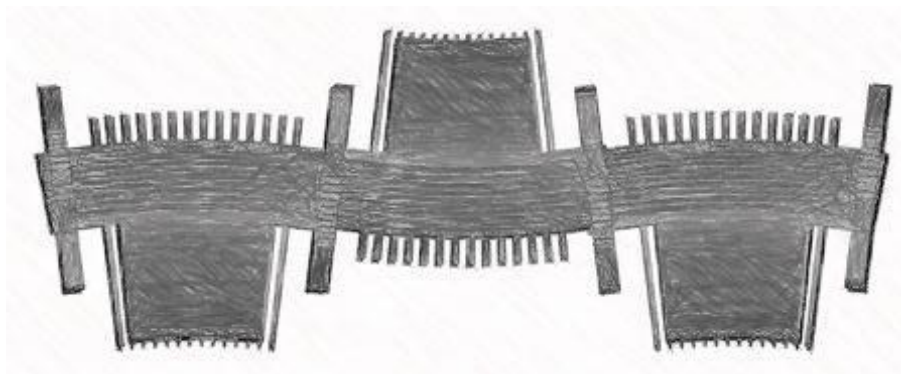
Modular

Another aspect of this concept is trying to rely more heavily on modularity design. While all components can be used as a unique working environment, each component should have the possibility to be used separately in another system. This flexibility allows the units to be used by themselves. For example the screen behind the seat can be made from three different parts; two on the sides and the back. Without the two side screens, a new design is achieved that would allow for more communication with the next unit. Small vertical and horizontal wooden parts, which provide privacy, can be replaced by some other materials like fabric or roll up curtain based on the consumers need. Seating area has a wooden structure and a cushion that can be removed. Without the cushion, seating area can be used in public area as a waiting seat with the possibility to have different arrangement.

The concept represents the message of the design with the whole components in one place. It doesn't mean that the whole pieces should be bought to have a complete picture of the product or if one or more parts of the product weren't purchased by the customer. Each part should have its own complete special design. Buying all parts of the product provides a better picture and each unit compliments each other to create a working environment for activity based offices.



Another specification of this concept is that seating cushion and backrest has a simple mechanism to be adjusted. The backrest and the seat cushion each have two pin or something similar on beneath. On the wooden base of seat, there are some continuous holes that are associated with adjustability. This mechanism is supposed to be used to adjust the seat height of the backrest and depth of the seat.



12 LIST OF RECOMMENDATIONS

In this chapter the issues needed to be addressed are listed and the next steps to be taken within the project to further develop a final concept for an ergonomic couch with a Cradle to Cradle design approach.

12.1 C2C Vision

This explains the vision of the future how the company should work in the mindset of a Cradle 2 Cradle based material flow.

A material flow within the company that has eliminated the concept of waste in its production line and business model.

Providing a furniture service with built in value in a take-back policy and reuse of furniture and parts. Renewable energy flow within the company's manufacturing and transportation lines.

They rent out furniture or office solutions to customers who receive the "service". When a contract ends the company takes back the furniture and either reuses it, services, remediates, repairs or cycles the materials and then rents the same quality furniture again to another client. Customers may have the option to replace worn parts or fabrics as an option to replacing them entirely. All materials are reused to the maximum extent until it's unserviceable during which it will either be up cycled into a product of similar quality or put back into nature as a biological nutrient. All energy comes from renewable energy sources.

All technical materials are free from toxins, are pure without additives or alloys and are non-hybrids, easily separated and from material sources that are vast and can be reused again and again. All biological materials are harvested and returned as biological nutrients to the soil from which they came to grow new products to be used in the same way.

Ideal soft seating solution: Produced with non-, toxic or hybrid materials, infinitely recyclable. Rented as a service for customers until it has reached the end of its life by either getting out of fashion, gets worn, breaks or just by decision that a new interior is needed. The product is upgradable if the need changes it can be improved upon to increase its usefulness. Its upholstery can easily be changed if the fabric becomes unfashionable or worn out, recycled of course to make new fabric.

When the furniture isn't needed anymore it's sent back to the company whom then either reuse, repair, replace parts or up cycle them to new similar products. Its disassembly only requires simple tools and doesn't take long even for the inexperienced user. All parts are correctly marked to indicate what materials they are made from to make third party recycling easier.

12.1.1 ABCD method

The ABCD method in the mindset of the natural step process is an excellent tool to plan and create an easy to view step by step process of how to achieve the C2C vision.

The company can start by aspiring and working towards one certificate now with all the implication that certificate requires. After that the ambition can be to improve that product and strive for getting a better certificate to build up knowledge and experience working with this kind of mindset. Creating a working process of how to achieve those goals and to think in that mindset of creating products that eliminate waste.

The next step would be to have more products included with certificates, and getting more materials excluded further complementing the product line and experience.

Further move and broaden the use of certified products and implement these aspects on a companywide perspective by adding them to the company values and aspirations.

In the end the goal is to create services where they provide furniture not just produce them for sale. They need to create the logistic support and process of taking back furniture with an intrinsic value in doing so. The point is to have this as a business model and not just do it just because. Where they take back, reuse, remediate, repair, up cycle and make new furniture when they are worn. The end goal is to have a continuous cycle of materials with renewable energy with a sustainable business model that creates value by doing so.

12.2 Silver certification

Three core strategies to establish eco design in office furniture industries were first categorized. The first strategy concerns designing products, which are easy to disassemble and take apart for recycling by for instance marking what materials they consist of. The second strategy involves design for durability, maintenance and repair services, reuse, remanufacturing and leasing to have longer lifetime and therefore reduction office furniture consumption and waste could be another strategy to launch green design. The third strategy includes eliminating toxicity of materials during the design process as an effective approach. (Parikka-Alhola, 2008).

