Flexible support furniture for office use
Master thesis, Design for all

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Summary

This report is written to describe the process of the development of a piece of flexible support furniture for office use. The office furniture is meant to be used by persons with different types of back and hip problems, as well as persons without to prevent damage and injuries to their bodies.

The Design for all method was used in order to develop the product. Throughout the process five user tests were conducted to establish the needs of the users and to involve them in the development. The test persons were chosen from the target groups of the product. A market research was done and existing office chairs were tested in order to establish the needs for such a product.

The results from the research and the user tests showed that there is a need for this kind of product today. A product was developed that can offer the users different kinds of sitting, standing and standsitting positions which gives the user more options and variations.

The last user test shows that the product fills a gap in the market today and that the test persons had more positions to choose from than in a traditional office chair.
1. Introduction
   1.1 Background
   1.2 About the company
   1.3 Purpose
   1.4 Aim

2. Method
   2.1 The design process
   2.2 Design for all
   2.3 The test persons

3. Results
   Research phase
   3.1 Market research
      3.1.1 Existing types
      3.1.2 Trends
         3.1.2.1 Chair trends
         3.1.2.2 Office trends
      3.2 Function analysis
         3.2.1 Traditional office chairs
         3.2.2 Active chairs
         3.2.3 Standing chairs
   3.3 Need's analysis
      3.3.1 Aging population
      3.3.2 Back problems
      3.3.3 Target group
   3.4 Ergonomics studies
      3.4.1 Mechanical principles
      3.4.2 Movement of feet and ankles
      3.4.3 Dynamic sitting
      3.4.4 Interview with physiotherapist
   3.5 User studies
      3.5.1 Observations
         3.5.1.1 Results
      3.5.2 Interviews
         3.5.2.1 Short interviews
         3.5.2.2 Interviews
         3.5.2.3 Results
   3.6 User test 1 - Existing models
      3.6.1 Description
      3.6.2 Results
      3.6.3 Conclusion

4. Conclusion

5. Discussion

5. References
1. Introduction

1.1 Background
It is well known that most of us sit too much today. From the moment we get up and eat our breakfast sitting down, to how we travel to work by car, train or bus, to how we sit during work and then to the way we sit at home watching TV in the evening. Since our bodies are not made for sitting still in the same position for that long, it is easy to develop strain injuries due to this. Especially damages and pain in backs and necks are common consequences of sedentary work and too much still sitting (Stami, 2010). To prevent this it is important to move your body during the work day. Not just your upper body, but your legs and feet too. To achieve this it is important to have furniture that encourages movement of the body in an easy way. It should offer different positions, between sitting and standing, and it should be easy to change between these.

For those who already suffer from back pain and injuries, it is also important to have furniture that offers the right positions for their bodies and needs. Some people are not able to sit in a traditional chair, and therefore need furniture which you can lean towards or standsit on. There is a lack of these types of furniture in the market today.

1.2 About the company
HÅG is a brand of Scandinavian Business Seating, which develops and produces office and conference chairs with focus on dynamic ergonomics, the environment, visual design and quality. HÅG aims to develop chairs that encourages you to move your whole body - including the legs and feet, while sitting, without thinking about it. Movement of the body is both natural and necessary, and it helps us stay fresh and healthy, while strengthening the body at the same time. HÅG offers chairs that stimulate intuitive and natural movement of the body.

1.3 Purpose
There is becoming more and more working elderly (Dahl & Lien, 2013). Therefore, it is important to include persons with different pains and problems in back and hip, or with straining injuries, in the workplace. These people might have a bigger need for other types of support for the body than the able-bodied have, and might require more often change of sitting and standing position. Today there are different standing chairs and rehabilitation chairs, but these are often meant to be used as helping aids for persons with injuries or disabilities. There are few products that are attractive for both able-bodied and for those with back and straining injuries, and at the same time strengthen and support the body. Therefore, there is a need for such a product in the market today.

1.4 Aim
The aim is to develop an office furniture that has a broader user group than traditional office chairs. This means a product that can also be used by persons with different straining injuries or back problems that make it hard for them to sit or stand in the same position for too long. The solution should offer different sitting, leaning and standing positions that make it possible for the user to vary between different positions often throughout the workday. The product should be easy to understand and use. It should be a product that offers support for the body and at the same time strengthens it. The result should also be a product that considers the environment and sustainability in the best possible way, and at the same time fits in with HÅG’s own design philosophy.
2. Method

2.1 The Design process
The process is divided into three phases; the research phase, the ideation phase and the realization phase.

Research phase
The research phase consists of a market research where existing types of office chairs are examined in order to get a picture of what is on the market and to get inspiration. Trends within office chairs and offices in general are also examined to establish what the needs are in this field.

Then two analysis’ are done; function analysis to establish the features of existing solutions and a needs analysis to look at the reasons why such a product is needed and to look at who the target group is.

In order to develop a product that fits different types of bodies and needs, an ergonomic study is done. Different sitting positions and mechanical principles of the body are examined, and an interview is done with a physiotherapist to support the findings.

To involve the users of the product, a user study is conducted to observe how people sit and/or stand while working in the office. Five short interviews and two deeper interviews are done in order to find the needs of the users. Then the first user test is done by testing existing products to find out what is positive and what is missing.

From the findings in this phase, the requirements of the solution is specified.

Ideation phase
This is the phase where the ideation starts. First by sketching the first ideas both alone and in group as a workshop. The ideas are then tested in the second user test and then further developed from the result of the test. This phase includes three user tests where models of the ideas are tested. After the last user test one concept is chosen to develop further.

Realization phase
In this phase the prototype and 3D models are created and tested. Material and colour are chosen in this phase.