14 DISCUSSION

In this chapter the problems faced, strengths and weaknesses of the project is discussed as well as methods and reasons why certain decisions were made. What could have been done different and better and what wasn't needed. As well as conclusions of what is needed to finish this project.

14.1 Planning & Scope

The entire process of the project was from the beginning very uncertain as the first brief was very wide with many factors included. The project was not an advertisement done by the company so when the students initially did the inquiry they received many wishes from the asked parties. Attempts were made to limit the scope somewhat but in the end it ended up being too wide as well, but this was noticed far into the project. The preliminary planning done before the project start ended up being too optimistic as everything took more time than first thought. The scope of the included aspects of Cradle to Cradle, ergonomics and activity based working was too much for this size of project as extensive literature review was needed for all of them with the addition of interviews, tests and so on. It would have been enough just focusing on one aspect of these three by example just doing a Cradle to Cradle soft seating or an exciting concept for activity based working. As an afterthought with the company's investment into activity based offices it would have made more sense just focusing on an activity based office solution without including Cradle to Cradle.

14.2 Confidentiality Agreement

As this project was made in cooperation with a large furniture manufacturer that wanted to protect their assets as well as a possible future product that might make it into production we had to sign confidentiality agreements not to disclose company secrets.

Due to the confidentiality agreement the final concept couldn't be shown. The company saw potential in the product and wanted to safeguard it if they decide to do anything with it. Therefore this also applied to anything that can show what they're working on including the 1:1 ergonomic mock-up model used in a fitting trial as it used the main principle and design of the final concept. As such concept sketches in the continued development phase of the project were also excluded as they also conveyed the concept and direction of the development.

This proved to be a problem as these parts couldn't be shown in the report as it is a public document and the examiner cannot grade anything that can't be published. The decision was made together with the examiner that only the parts up until the mid-presentation at the company were to be included in the report since they are fairly ambiguous. Also all mentions of what company this project involves were removed from the report to not hint at what they might be working with.

This was a huge disappointment to the project members as we cannot show the fruit of our labor and had to settle with showing early renderings and solutions. This report represents little over half of the actual work put into this project that spanned for a long duration, far longer than it was initially planned.

14.3 Literature review

One of the biggest strengths of this project is probably the literature review into the three main subjects. They delve deep into what they mean and their importance for creating furniture for these environments. They can by themselves be a good tool for getting a holistic view into these subjects and how they may be implemented in furniture design.

14.4 Requirements

Since there were many requirements regarding a very wide area of usage there had to be limitations in what to include as important within the scope of the project. There was talking about having completely private closed off areas for having phone calls, meetings, working with sensitive materials and for either relaxing or concentrating. Also mentioned were tasks relating to working CAD, doing research, processing cases and tasks requiring adapted work areas for those purposes. Furthermore for instance the need for permanent personal storage within a couch, built in headsets, shoe racks, keyboards, and screens and massage functions. However since the activity based working environment is meant to contain areas for different purposes these types of demands were considered to be outside of the scope of the project for a soft seating solution.

14.5 The solutions

The solutions presented in this report reflect a choice that was made to only show four directions presented in the middle of the project to company representatives in order to have a discussion about what direction the project should head into. Based on that discussion strengths of all the solutions were combined that sparked a more detailed design process.

However the strengths of these four solutions are that they provide with different directions of how to achieve an activity based office environment with focus on different aspects. The weaknesses are that they don't give specific concepts of how they should look like and go into detail of what materials are used and where, how they solve their respective ergonomic issue and relate to the different personas to describe their uses.

14.6 Ergonomics

Ergonomics isn't an exact science with all known answers. There was a difficult choice to choose between which type of sitting position was to be used and how the project group should achieve it. The first thought was to use computer simulations to find the optimal

solution early on. However it turned out that there was many concepts with very different ways of sitting so it was decided that a first a main concept was to be chosen which then received a more thorough evaluation into comfort and what dimensions were to be used to get the best result. This made the process somewhat faster since there were big problems with getting things done in within set deadlines.

The choice of making a mock-up with changeable variables in backrest angle, sitting height, armrest height, adjustable tilt and table height as well as adjustable headrest gave options that weren't available with simulations. This would then allow for experimentation in what works and doesn't work. The ambiguity of comfort was a hard aspect to evaluate with simulations which also weighed heavily towards user tests with mock-ups.

One weakness with the project would be that the ergonomic aspects aren't tested in this report; however the tools and process of doing so are available for further development and a fitting trial.

14.7 Cradle to Cradle

Cradle to Cradle offers an interesting and hopeful vision of the future where all man made things are reusable, recyclable or upcycled or biologically degradable. As things are now this kind of vision seems like a far-fetched idea that is impossible to achieve but more and more companies are doing so today. For any company to strive to improve their environmental image and impact is commendable and Cradle to Cradle is a good next step to strive for in the future.

Since many companies' today measure environmental impact using methods like life cycle analysis and such the notion that an product that might have a high LCA score might still be environmentally good in an cradle to cradle aspect. This can make it hard for engineers that are accustomed to thinking in reducing environmental impact instead of trying to make a product work with the environment.

The Cradle to Cradle aspect of 100% renewable energy input is an idealistic goal at best since most of today's energy comes from non-renewable energy sources. However Sweden has potential to achieve this as much comes from hydroelectric power and a company can always favor and improve in this aspect by using solar or wind power instead of conventional energy sources.

Another aspect of Cradle to Cradle is that it is a trademark that cannot be freely used or implemented to label products without the permission and certification of MBCD (McDonough Braungart Design Chemistry). This requires close cooperation with MBCD to have products certified and to have access to Cradle to Cradle knowledge which makes it hard for designers to gather good information on materials and information.

The company in question had already an extensive environmental policy and were aware and want to change their impact on nature. Considering they already had a good start in

many of the aspects of what C2C required for a silver certification it wouldn't require too much for them to achieve that first goal.

14.8 What's left

The initial plan was to present the complete concept with an fitting trial and a prototype of the final concept. However since this report shows only four solutions on how to solve the problems further concept development is needed as well as an ergonomic study and finally a final concept with a prototype to reach the final goal.

Included in the "what's left to do" category is the implementation of Cradle to Cradle principles on a company level and in detail with the final concept as well. In the company wide scope the ABCD method can be implemented to set gradual goals and to build on them further. This was used as a good incentive to give company representatives an visual and easy to understand step program to what is needed to achieve those kind of environmental goals. Many within the company had very little knowledge of what C2C is and underestimated the commitment needed.

For the product level working towards a silver certification would be the first step in how to set up material goals regarding toxicity, recycled materials, FSC certified woods and so on.

14.9 In conclusion

Despite not being able to show the end results this report give a good view of what these three main fields require and ways of how to solve them can be achieved. It gives tools on how to reach these goals and what results may be expected. In summary we are happy with the results and the reaction received from the company regarding our solutions and work effort. It brought together very different fields with each other and we learnt a lot about ourselves and the furniture industry.

References

- Adlin, Tamara and Pruitt, John (2010). *The Essential Persona Lifecycle: Your Guide to Building and Using Personas*. Morgan Kaufmann. ISBN-13: 978-0123814180.
- Bjørn, Anders and Hauschild, Michael, Z. (2011). Cradle to Cradle and LCA – is there a Conflict? *Glocalised Solutions for Sustainability in Manufacturing: Proceedings of the 18th CIRP International 599*, (599-604). Technische Universität Braunschweig, Braunschweig, Germany.
- Bartlett, C. (2009). Reuse of Office Furniture –Incorporation into the ‘Quick Wins’ criteria. *Centre for Remanufacturing and Reuse*.
- Baxter, Kathy and Courage, Catherine (2005). *Understanding your users: A Practical Guide to User Requirements Methods, Tools, and Techniques*. Elsevier Inc, ISBN: 978-1-55860-935-8.
- Berkhout, A., L.; Hendriksson-Larsén, K. and Bongers, P. (2004). The effect of using a laptopstation compared to using a standard laptop PC on the cervical spine torque, perceived strain and productivity. *Applied Ergonomics*, 35 (2), 147-152.
- Beasley, R. W. (01/2004). *Beasley's Surgery of the Hand*. New York, NY, USA: Thieme Medical Publishers, Incorporated.
- Boghart et al. (2009). *Work and technology on human terms*. Stockholm: Prevent.
- Brunnberg, H. (2000). EVALUATION OF FLEXIBLE OFFICES. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* , 44: 667.
- Carcone, Steven, M. and Kier, Peter, J. (2007) Effects of backrest design on biomechanics and comfort during seated work. *Applied Ergonomics*, 38, 755-764.
- Chen, K. and You, K.C., 2006. Applications of affordance and semantics in product design. *Design studies*[e-journal] 28(1), 23-38 Available through: Elsevier [Accessed 18 August 2012].
- Clarkson, P.J. Crilly, N. and Moultrie, J., 2004. Seeing things: consumer response to the visual domain in product design. *Design Studies* [e-journal] 25, 547-577 Available through: Elsevier [Accessed 18 August 2012].
- Clarkson, P.J. Crilly, N. Good, D. and Matravers D., 2008. Design as communication: exploring the validity and utility of relating intention to interpretation. *Design studies* [e-journal] 29 (5), 425-457 Available through: Elsevier [Accessed 18 August 2012].
- C. Greene, J., M. (2011). Space for thought: designing for knowledge workers. *Facilities*, Vol. 29, Iss: 1, 19-30.
- Foundation, E. M. (2010). *TOWARDS THE CIRCULAR ECONOMY*. Ellen MacArthur Foundation.
- Groenesteijn et al. (2012). Office task effects on comfort and body dynamics in five dynamic office chairs.

- Groenesteijn, Lisbeth; Vink, Peter; de Looze, Michiel and Krause, Frank (2009) Effects of differences in office chair controls, seat and backrest angle design in relation to tasks. *Applied Ergonomics*, 40 (2009), 362-370.
- Grandjean, E. and Hünting, W. (1977) Ergonomics of posture Review of various problems of standing and sitting posture. *Applied Ergonomics*, Sept 8 (3), 135-140.
- Holden J., M.; Fernie, G. and Lonau, K. (1988). Chairs for the elderly - design considerations. *Applied Ergonomics*, 19 (4), 281-288.
- Haigh, Ruth. (1993). The ageing process: a challenge for design. *Applied Ergonomics*, 24 (1), 9-14.
- Hoskins, Ian; Waller, Sam and Clarkson, P., John (2010). It is normal to be different: Applying inclusive design in industry. *Interacting with Computers*, 22, 496-501.
- G. Rebitzer, a, , T. Ekvallb, R. Frischknechtc, D. Hunkelerd, G. Norrise, T. Rydbergf, W.-P. Schmidtg, S. Suhh, B.P. Weidema, D.W. Penningtonf. (2004). Life cycle assessment: Part 1: Framework, goal and scope definition, inventory analysis, and applications. *Environment International*, 30, no. 5, 701–720.
- Matthews, H., Scott; Hendrickson, Chris, T. and Weber, Christopher L. (2008). The Importance of Carbon Footprint Estimation Boundaries. *Environ. Sci. Technol.*, 5839–5842.
- Norman, D.A., 2002. *The design of everyday things*. New York: Basic books. ISBN-13: 978-0465067107
- <http://www.mer.se>. (n.d.). Retrieved from <http://www.mer.se/mer/sv/mer-inredningsarkitekter-arkitekter-hjalper-dig-inreda-nytt-kontor-i-stockholm/>: <http://www.mer.se/mer/sv/mer-inredningsarkitekter-arkitekter-hjalper-dig-inreda-nytt-kontor-i-stockholm/>
- Vilnai-Yavetz, Iris; Rafaeli, Anat and Schneider Yaacov, Caryn. (2005). Instrumentality, Aesthetics, and Symbolism of Office Design. *Environment and Behavior*, 533-552.
- Kee, D. and Karkowski, W. (2002) Ranking systems for evaluation of joint and joint motion stressfulness based on perceived discomforts. *Applied Ergonomics*, 34 (2003): 167-176
- Kee, Dohyung and Lee, Inseok (2011) Relationships between subjective and objective measures in assessing postural stresses. *Applied Ergonomics*, 43 (2012), 277-282.
- Charter, M. and Gray, C. (2006). *Remanufacturing and Product Design*. London: University College for the Creative Arts, Farnham, UK.
- Rossi, Mark; Charon, Scott; Wing, Gabe and Ewell, James. (2006). Design for the Next Generation. *Journal of Industrial Ecology*, 10 (4), 193-210.
- MBDC. (n.d.). Retrieved from MBDC website: <http://mbdc.com/detail.aspx?linkid=2&sublink=8>