At the end of the process there is a conclusion and a discussion.

2.2 Design for all
Design for all is a design philosophy that aims to develop products and services that can be used by as many as possible without requiring any special adjustments. The vision is that the whole society should work for all people, with or without disabilities. That means that all products, environments and services are developed in a way that makes it easy to understand and use for everyone. In order to achieve this, one important part of the Design for all approach is user involvement. Including the users in the design process to fulfil their needs and establish the problems that are connected to the product or service.

Throughout this project, five user tests are done;
- User test 1 - To evaluate existing types of office chairs and working in standing position to establish problems and needs (research phase).
- User test 2 - To discuss and test initial ideas by looking at sketches and testing mock up models (ideation phase).
- User test 3 - To evaluate ideas by rating physical models for the different functions. For example, three different heights, three different shapes etc. (ideation phase).
- User test 4 - To test and evaluate two concepts in order to choose one for the final solution (ideation phase).
- User test 5 - To test and evaluate the final solution by testing a function model by using the Design for all scale (See 3.6.1) (realization phase).

The test persons are educated and trained to perform user tests and to express themselves in an understandable way. The test persons for this project are chosen to represent the extreme users within the target group. They have different kinds of back, hip and pelvic problems. In addition, there are also test persons that have arthritis and that are blind. To test the product on able-bodied persons, there are also a few test persons without any pains or problems.
2.3 The test persons (In order of appearance in user tests)

**Kristina, 49**  
**Medical condition:** Hip replacement and back problems.  
**Sitting habit:** Hard to sit, stand or walk for longer periods. Pain in seat bones and hips when sitting. Can’t sit on hard surfaces.

**Kjell, 65**  
**Medical condition:** Has arthritis, and has replaced parts of his hips, knees and feet. His body is very stiff and he has problems with bending it. He experiences pain in his hips, knees and feet.  
**Sitting habit:** Varies between sitting and standing. Hard to get up from the chair. Slides down on the chair after a while.

**Niklas, 32**  
**Medical condition:** Spina Bifida and uses usually a wheel chair when he is outside. Can walk with crutches 15-20 m. Has very weak muscles in his legs.

**Niklas Ö, 38**  
**Medical condition:** No back or hip problems,  
**Sitting habit:** Feels some pain in the back after sitting still too long.

**Gunilla, 60**  
**Medical condition:** Nerve damage in hand and arm, and arthritis.  
**Sitting habit:** Needs to change position often because her damaged nerve becomes painful and she becomes tired.

**Esther, 40**  
**Medical condition:** Two herniated discs and problems with the pelvic. Experiences cramps and pain.  
**Sitting habit:** She has to think of how her arms are positioned and how she is standing or lying down. She has to think of the movements she is about to do, especially any big movements. It is almost impossible for her to sit at all so she practically stands the whole day.

**Åke 1, 70**  
**Medical condition:** Uses crutches. Had a stroke 7 years ago, which caused reduced strength and function in the right side of his body. Has had operations in his back, and sometimes feels pain down the thighs and legs.  
**Sitting habit:** Varies between arm chair and kitchen chair at home. Feels pain in neck after sitting still too long.

**Åke 2, 51**  
**Medical condition:** Got a back injury when he was 18. Herniated discs in the lower and upper back. Has hip problems.  
**Sitting habit:** Has learned to live with it, so he moves a lot when sitting to avoid pain and stiffness. Stretches a lot and varies between standing and sitting.

**Cecilia, 31**  
**Medical condition:** Back pain and problems due to lumbago in lower back.  
**Sitting habit:** Stands by her desk most of the day because of her back problems, but sometimes she sits in a bar stool for some change and relief.

**Yvonne, 53**  
**Medical condition:** Sciatica and lumbago. Pain from the back through the thighs and feet. Arthritis in hands.  
**Sitting habit:** Has problems with sitting still too long, causes pain in back and legs. Varies between standing, sitting and walking. Likes to stand while working.

**Violetta, 48**  
**Medical condition:** Four herniated discs, soft skeleton and painful joints.  
**Sitting habit:** Has problems finding a chair that is good for her. Gets up a lot from the chair when she is working because her body gets stiff and painful. Is moving a lot when sitting in the chair to avoid pain.

**Magnus, 35**  
**Medical condition:** No back or hip problems. Works within IT.  
**Sitting habit:** He sits about 12 hours a day. Experiences stiffness and pain after sitting still too long.

**Lennart, 60**  
**Medical condition:** Blind from birth
3. Results

3.1 Market research

3.1.1 Existing types

Office chairs have pretty much looked the same and had the same functions during the last decades. But over the last years, they have started to change both in function and looks. Ergonomics has become more and more important, which can be seen in the many new types of chairs that have been developed lately. These are chairs that are claimed to be ergonomic and to keep your body strong and healthy.

Office chairs can be divided into five different categories. Some of them are overlapping and you can find some chairs in more than one category.

Traditional office chairs

Comes in all kinds of colours and shapes, but mainly have the same, standard functions. They have wheels and you can turn around on them. Some have short backs, some have long, some have arm rests and some don’t. The most common functions they have are to adjust the height, adjust the angle of the back and to adjust the arm rests. On some chairs you can also adjust the angle and the depth of the seat.

"Ergonomic" chairs

Here there are many different types of chairs. There are the ones that are similar to the traditional chairs, but have a lot of options for adjustments, and there are the ones that encourage you to sit in a different position than what is usual. Depending on what type of chair it is, there are some various problems with these chairs. Some chairs might be ergonomic if you sit in it only for a while, but is not good for the whole day, because you end up sitting in the same position without the possibility to change. Others might be good for you because you are able to adjust it exactly to your body and for different positions, but they might be too complicated to adjust for a person to do it several times a day.