- McDonough, W. A. (2006). *The Cradle to Cradle Alternatives, Writing By, William McDonough*. Retrieved from William McDonough:
http://www.mcdonough.com/writings/cradle_to_cradle-alt.htm
- Braunga, Michael; McDonough, William & Bollinger, Andrew. (2006). Cradle-to-cradle design: creating healthy emissions e a strategy for eco-effective product and system design. *Journal of Cleaner Production*, xx, 1-12.
- Microsoft UK. (n.d.). Retrieved from Microsoft UK Web site:
<http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&ved=0CGA QFjAD&url=http%3A%2F%2Fhybridorg.blob.core.windows.net%2Fmedia%2FActivity-based-working.pdf&ei=4nLoT9WLLaaj4gTYIZHaAQ&usg=AFQjCNFcDSfc4K7bv0M6CSvr9FVlc l48sQ&sig2=q67P8VrzKN1cOgbBG5UIBg>
- Nasr, Nabil; Thurston, Michael. (2006). Remanufacturing: A Key Enabler to Sustainable Product Systems. *13th CIRP INTERNATIONAL CONFERENCE ON LIFE CYCLE ENGINEERING*. PROCEEDINGS OF LCE.
- P. Morrell et al. (May 2005). The impact of office design on business performance. *Published by the Commission for Architecture & the Built Environment and the British Council for Offices*.
- Paulsson, J., (2006). Design för alla = Universal design education. Stockholm: European Institute for Design and Disability (EIDD Sverige), ISBN: 978-91-971345-5-2.
- Parikka-Alhola, K. (2008). Promoting environmentally sound furniture by green public procurement. *Ecologicaeconomics*, 68, 472-485.
- Philip Ross, C. C. (n.d.). ACTIVITY BASED WORKING.
- Prendeville, S.; Dr. O'Connor, F. and Palmer, L. (2010). Barriers and Benefits to Ecodesign: A Case Study of Tool use in an SME.
- Schriefer, A. E. (2005). Workplace strategy: What it is and why you should care. *Journal of Corporate Real Estate*, 222-233.
- Pheasant, Stephen and Haslegrave, Christine, M. (2005). *Body Space: Anthropometry, Ergonomics and the Design of Work, 3rd edition*. Taylor and Francis, CRC Press. ISBN-13: 978-0415285209
- Stocks, M. (1998). The virtual office - putting management ahead of facilities. *Facilities*, 16 (1), 29-33.
- Straker, Jones and Miller (1997) A comparison of the postures assumed when using laptop computers and desktop computers. *Applied Ergonomics*, 28 (4), 263-268.
- TheNaturalStep (2012). The Natural Step <http://www.naturalstep.org/en> [Accessed 2014-06-24]
- Van De Graaff, Kent M. Rhees, R. Ward . (02/2002). *Schaum's Outline of Human Anatomy and Physiology*. Blacklick, OH, USA : McGraw-Hill Trade .
- Mcdonough, William; Braungart, Michael; Anastas, Paul.T. and Zimmerman, Julie.B. (2003). Applying the Principles. *ENVIRONMENTAL SCIENCE & TECHNOLOGY*, 431-444.

Winston Churchill, 1.-1. (n.d.).

Wyatt, Todd and Verbick (2006) Oh, My Aching Laptop: Expanding the Boundaries of Campus Computing Ergonomics. *SIGGUCCS 06 Proceedings of the 34th annual ACM SIGUCCS fall conference: expanding the boundaries*, November 5-8 (2006), 431-439.

APPENDIX 1 – CRADLE TO CRADLE

Cradle to Cradle Certification Process

Inquiry & Application

1. Review certification criteria and application documents
2. Fill out the Applicant Survey and Material Appendix.
3. Send completed documents
4. Once documents are received, a MBDC representative can review with you the process for getting a product certified and provide an estimate of cost and time to work with MBDC Pricing ranges from \$5,500 to \$75,000+ depending on the chemical complexity of the product.

Product Assessment

1. The certification process involves partnering with the product manufacture on data collection and product assessment. (This step typically takes 2-6+ months depending on the complexity of the product and its supply chain)
2. Assigns a project manager to serve as a guide through the certification process by assessor.
3. Work together to collect all the data required for certification.
4. Site Visit to the manufacturing facility of final assembly.
5. Submit the completed Certification by assessor Packet and supporting documentation to the Cradle to Cradle Products Innovation Institute (C2CPPI) for review.

Certification Issuance

1. C2CPPI will review the Certification Packet and supporting documentation.
2. If all criteria are met, C2CPPI will issue the certificate at the appropriate level.