Even though many manufacturers claim that their chair is ergonomic and good for your body, they might not be tested enough to be rightfully called ergonomic.

Active/balance chairs

There are different types within this group too. You have the gym ball chairs which require a lot of strength and you have the saddle chairs with a round bottom which makes you move the whole time to stay in balance. These chairs are good in that way that you have to move a lot when you sit on them. But again, you usually don’t have the chance to change position. Another problem might be that because you have to move this much the whole time, you might end up not using it, because it is too exhausting to sit and balance the whole working day.
Saddle chairs
These chairs force you to sit up right like one would sit while riding a horse. The position you then sit in is said to be better than the regular position with a trunk-to-thigh angle of 90 degrees, but these chairs also often only give the possibility to sit in one position. These chairs vary little in function and design, but some have backs and some have the possibility to adjust the angle of each half of the seat.

But if you can only choose to stand or “standsit” in one position, your body might get stiff and painful after a whole day of work. Even though you are standing, you need to move your body.

Standing chairs
Here there are different types of chairs. There are some that have the traditional design of a bar stool, and there are those that you can choose to either sit in a regular height or choose to “standsit” on. There are also the electrical ones that are more associated with wheel chairs or aid for people with reduced strength and mobility in their legs.

The first mentioned ones might be good if you easily can change between standing and sitting, and if you can also move your feet in different positions.

Ergonomic chairs
Over the last years different kinds of ergonomic office chairs have appeared on the market. Although there are different opinions about how ergonomic some of these chairs actually are, it is still something that is getting more important in the office chair market. Examples of these types of chairs that claim to be ergonomic are the balance chairs made of a gym ball with feet, and the well-known saddle chair.

This trend was also visible at Stockholm Furniture Fair 2013. Several “ergonomic” office chairs were presented and some companies even claimed to have the best chair in the world for your back.

3.1.2 Trends
3.1.2.1 Chair trends
Sustainable chairs
In most product categories sustainability and care for the environment is getting important for more people. Both for the users and the manufacturers. This is something you can also see in the office chair market. Office chairs that are almost 100% recyclable are made today, and there are also chairs that are made of recycled material. Some chairs even got the Cradle-to-cradle certificate, such as the Think Chair from Steelcase and Mirra Chairs from Herman Miller. This means that the whole process is sustainable. Not only the materials, but also the production, logistics and the life after the product has been used, how it is recycled or reused. A product can also be sustainable in a way that it is long lasting and has good quality and a visual design that lasts for a long time.
3.1.2.2 Office trends

Open offices
The traditional closed office rooms with a desk and office chair where you sit the whole working day is changing towards more open office landscapes and more dynamic offices. Meetings are held in other places than the office; in cafés, over phone, on Skype etc. This open office trend was seen at Stockholm Furniture Fair, where different kinds of soundproofing walls were presented. We want open offices, but we don’t want to be disturbed. Instead of having your own office room, there might be workstations consisting of a chair with an attached table for your lap top or a small table next to it, for everyone to use.

Less distinction between business and leisure
When Vårt Nya Förlag AB did a special edition of Vårt Nya Kontor 2013, 19 designers from different design companies in Europe were asked how they think we will work in the future and how the office will look like. One thing that was mentioned was that the home environment and office environment are getting closer and closer. Offices look more like homes, and more people work from home. This is also something that author John Medina writes about in his book Brain Rules. He says that the business generation today is used to alternatives and that they expect this in the business life as well. The phone call has been replaced with e-mails, Facebook and LinkedIn, the conference rooms have been replaced by Skype and the office has been replaced by a comfortable air plane seat in business class. This is called “bleisure” by The Future Laboratory, and it describes the constant striving to combine business and leisure.

End of offices, desks and office chairs
Lloyd Alter wrote an article about the future trends in offices where he listed 6 trends that will shape the way we work. Three things on his list were the end of offices, desks and ergonomic office chairs. He believes that in the future most work will be done online and that you can work from home, the beach or your cabin in the mountains (Alter, 2010). This might sound attractive and tempting at first, but if we think about it, is this something we really want? It might be luxurious to be able to work from home from a comfortable couch, with possibilities for coffee breaks whenever it suits you. You could spend the time as you like, maybe sleep a little longer one morning and work later in the evening.

One can then conclude that it might be hard to separate between business and leisure. Instead of logging off at 5 in the afternoon to go home to focus on your family, you might end up working the whole day instead and having problems separating business and leisure.

Even if the closed offices, desks and office chairs might disappear in many work environments, it is still important that we move our bodies and don’t sit still for too long. Even if you are able to work from your couch, bed or a café, the need for your body to change between positions and moving is there. Therefore, it is still important that you have some kind of furniture that can offer this kind of variation and body movement, even if you don’t have to leave your home for working. It might be tempting to lean back in a soft and comfortable couch while working on your computer, but it can damage your body.

Also, there will always be some professions where it is impossible to work from home. Professions that will always need some kind of office to work from, even in the future. Therefore, the office may exist even long into the future.
3.2 Function analysis
3.2.1 Traditional office chairs
There are big variations in traditional office chairs, some chairs have many functions and adjustments, while other chairs only have a few. But these are some of the functions that can be found:

3.2.2 Active chairs
There are different types of active chairs, such as the balancing Back App and the many different types of gym ball chairs. These chairs have usually fewer functions and adjustments, but these are the most common ones:

A) Adjustable height
B) Exercise for your core and upper body
C) Balance exercise
D) Back support

3.2.3 Standing chairs
The standing chairs can have one or more of these functions and adjustments:

A) Adjustable height
B) Different positions such as “standsitting” or sitting
C) Back support
D) Feet support
E) Possibility to move feet
3.3 Needs analysis

3.3.1 Aging population

The age of the population is increasing. This graph from SSB shows how the expected population growth will be in Norway in 2050. The light fields show the population today and the dark fields show the expected population in 2050 (SSB, 2012).

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Figure 2

SSB: Befolkningsfremskriving. The dark fields show which age groups where the population will increase in 2050 in Norway.

As one can see here, there will be an increase of age in the population, and it is therefore important to include the elderly in the job market. It is important to offer office facilities that are adapted to the needs of the elderly, so that it is possible for them to keep working in offices. Health problems increase with the age, and common problems caused by work among seniors are often strain injuries, which can include pain in neck, shoulders, back and arms. These problems are more common for women than men (SSB, 2012).

If we are going to handle this change to an aging population, more people need to work longer. Those who will be in the age group between 55 and 75 in 2050 and would need to work longer in the future, are between 18 and 38 years old today. It is therefore also important to keep these people healthy enough to keep working longer than what is expected today. So it is not only important to make it possible for elderly to stay in their jobs longer, but it is important to keep those who are young today healthy and without back pain or problems.

These are the numbers for Norway, but according to Lars Østby and SSB, this is the same over all of Europe. In Norway there is expected an growth in amount of people over 60 years old from 20% to 32% in 2050, while in other countries in Europe, such as Spain, Italy and Estonia, this number is expected to be over 40% (SSB, 2012).

Not only is the age of the population increasing, but the wanted retirement age by the population has also increased. A survey was done by inFuture on behalf of Virke, where 1611 people were asked when they would like to retire if they could choose freely. The average age chosen was 64.4 in 2012. This is an increase of 3.4 years from 61 years chosen in 2004. This shows that the people also want to work longer (Virkemål, 2012).
Karla Gadge and Ev Innes did a study in 2006 to investigate the immediate effects of comfort, productivity and posture of the Bambach saddle chair and a traditional office chair. They state that the sitting position is one of the most thoroughly studied occupational postures today because of the strong association with lower back pain. Seating that is poorly designed and the lack of education regarding healthy sitting postures can be the cause of inefficient operation, musculoskeletal disorders as well as decreased productivity and discomfort (Gadge & Innes, 2006). Work has changed a lot during the last decades. Less people do heavy, manual labour, while the amount of people who work in front of a computer increases. In spite of this, the number of musculoskeletal disorders is not decreasing. The connection between muscle activity and pain is suggested to be inadequate blood supply and lack of energy in the muscle fibers (Stami, 2010).

It has long been a common view that the optimal sitting position is the one where the natural curves of the spine is maintained, as it is when standing. For many years it has been believed that to achieve this posture, you should sit in a 90-90-90 position, which means that the trunk-to-thigh angle is 90 degrees, as well as the knee angle. But studies show that sitting in this position for too long, can contribute to the development of lower back pain because it places potential strain on the lumbar spine. Other chairs that have been claimed to provide the optimal sitting posture are the forward sloping seat and the kneeling chair. However, the forward sloping seat may cause the body to slip forward, which can increase the leg muscle activity to prevent this from happening. This can result in extra pressure in the legs in order to maintain the seated position. Research has also indicated that the reduced use of the back rest can result in muscle fatigue. There are also identified different problems connected to the kneeling chair: there is a too big load on the knees and the lower legs; the possibility of shortening the hamstrings; and sitting discomfort (Gadge & Innes, 2006).

Another chair that is claimed to provide the user with optimal sitting posture is the saddle chair. One type is called Bambach, and a study was done to find out the effects of these chairs compared to the effects of traditional office chairs. The results show that the discomfort ratings seemed to increase over time regardless of which seat was used. The saddle chair seemed to reduce the level of lower back pain, but it gave higher discomfort in the lower limbs, especially the hips and buttocks. The saddle chair did provide a bigger trunk-to-thigh angle though, which is associated with an optimum sitting posture (Gadge & Innes, 2006). As these studies show, there is not one single sitting position that is the right one. Even the postures that are considered ergonomic can cause pain and damage to your body after time. The important thing is to change positions and move your body during the work day.

There is not one special disorder which cause back pain and problems with sitting in a chair. Back pain and injuries can play out differently for different persons and the same injury may have different effects on people. The same injury can make it hard for one person to stand, while for another person the same injury can make it hard to sit down. But these are some of the disorders and injuries that can make it hard for people to sit still for longer periods:

- Lumbago
- Herniated/slipped disc
- Sciatica
- Spine degeneration
- Pelvic problems
- Arthritis
- Hip problems

3.3.2 Back problems
3.3.3 Target groups
The target group for this project can be divided into two; one group for preventing damage to the body, and one group who already have pain and injuries.

Preventing
Healthy women and men of all ages working in an office

Back/hip problems
Women and men with back pain or other injuries which makes it hard to sit or stand for longer periods, such as:
- Lumbago
- Herniated/slipped disc
- Sciatica
- Spine degeneration
- Pelvic problems
- Arthritis
- Hip problems

It might seem strange to have these two different target groups for the same solution, but what they need might not be too different from each other. It is good for everyone to move their bodies more, even when sitting, whether you are young or old. It is important to use your body to prevent damages and pain later in life. As the research showed, it is expected that we will have to work longer in the future to keep up the standard of living we have today and to keep the community running. Therefore, it is even more important that the people who are young today stay healthy.