Renewal

1. Certification is valid for one calendar year from the certification date and must be renewed on an annual basis.
2. A few months prior to certification renewal date, you will receive a letter of notification and a renewal packet from MBDC.
3. Review the Certification Renewal Packet and collect any new information related to product formulation or manufacturing process. (Review data and evaluate any changes in the product formulation or manufacturing process.)
4. Once the Certification Renewal Packet is complete assessor will send the packet and supporting documentation to C2CPPI for review.

APPENDIX 2 – FOCUS GROUP

Focus group at school

Aim is to gather information from the student perspective to find possible solutions that meet their needs etc.

Any ideas from the top of your heads?

How will they use such a product? What would they need? What would they do? How would they evaluate the product?

How would they like it?

TASKS TO DO:

1. Describe the project. What the goal is. What it contains and what kind of product it may be.
2. Describe what the task is for the day!
3. Describe the different user types that we have identified and what we will try to do with them.
4. Introduction:

Explain: All ideas are welcome. Each have your own experiences and should voice them. Don't critique others opinions. All ideas are correct.

Different areas:

Describe: Work environment (office), study place (own room etc.), library, lounge, hallway etc.

Ask: If it was in your own study area. In a library, lounge, coffee shop What would your concerns be in those situations?

Questions/ Topics

TOPIC 1

What is the first thing that comes into mind when you hear this?

Look through the typical day of a student studying? School, public areas, libraries etc.? What are your experiences? How do you usually do it? What do you need? What are you missing? What are your experiences?

What tasks do you usually do? How often do you do them? Where do you do them? What do you use to do them (furniture etc.)?

IS the concept of privacy important? Ability to work together? Noise? Size? Storage? Time sitting and studying? Leave your things and go somewhere?

Have you worked in a public environment? (train station, park, lounge, library) What do you do? How?

What do you like about your study environments? What do you not like?

What are your goals?

What is your reaction to our product concept/ area? Whats good? What is bad? What do you think? Anything missing?

What would you like to see in the product?

If it allowed for more than one to work? Two or more?

How long would you think that you would use the product? If it was in your own study area?

In a library, lounge, coffee shop?

How close do you need to work together?

Concerns then?

What do you think is needed in order for a product to look ergonomic?

Topic:

- Storage
- Worksurface
- Seating
- Privacy
- Complexity
- Adjustability
- Feeling
- Design?

APPENDIX 3 - AFFINITY DIAGRAM

Easy to adjust

- Use default setting for short time
- Visible adjustment
- Handles show adjustment
- Few features
- Visible handles
- Obvious
- Logical
- Short time not adjust

How to see ergonomic

- Not too hard
- Armrest between seats
- Rounder bottom (show movement)
- See functions
- Easy to see adjustable (Separated parts or sections)
- Show hinges
- Having a table attached
- Few functions
- Easy to understand how it works
- Form language supports body
- Ergonomy priority over aesthetics

Adjustments

- Armrest
- Backrest
- Depth
- Height
- Footrest is a plus
- Table top

Work tasks/activities

- Welcome customers
- Write letters
- Presentation with projector
- Iphone
- Administrative computer work
- Surf the web
- Reading emails
 - Starts day reading emails
- CAD work
- Cup of coffee talk
- Discussions
- 25% personal and 75% meetings
- Laptop primary tool

- Prepare text, write text,
- Reading and writing articles
- Do appropriate work in public
- Show/ presenting cad models (reports and other things aswell)

Phone calls

- Doesn't want to disturb others
- Private phonecalls
- Use phone booth
- Sensitive/ difficult calls
- Work calls
- Telephone meetings
- Somewhere private – no overhearing
- Skypecalls

Feelings/ characteristics

- Feel my own space (anchor)
- Robust
- Approving form language – burst with colors
- Looks good is good for morale
- Color and form
- True to material
- Quality
- Cozy – pillows
- Loves mobility and being mobile
- Modern person
- Sexy to look good!
- Clean fresh – eco friendly IIII
- Likes activity and pulsating environment
- Activity = effective work
- Look good for customers
- Wouldn't mind if its reused – improve on image environmental
- Warmer feeling – couch
- Inspiring environment, hotel lobby etc.
- High ceiling environment – openness

Storage

- Phones (2)
- Hassle to hand in things (reception, safety)
- Pen and paper
- Place for documents
- Coffee cup
- Place for notepad
- Briefcase, bag, handbag
By feet, next to seat, table
- Place for electric cable
- Coats, jackets and suit
- Fruit and other things.

Worksurface

- Good place to work with computer

- Support arms
- Headset for phone
- Space for mouse and mousepad
- Large work surface
 - Place paper, notepads, mouse, books
- Close enough to body
- Table in front
- Other electric tools (puck)
- Good lighting
- Telephone
- Charge telephone
- Electric outlet
- Ipad
- Trips – less items with (small bag)
- Wide armrest – for support and work
- Double functions
- Easy to clean – good surfaces
- Not too small to work
- Non stick surface
- Researchers, journalists etc. need more space to work!