For those who already have some kind of hip or back problems, it might be hard for them to sit in the same position for longer periods, or to even sit at all. For some it is essential to change position often to prevent the body to get stiff and painful. Then it is important to keep moving the body, even when sitting still.
3.4 Ergonomic studies
3.4.1 Mechanical principles

The pelvic has a lot to do with our sitting position. It tilts forwards or backwards according to your sitting position. According to Engström (2002) the pelvic is affected by the feet, legs, hips, and sacrum in these ways;

**The feet and lower legs affect the pelvic indirectly**
The feet affect the position of the hips and then indirectly affect the pelvic. The position of the feet, either outwards or inwards, rotates the hips. This means that the position of the feet indirectly affect the position of the pelvic. When the feet rotate outwards or inwards, the lower legs also rotates outwards or inwards. Further, the muscles, ligaments and tendons that connect the lower leg with the thigh bone affect the thigh bone to rotate too. Therefore, the lower legs affect indirectly the pelvic through the thigh bone.

**The hips affect the pelvic directly**
The muscles and tendons which stretch between the thigh bone and the pelvic affect the position of the pelvic directly. When the thigh bones change their positions according to the pelvic, the muscles and tendons are tightened or loosened. In this way the hips affect the position of the pelvic directly.

**The sacrum affects the spine directly**
The sacrum (korsbenet) affects the spine directly. So when the position of the sacrum is changed, it directly affects the position of the spine.

This shows that every part of the body is connected and affected by each other. A sitting position is not just affected by how the spine is positioned, but also by how your feet, lower legs, thighs and hips are positioned.

When standing, good body posture is when the body is balanced and straight, and you can walk and stand easily. Good body posture creates increased muscle efficiency, which makes it less tiring to hold up and move the body. When we are standing, the hip joints are almost completely stretched, which means that the pelvic gets a lot of help from different muscles to keep its forward tilted position. But when sitting in a reclined or neutral position, the pelvic tilts backwards. When the thoracic spine falls together, the pelvic is affected and tilts backwards. As long as the thoracic spine is straight, the pelvic will be stabilized. The tendency of the thoracic spine to sag is a big problem in sitting position, but one way to decrease this is to sit a little forward tilted, like you do in a saddle chair (Engström, 2002).
When you look at how children sit and use their body in a natural way with lots of activity and much variation between movement, support and rest, you can see what is natural to us. This is how we should move, even when we grow up. Not to be forced to sit in one particular position the whole day, but to move in a natural way (HÅG Ergo binder, chapter one).

In a way we have become cowardly and lazy. A fully mobile person can choose between different sitting positions and thereby different ways of spreading the pressure while sitting. The body chooses its pattern of movement after simple priority principles. First we choose stability since we don’t want to fall, then we choose the position that decreases pain and discomfort, and at last we choose the position that requires a minimum of energy. Therefore, one can say that we have become lazy. We want to be as comfortable as possible, while using as little energy as possible (Hammarskiöld & Vessman, 1999).

It is very important to move the feet and ankles to aid the blood supply back to the heart. It is the heart that pumps the blood out into our body, but the heart isn’t strong enough on its own to ensure the full return of the blood back into the heart. That is why we are dependent upon gravity and muscle activity for the blood to return to the heart. When sitting, it is the feet that should move so that the blood gets pushed back to the heart. The more we move the ankles and feet, the more the blood circulation is increased. This is why walking for hours is possible without feeling discomfort or pain, but when we move on a push bike, using one leg to push the bike forward, we usually have to change legs because of discomfort. It is not because we get tired in the leg that is pushing the bike, but because we get tired in the leg that we don’t use. The body cells that carry out this work need energy to work, and this energy is the blood. So the movement is important because the pain we feel in our legs when standing or sitting still for too long, is because of bad blood circulation and lack of nourishment for the working muscles (HÅG Ergo binder, chapter 3).

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3.5 User studies
3.5.1 Observations
To get an idea of how people actually sit on their chairs, observations of 10 persons were conducted in three different offices. The persons were observed and photographed when working as they normally do, sitting or standing in different positions. Five of them were also interviewed about their habits in the office. The age of the persons ranged from 25 to 65, and there were three men and seven women. The results showed many different sitting and standing positions, and some of them are shown here;
3.5.1.1 Results

These are just some of the positions that were observed, but it was clear that some persons change positions often, every 1-2 minutes and others don’t change that often at all. One said the reason she changed position all the time was because the chair didn’t fit her.

Even though some of the chairs offer several sitting positions, it was obvious that people find their own positions in the chair that fit them.

When it comes to standing and standsitting positions, there were not that many variations. Some of the persons mentioned that they like to stand for a while during the day, but then they were just standing in a regular position without any kind of support for their body.

The observations showed that they like to change positions according to what they are doing. When working on the computer it was popular to sit straight or leaning forward. But when talking on the phone, many of them wanted to sit in a reclined position. Also when they talked to visitors in the office they liked to change the position to more reclined or sideways position.

Even though the observation was done of only 10 persons, which only 3 of them were men, the results showed that the men usually sat straight in the chair with both their feet on the ground, while the women used their legs a lot more, sitting on them or resting them on the table or another chair. The women also had a bigger number of positions they varied between.

The observation showed that two persons were standing the whole day, while three persons wanted to stand for a while every day. The rest seemed to prefer to sit the whole day.

The observation also showed that it was normal to stretch every now and then. Sometimes without any aid, but sometimes using parts on the chair as help for stretching.

3.5.2 Interviews

Five short interviews were done with randomly picked persons at one office. Two deeper interviews were done with two chosen persons that have problems with their back. They were asked about what kind of chairs/positions they use today, how often they change positions, what kind of problems they experience and what kind of support they need in a chair.