Extras

- Charge phone and things
- Separate desk for computer and meetings
- Personal work and meeting in one.
- Workstation computer
- Whiteboard
- Projector
- Real keyboard
- Provide massage
- Alarm for bad posture
- Storage for document, binders, folders
- Place for shoes

Concentrating

- Like a workstation seat
 - headrest and armrest
- Sit down for concentrating
- Table close to the body
- Not loose expression of couch
- Dimensions of chair but appearance of couch
- Too straight (sitting) loses feeling of couch
- Straightened back – better posture
- Sit upright
- Sit properly
- Shifts posture upright to lying
- Easy access to things
- Looks for chair and table!!
- See screen the best
- Not necessary a couch, workstation chair
- Need to look good?
- Likes office chair for computer working task

Relaxing

- Unnatural positions while phoning
- Computer in lap
- Problem to sit straight and have relaxed shoulders
- Try to have different positions – sitting to standing
- Work in office – easy to get up
- Not too comfy to sink in it
- Not too deep
- Lying down – table close
- Provide variation
- More comfortable seating for informal meeting
- Sit comfortably but not “correct”
- More movement sitting in couch
- Aesthetics and comfort together

Privacy

- Doesn't like people behind back
- Screened off from behind
- Quiet place
- Would be great to sit in quiet area
- Noise dampening
- Working island
- Wouldn't choose to sit here if it has overhearing
- Work on sensitive material, administrative work
- Mostly introvert work
- Doesn't like to sit in public area
- Not disturbed
- Closed off but see out (windows)
- Little privacy is needed
- Without insight on comp. screen
- Little cozy
- Music to shield out noise
- No need for shared work surface
- Show you don't want to be disturbed
- Easy to see its occupied
- Clear boundaries
- Prepare for negotiations

Semi-privacy

- Can not sit in too small places
- Wouldn't like to sit screened from others
- Possibility to screen off
- Even public, but not too close to see work (distance)
- Too easy to eavesdrop – need to focus
- Could talk to each other, but not shout (Good distance)
- Semi-adding existing (add more work places)
- Able to talk
- Give inspiration
- Easy to fit for personal work and group work
- Possibility sit in an angle towards each other

- Movement, momentum and overhearing – choose it over quiet”
- Semi-shielded working area
- Private discussions
- See you – you see them
- Peaceful quiet area for co-op
- Doesn't like to work on the same table as others
- Fika couches – fika rooms
- Discussions
- Cooperation . secondary to disturb others
- Close to colleagues
- Bring laptop for cooperation
- Takes time to go somewhere – book etc,
- Go to desk for cooperation
- Show computer screen to others
- Discuss with colleagues
- Informal meetings
- Table to put coffee and things on
- Small meetings – stand quick
- Informal anywhere, fika desk- quiet.

Meetings

- Share tv or screen.
- Whiteboard
- Shared workspace with computer
- 4-5 people meeting
- Show presentation and things
- Face each other
- Meetingrooms are boring
- Daily meetings

Lounge – pretty

- Space to welcome customers
- Normal couch is unprofessional
- Interaction needs closeness
- Business meetings
- Negotiations
- Informal meetings
- Interaction in couch area
- Likes making deals in couches
- Relaxed meetings

Places for work

- Office hotel
- Train
- Car
- Lunchroom – meetings
- At home
- Desk at hotel
- Desk for paperwork
- Hotel lounge
- Meetingrooms . work

- Airports, hotels for work during travel
- Coffeeshops
- Airy places
- Library
- Sit all day in one place
- 2 hour sprints
- Mostly meetings
- 1 hour personal work/day
- Stays 15 minutes between meetings
- Education hall
- Desk for longer work
- Meetingsrooms for between meetings
- Foalje to get people around while traveling alone
- Desktop computer work all day
- 50% privacy 50% cooperation
- Never more then 2.5 hours at a time.
- Create homebase, go back throughout the day. Return after meetings etc.
- Couch for short moments, desks for longer work

APPENDIX 4 – FITTING TRIAL

To do before:

Choose subjects to include in the testing of the seat and table.

Make sure they have the right characteristics that are needed.

To do during fitting trial:

1. Introduce the activity.

Describe that the purpose is to evaluate the comfort and ergonomics of the seat and table while working with computers and other tasks. Not in particular the design. The purpose is to have a comfortable working position in a soft seating product.

The functions will be described and questions will be asked on how they perceive the comfort to be.

2. Describe the tasks they will be doing.
 - Working with computer, reading writing
 - Having accessories for the computer, mouse etc.
 - Reading and writing on notepads or books.
 - Taking notes and writing on computer
 - Reading notes and typing on computer
 - Use a tablet or smartphone.

3. Present the features.

Purpose of the product is to improve ergonomics while working with portable computers and other devices. Something different from the normal deskchair, as an option to those areas. The table's adjustable height and angle makes it easier to work close to the body to improve posture and comfort. Seat is designed to make it more comfortable to work and improve the feeling that it is made for that purpose. The adjustable backrest is there to introduce movement and enable change in posture.

4. Describe how they can use the features.
5. Process off testing.

Allow the participant to seat themselves.

Ask questions about the general comfort and feeling of the seat. What their impression is.

Start tasks:

- Reading and writing.

Provide a book, a notepad and a pencil. Task is to read the book. Instruct them to adjust or use the work area however they want. Inquire on comfort and how they like it. Next task is to write in the notepad. Inquire on comfort. The next task is to copy text from the book. Inquire on the comfort.

- Using tablet or smartphone.

Provide materials. Instruct them to adjust or use the work area however they want. Inquire on comfort and why they choose to work like that. Simulate talking on phone and taking notes. Inquire.

- Working with a computer

Provide a 13" portable computer as reference. Instruct the participant to read a few documents and write some text on the computer. Instruct them to adjust or use the work area however they want. Inquire on comfort while working with the computer. Add computer accessories to the task. (mouse or something else. Computer charger??)

- Working with computer and text.

Provide notepad and pencil. Instruct them to copy text to the notepad and the opposite. Instruct them to adjust or use the work area however they want. Inquire on the comfort and if things are lacking or need changing.

6. Evaluate findings.

Look through the results and draw conclusions.

7. Do appropriate changes, if needed do more testing.
8. Determine compromise.
9. Decide on final design with range, shape and measurements.

Fitting trial questions:

What is your impression of the seat?

How does the seat feel like?

How does the seat padding feel like? Too hard or soft? Sharp edges? Shape?

How is the seat height?

Do you like it?

What do you think about the size? The pads on the side? Need to be larger or smaller?