3.5.2.1 Short interviews

<table>
<thead>
<tr>
<th>Sex</th>
<th>Age</th>
<th>Chair and position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>31</td>
<td>Stands by the desk all day, having two types of foot support to choose between; one balancing board and one board with an angle.</td>
</tr>
<tr>
<td>Female</td>
<td>28</td>
<td>She shifts between standing and sitting in a traditional office chair.</td>
</tr>
<tr>
<td>Male</td>
<td>39</td>
<td>Sits in a flexible, traditional office chair with long back. Sits most of the time, but tries to stand up while working a few hours each day.</td>
</tr>
<tr>
<td>Male</td>
<td>65</td>
<td>Sits in a flexible, traditional office chair with long back. He sits in the chair most of the working day. He has an adjustable desk, but doesn’t feel the need to stand and work.</td>
</tr>
<tr>
<td>Female</td>
<td>47</td>
<td>Stands the whole day without any kind of support.</td>
</tr>
</tbody>
</table>
3.5.2.2 Interviews

Age: 34
Sex: Female
Occupation: Full time student
Medical condition: Back problems because of disc herniation in the lower back in 2004. Has problems with sitting for a longer period, it is like ripping the wound open again. Doesn’t need any special support while working, but needs to move her back and body to avoid pain. She also has problems with her feet because of all the standing.

Age: 62
Sex: Female
Occupation: Full time job at a hospital. Sits by a desk most of the day, but has to go up and down a lot during the work day.
Medical condition: Has general back pain and spine degeneration on 4 of the lowest spinal discs. Doesn’t have big problems while sitting in a traditional office chair, but has problems getting up from it and afterwards. If her back is not straight while sitting in the chair, she has problems straighten it after. Therefore she needs to vary positions often so her back doesn’t get stiff.

3.5.2.3 Results

- Half of the persons being interviewed have problems with their backs, which makes it hard for them to sit for longer periods.
- The persons who stand all day don’t have much support for their body, except for a balance board to stand on.
- One experienced that her legs get swollen after standing the whole day.
- Only one person preferred to sit the whole day, while six persons would like to stand all day or switch between standing, stand sitting and sitting.
- The men switched between only a couple of positions, while the women moved their bodies more.
- Two persons use HÅG Capisco, but thought it was too wide when sitting in saddle position, and they wanted to be able to stand while leaning towards it, which is not possible.
- For those with back problems they mostly wanted to switch between standing and stand sitting.
- Those with back problems would like a solution where they can easily vary between different positions.
- One said it was important to stretch her body during the day.
3.6 User test 1 - Existing models
3.6.1 Description

What: Testing three existing chairs & standing position when working

How: The test started with some open questions about the condition of the test person, how it affects their day and how much they sit while working during the day and what kind of chairs they use. Then three different existing chairs and standing position were tested, according to the Design for all scale and with comments. When using the Design for all scale, the test persons judge from a scale from 0 to 5, where 0 is “impossible” and 5 is “Very easy” or “Very comfortable”. The test persons judged how each chair was to adjust and sit in, and they were also asked if they experienced any problems or pain using the chair. Then they were asked how it is to stand while working and what kind of support they need then. At last they were asked what they thought of the idea of a furniture where you can easily change between sitting and standing and different positions.

Impossible Very hard Rather hard Neither hard nor easy Rather easy Very easy

When: 11.02.13  
Where: Mid Sweden University, Sundsvall  
Who:

Kristina, 49  
• Hip replacement  
• Back problems

Esther, 40  
• Two herniated discs  
• Problems with the pelvic  
• Experiences cramps and pain

Gunilla, 60  
• Nerve damage in hand and arm  
• Arthritis

Niklas, 32  
• Spina bifida

Hedemora Stolen  
HÅG H03 340  
HÅG Capisco 8107

Kristina, 49  
• Hip replacement  
• Back problems

Esther, 40  
• Two herniated discs  
• Problems with the pelvic  
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Gunilla, 60  
• Nerve damage in hand and arm  
• Arthritis

Niklas, 32  
• Spina bifida
3.6.2 Results

Hedemora stolen

**Reaching the adjustment handles**
- They all found it rather hard to reach them
- The handles were too far back *(fig. 3)*
- The arm rests were in the way *(fig. 4)*

**Adjusting the chair**
- Hard to see the pictogram on the handles when they point outwards *(fig. 5)*
- Hard to adjust while sitting in the chair because you have to bend away from the chair to adjust it *(fig. 5)*

**Sitting comfort**
- One thought the seat was too deep *(fig. 6)*
- One thought the seat was too short *(fig. 7)*
- Trunk-to-thigh angle is too small, 90 degrees *(fig. 8)*
- One felt pain in the seat bone and hips
- One wanted a taller back rest for better support *(fig. 9)*
- One felt pain in the back
- The chair gives you bad posture *(fig. 10)*
- One refused to test this chair because of pain
HÅG H03 340

Reaching the adjustment handles
- One found the back rest adjustments hard to understand
- They all found it easy to reach
- One wanted the back rest handles to be placed lower (fig. 11)

Adjusting the chair
- Two thought the back rest adjustment had a too hard grip (fig. 12)
- They all thought it was easy to adjust the height

Sitting comfort
- Three of them found the rocking nice, but one wanted to be able to lock it in a position
- One thought the trunk-to-thigh angle was too small (fig. 13)
- Two felt it was unstable and wanted arm rests (fig. 14)
- Two thought you got a good posture in it (fig. 15)
- One didn’t like it when she was sitting straight on it.
- One wanted more support on her lower back (fig. 16)
- One couldn’t sit on the chair because it was rocking
HÅG Capisco 8107

Reaching the adjustment handles
- All thought it was easy to reach the handles under the seat (fig. 17)

Adjusting the chair
- Two thought it was hard to see the markings on the handles when sitting on the chair
- One wanted to be able to lower the chair without sitting on it (fig. 18)
- Hard to adjust the back rest because of the neck support (fig. 19)

Sitting comfort (regular position)
- Three thought the legs were spread too much (fig. 20)
- Two experienced pain in their hips when sitting
- One thought the seat was too hard
- One didn’t get enough support on her back (fig. 21)

Sitting comfort (backwards)
- One thought it gave relief to her upper back (fig. 22)
- One thought it was OK, but thought it was too complicated to change to this position often
- One thought it was good when you could tilt forward a little (fig. 23)
- One feels a little trapped when sitting like this

Sitting comfort (standsitting)
- Two thought it was OK to standsit on
- Two thought the truck-to-thigh angle was very good (fig. 24)
- One thought the shape of the seat was good for the hip bones
- One wanted to be able to tilt the seat more forward
- Two wanted back support in this position (fig. 25)
Standing position

**Working position**
- One preferred to stand while working over sitting *(fig. 26)*
- One thought it was comfortable to stand, but only for 30 minutes at the time before she gets tired and needs to rest *(fig. 27)*
- One has to stand while working, but gets tired and needs to change position often *(fig. 28)*
- Two wanted a soft mat or good shoes while standing
- One was not able to stand

**Resting position**
- One rested on her elbows and underarms *(fig. 29)*
- One changed between resting with her legs wider apart, with her back against the wall with extra lower back support, or sideways *(fig. 30-32)*
- One wanted a cushion on the desk that she could lean her chest and stomach against
3.6.3 Conclusion

- The most important thing for all test persons was to be able to vary between different sitting and standing positions. And to be able to change between active and passive positions.
- The solution should be easy to adjust, so it doesn’t take too much time.
- The test persons wanted to be able to lean backwards without the furniture rolling away.
- The tilting function should be able to be locked.
- It was important for the test persons that you can vary the trunk-to-thigh angle and width between their legs.
- It was important to have support at the right places, especially in the lower back.
- It was important to be able to tilt the seat forward.
- It should be possible to adjust the size of the seat so it fits.

3.7 Conclusion research phase

Many new kinds of office chairs have been developed over the last years, which many claim to be ergonomic. However there are still few chairs that offer variations in sitting and standing positions and that encourages you to move your body. There is a need for this type of furniture today.

Ergonomic chairs are becoming more and more popular. People are interested in these types of chairs.

Sustainability is also getting popular among both manufacturers and the users. Some chairs are even Cradle to Cradle certified.

Some people predict that the office as we know it will disappear completely. That most people will work from home and that meetings will be held on Skype etc. However, even if some people work from home, the need for flexible furniture that encourages you to move your body is still needed. Also, there will always be some professions where it is impossible to work from home.

To keep up the standards of living and to keep the community running, people need to work longer in the future because of the aging population both in Norway and the rest of Europe. It is therefore important to offer facilities that are adapted to the needs of the elderly, but also to keep the people who are young today healthy.

Research shows that even if you sit in what is considered an ergonomic position, as on a saddle chair, you still might damage your body over time if you don’t vary between different positions and move your body.

The target group can be divided into two; for preventing damage and for those who already have back/hip problems and pain.

Every part of the body is connected to each other, therefore the position of your feet, legs, hips and pelvic affect the position of the spine.

The sitting positions can be divided into different groups. Some positions are chosen because you want to relax and increase the stability of your upper body, while other positions are chosen because you want to be more active. Your whole body including your arms and legs vary in different positions. There is not one single position that can be called the right one, the important thing is to move and vary between different positions.

It is important to move the ankles and feet in order to aid the blood supply back to the heart.

The observations show that some people change positions often, while others almost don’t change at all. Some people find their own positions, using the chairs in ways that they probably weren’t designed for. People change positions according to what they do. There were not that many variations in the standing and standsitting positions. It was normal to stretch now and then.
3.8 Requirement specification
After the research phase and the first user test, some needs and requirements for the functions of the product were established. The requirements are divided into three; shall, should and could, to rate the importance of each requirement.

**Shall**
- Offer at least 3 different positions
- Offer sitting, standsitting and standing position
- Height adjustable
- Back support
- Lower back support
- Easy to adjust
- Have wheels

**Should**
- Tilting function
- Lockable tilting function
- Changeable covers
- Have armrests

**Could**
- Have foot support
- Have foot mat
- Lockable wheels
- Stretching possibilities
- Neck support
- Function for activating feet
3.9 First ideation
3.9.1 Sketching

Equipment that is attached to the chair and easy to reach to stretch arms and legs during the workday. Elastic bands, fixed bar or something else to stretch with.

A furniture that has one type of seat on one side and when you turn it upside down, there is another type of seat on the other side.

To be able to turn the seat around, the solution should have one of these two bases.

However, this function is possible to create in an easier way, without turning the seat around.

A furniture that has different seats in different heights that are attached to a pole in the middle. The seats can be turned around the pole and up and down to give the optimal seat.

The back rest has no front and back, but a round shape with different types of support for your back. It can be turned around and up and down.
A furniture that consists of three different, flexible parts. The back support, seat and leg support can be adjusted in angle and height.

Something that is attached to the furniture that you can use to move your feet while standing or sitting.

When the furniture is bought, the customer chooses different parts to build the seat he prefers the most.

A regular seat for some positions, and a saddle seat for other positions. Either by pulling out the saddle seat or by folding it out.
Five positions

A furniture that allows five different positions; two sitting positions, two standing positions and one standsitting position. The seat should have a saddle seat on one side and a regular, straight seat on the other side. The back rest should be used on both sides; both as stomach and back support. The back rest can be turned around for different functions and for variation in back support.