How comfortable are you? Scale 1- 10 (10 being "heaven")

How is the armrest height, position, size and shape?

How does the backrest feel like? Do you get good contact with the backrest? How does the curvature of the back feel like?

How is the angle of the backrest?

How would you access your ability to move in the seat?

How does it feel to get up from the seat? Sit down?

How well does the work surface support your arms?

What do you think about the possibility to adjust the worksurface?

What do you think about the possibility to adjust the backrest?

What do you think about the size and shape of the work surface?

How comfortable are you right now? During testing 1 - 10

Why did you choose to have this height and position of the table and seat?

How would you evaluate this position? Does it feel natural? Would you work like this for long?

How do you access your privacy while sitting in this product?

Is there anything that you do not like? Anything you would like to change?

Fitting trial Participant protocol page 1.

Participant number:

Sex:

Age:

Height:

Body type:

Reference seat. Test.

On a scale on 1 – 10 how comfortable are you?

Use mock-up

Backrest angle:

On a scale on 1 – 10 how comfortable are you?

95 degrees -

110 degrees -

100degrees -

115 degrees -

105 degrees -

120 degrees

Start:

Answers:

Fitting Trial Participant protocol page 2.

Participant

Tasks:

Reading and writing

Equipment: Book, notepad, pencil

Task: Read book, Write in the notepad, copy text from the book.

Settings:

I: Comfort : 1-10 ...

II: Why?

III: How position?

Using smartphone

Equipment: Smartphone

Task: Read and type on telephone, Talk on the phone.

Settings:

I: Comfort : 1-10

II: Why?

III: How position?

Working with a computer

Equipment: Portable computer, computer mouse, coffee cup.

Task: Read documents, write documents, add computer mouse work in photoshop.

Settings:

I: Comfort : 1-10

II: Why?

III: How position?

Fitting Trial participant protocol page 3.

Working with computer and text

Equipment: Computer, notepad, pencil

Task: Copy text to the notepad, copy notes to the computer,

Settings:

I: Comfort : 1-10 ...

II: Why?

III: How position?

Other things

Equipment: Same as before, add coffee cup, papers and things.

See how they would use the things:

How do you like the settings?

Fitting Trial Guide description

Start tasks:

- Reading and writing.

Provide a book, a notepad and a pencil. Task is to read the book. Instruct them to adjust or use the work area however they want. Inquire on comfort and how they like it. Next task is to write in the notepad. Inquire on comfort. The next task is to copy text from the book. Inquire on the comfort.

- Using tablet or smartphone.

Provide materials. Instruct them to adjust or use the work area however they want. Inquire on comfort and why they choose to work like that. Simulate talking on phone and taking notes. Inquire.

- Working with a computer

Provide a 13” portable computer as reference. Instruct the participant to read a few documents and write some text on the computer. Instruct them to adjust or use the work area however they want. Inquire on comfort while working with the computer. Add computer accessories to the task. (mouse or something else.

- Working with computer and text.

Provide notepad and pencil. Instruct them to copy text to the notepad and the opposite. Instruct them to adjust or use the work area however they want. Inquire on the comfort and if things should be changed.

- Add other things

Add coffee cup, papers, notes and things, and a bag. Instruct them to organize the things. How would they work with all that?

Fitting trial questions:

1. What is your impression (intryck) of the chair?
 2. How does the chair feel like?
 3. How does the padding feel like?
 4. How is the seat height?
 5. What do you think about the size?
 6. How do the armrests feel like?
 7. How does the backrest feel like? Do you get good contact with the backrest? How does the curvature of the back feel like?
 8. How would you access your ability to move in the seat?
 9. How does it feel to get up from the seat? Sit down?
 10. Is there anything that you do not like? Anything you would like to change?
- I. How comfortable are you right now? During testing 1 - 10
 - II. Why did you choose to have this height and position of the table and seat?
 - III. How would you evaluate this position? Does it feel natural? Would you work like this for long? How well does the work surface support your arms?

In overall how comfortable do you consider this chair?

APPENDIX 5 – USER REQUIREMENTS

User needs and requirements		
Ergonomics	The product should allow for an upright and proper sitting posture however still provide variation in posture.	The product should support the body during work and be easy to adjust.
	The product should not be too deep, too narrow or too wide to sit in.	
	The product should support the arms, back, lower back, head, shoulders and legs.	
	The product should allow for easy embarking and debarking.	
	The product seat padding should not be too soft .	
	The product should support a good working posture.	
	The product should support the arms during work.	
	The product should support work close to the body.	
	The product should be adjustable from a seated position.	
	It should take little time to adjust the product.	
Handling	The product should be easy to adjust, indicate it is adjustable, what parts are adjustable and how they are adjustable.	The product should be easy to understand.
	The product should be low in complexity and show its functions.	
	The product should have few controls.	
	The controls should be easy to see, understand and see what they controls.	
	The product should revert to a default setting.	
Working tasks	The product should consider a maximum working time of 2 to 3 hours at a time.	The product should support general office work.
	The product should allow for general working tasks such as reading and writing text and email, surfing the web, preparing presentations, general telephoning and so on.	
	The product should be a good place to work with laptops, tablets and smartphones.	
	The product should allow usage of chargers and provide electricity.	
	Provide a large enough worksurface for atleast an laptop and a piece of paper.	
	The product should support the use of a mouse or other accessories.	
Working activities	The product should provide an area suitable for coffee breaks.	The product should provide for contemplation, cooperation and group oriented work.
	The product should provide an area suitable for contemplation.	
	The product should provide an area suitable for discussions.	
	The product should provide an area suitable for cooperative working.	
	The product should provide an area suitable for sharing of ideas or work.	
	The product should provide an area suitable for presenting work.	
	The product should provide an area suitable for relaxation.	
	The product should provide an area suitable to welcoming customers.	
The product should provide an area suitable for teleconferencing.		

	The product should be suitable for personal work and meetings.	
	The product should provide an area suitable for just sitting down for a short time or doing short computer work.	
	The product should provide an area suitable for 1 up to atleast 4 people.	
	It should be easy to add to or adapt the working place.	
Storage	The product should provide temporary storage for either an bag, purse, briefcase or backback.	The product should provide temporary storage for various items.
	The product should provide a temporary place for documents, foodstuffs, coffee cup, cellphones and other accessories.	
	The product should allow for a temporary place to put electric cables.	
	The product should allow for a temporary place to put coats and jackets.	
Privacy	Should provide a feeling of "my own space".	The product should provide semi-privacy with the option to screen off if needed.
	The product should provide an area to do sensitive work, private phonecalls or have sensitive negotiations.	
	The product shouldn't allow for passage behind the user, no insight on private work.	
	The product should provide noise dampening.	
	The product should provide an working island in a landscape.	
	The product should allow for contemplating work.	
	The product should provide a indication not to disturb or provide clear boundaries.	
	The product shouldn't provide shared worksurfaces.	
Semi-privacy	The product should provide for a semi-shielded environment.	The product should provide ergonomic association and a for work atmosphere.
	The product shouldn't allow for others to sit too close, have seperate worksurfaces, provide a possibility to screen off from others at need.	
	The product should allow for flexibility from seperated work to coworking/meeting, adding extra work places, sitting in an angle towards each other	
	The product should allow for a peaceful area for cooperation, normal conversation and support informal meetings.	
	The product should be in close proximity to private workareas.	
Aesthetics	The product should show it is ergonomic, follow the curvature of the body and feel like a seat for work but without loosing the feeling of a couch.	The product should support different types of activities.
	The product could be rounder at the bottom to show it's adjustable.	
	The parts could be seperated to show it is adjustable.	
	The product should provide an work atmosphere.	
	The aesthetics should not be more important than the ergonomics	
	The product should burst with colours, be true to material, have a clean and fresh appearance, warm feeling, promote a feeling of openness and promote the feeling of activity and mobility.	
	The product should be cozy.	
Features	The product should have an a worksurface, back, seat, armrest, footrest and headrest that are adjustable.	The product should support different types of activities.
	The product should have armrests between seats and have wide enough armrests to support work.	

	The product should have adjacent or built in electricity and lighting.	
	The product should have built in or adjacent screening.	
	The product should have adjacent or built in whiteboard, tv-screen or projector.	
	The product should have non-stick surfaces.	
	The product should have built in chargers for accessories.	
	The product should have a built in or adjacent work surface.	
	The product should have temporary storage for various items.	
	The product should have easy to clean surfaces.	
	The product should alarm for a bad posture.	
	The product should provide a more permanent storage for documents, binders and folders.	
	The product should provide a place for shoes.	
	The product should allow for working from sitting and standing.	

APPENDIX 6 – REQUIREMENTS SPECIFICATION

Requirements specification				Value	Importance							From			
	Verb	Noun	Comment		8	7	6	5	4	3	2	1			
Ergonomics	Allow	upright sitting	through combination of back angle, seat depth and shape		X								U, T		
		variation in posture	by allowing for movement				X							T	
			by having a wider seat			X								T	
			by having variable inclination				X							U, T	
		proper sitting	by not allowing strange posture					X						U, C	
		easy reach	from a sitting position					X						U, T	
		breathing	foam and textile structure					X						T	
		inclination	of back					X						U, T	
		adjust position	of lumbar support							X					T
			of work surface			X									U, T
			of seat							X					U, T
			of headrest							X					U, T
			of armrest							X					U, T
		Afford	comfortable sitting	anthropometric data of swedish population			X								C
	by seat compression seat hardness			kg				X						U, T	
	by form of seat and backrest							X						U, T	
	Prevent	slipping	by fabric texture or seat angle					X						T	
			by worksurface material					X						T	
		stickiness	through textile and foam				X							T	
	Support	back	backrest height, shape and amount of contact			X								T	
			lumbar support of 3 cm				X							T	
		arms	pressure, rest height, size and shape		X									T	
		head position	table height and position		X									T	
		buttocks	cushion shape, softness and height				X							T	
		legs	support or height						X					T	
		head	headrest						X						
		posture	arms close to the body				X								U, T
			easy reach						X						U, T
			allowing for varying posture						X						U, T
	by providing lumbar support							X						T	
	Consider	time of use	up to between 1 to 3				X						U		

		through showing what parts are adjustable				X							
		by showing how parts are adjustable				X							
	relaxation							X					
	ergonomic	through following the body				X							
		through ergonomic shapes				X							
		through support surfaces				X							
	way of use	through logical mapping				X							
		through clear functions				X							
		through intuitive controls					X						
		by showing what parts are controlled with what controls					X						
	high quality	use of materials				X							
		use of details					X						
		through perceived quality by haptics and acustics						X					
	detail focus	splitlines, details where they are needed						X					C
	crafted	appears handmade							X				C
		built in features					X						C
		true to material					X						C
		True to manufacturing							X				C
	Sustainability	thinking about the environment							X				C
	Enduring	long lasting, known design					X						C
	Durability	long lasting, easy service						X					C
	Differentiated	company interpretation of scandinavian design					X						C
	Authentic	reflect heritage								X			C
	Expressive	show ergonomy, etc					X						C
		provide understanding					X						C
		look stable					X						C
		look durable								X			C
		quality						X					C
	suitable for work	material, form, aesthetics and posture				X							C
	good for the environment	true to material, natural						X					U
Expresses	scandinavian	use of wood				X							C
		use of colours				X							C
		be playful							X				C
		Simplicity					X						C
		clean, fresh and bright colours							X				U, C
	Friendly							X					C
	Intuitive						X						C