Leaning towards the desk while standing

Leaning backwards on the back rest

Sitting backwards, leaning towards the back rest

Normal sitting with back support

Standsitting with back support

Leaning backwards with foot mat

To be able to lean backwards, the furniture should be kept in position so it doesn’t roll away when you lean towards it.

One suggestion is a foldable mat that is attached to the wheels of the furniture. When the furniture is used in a sitting position, the mat is folded in a triangular shape and put on top of two of the five legs of the furniture. When the user wants to switch to a standing position, he unfolds the mat and steps on it to keep the furniture from rolling. The mat could also have a soft material so that it functions as a cushion for the feet.

It should be easy and fast to adjust to this position, so it will be used and not forgotten about. The best thing would be to be able to do the folding and unfolding without bending down.
3.10 User test 2 - Testing ideas and models

3.10.1 Description

**When:** 06.03.13
**Where:** Mid Sweden University, Sundsvall
**Who:**

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kristina, 49</td>
<td></td>
<td>Hip replacement, Back problems</td>
</tr>
<tr>
<td>Esther, 40</td>
<td></td>
<td>Two herniated discs, Problems with the pelvic, Experiences cramps and pain</td>
</tr>
<tr>
<td>Kjell, 65</td>
<td></td>
<td>Arthritis, Hip, knee and feet replaced, Pain and stiffness</td>
</tr>
<tr>
<td>Cecilia, 31</td>
<td></td>
<td>Lumbago</td>
</tr>
</tbody>
</table>

**What:** Testing different ideas by looking at sketches and testing simple function models.

**How:** The test started by showing and explaining the sketches of the ideas so far. Then the models of the ideas were tested while having an open discussion about them. Because of the different conditions of the test persons, some of the ideas was not possible to test on all the test persons.
**Standsitting with lower back support**

The model consists of a hard part to create a shorter seat, and a soft, cylindrical part to give good and comfortable lower back support while standsitting.

**Support for stomach/chest and arms while standing and sitting**

This model consists of one elbow support and one cushion to have between the stomach/chest and the desk.

**Standing while leaning backwards on the furniture**

The model consists of a foot mat that is foldable and back support which is attached to the back of the back rest.

**Stretching arms and feet**

The foot stretch model is made of elastic bands attached to a cylindrical shape to place the feet on.

The arm stretching model is made of elastic stretching bands that are attached to the chair, so you can stretch your arms up or to the sides.

**Foot rolling**

The model consists of a cylindrical shape. The model was tested while standing and sitting, and in different heights above the floor.

**Sitting backwards with extra padding under the butt**

This idea was tested by placing a folded piece of foam under the test persons butt, so that the chair would follow the angle of the thighs.
3.10.2 Results

**Standsitting with lower back support**
+ All test persons said it feels good to sit like this because you get more support on your back (*fig. 33*).
+ All test persons think you sit straighter like this (*fig. 33*).
+ All test persons could work like this.
+ One person wanted this on the Capisco chair.

**Support for stomach/chest and arms while standing**
+ All test persons said it feels good to stand like this and that you get some relief on your arms (*fig. 34*).
+ Three test persons said they would work like this, and one said it depends on the depth of the arm rests. If they are too deep, she feels a little trapped (*fig. 35*).
+ Three test persons said it feels soft against their stomach and prefer this over leaning towards the desk with no support (*fig. 36*).
+ One said it activates the back in a good way (*fig. 37*).
+ One said it is good to lean on your stomach instead of “hanging on your shoulders”.

**Standing while leaning backwards on the chair**
+ All four test persons like this position and feel that it gives some relief on the legs and back. It also gives good lower back support (*fig. 38*).
+ Two persons would use this function
+ Two persons did not have any problems unfolding the mat.
+ Two persons would like to have a soft mat like that to stand on
  - One thought it was too much job to fold out the mat, and one is not able to bend down to unfold it.
Stretching arms with elastic bands
+ Three of the test persons wanted this on their chairs **(fig. 39)**.
+ One said it felt really nice to stretch her arms up in the air and to the sides **(fig. 40)**.
+ One would like handles on the side of the chair to stretch her neck **(fig. 41)**.
+ Three of the test persons usually stretch their arms during the day **(fig. 42)**.
- One has problem with lifting his arms, but if he could pull the bands instead of pushing them, he would use it.
- One said it has to be easy to access for her to use them.

Stretching out legs
+ One thought it was very nice to be able to do this during the day, because of her hip problems **(fig. 43)**.
- One thought it was nice, but thought it might be too straining to do **(fig. 43)**.
- One had too weak muscles to do this.
- For one person it didn’t work at all because of her problems, but she usually squats sometimes during the day to stretch **(fig. 44)**.

Foot rolling
+ One liked to roll his feet, especially if it would have bumps for massaging, because he has bad blood circulation in his feet **(fig. 45)**.
+ One liked to have her feet on something, but wasn’t sure about the rolling.
+ One thought it would be a nice thing for her feet if it would be attached to the chair, otherwise she would forget to use it.
- One was told not to stand with one foot up because of her pelvic and hip problems.

One leg up
+ Three test persons liked to put their knee on something to stretch the front thigh muscles and hips **(fig. 46)**.
+ Two usually do this on a couch or chair during the day.
+ One likes to stand like that while talking to people, to get some relief.
- One was not able to test this, and one shouldn’t stand like this for long because of her hip and pelvic.
- One said it was important to stretch like this when you have hip and back problems **(fig. 47)**.
Sitting backwards with extra padding under the butt
+ Three of the test persons prefer the extra padding under their butts over no padding, so that the trunk-to-thigh angle gets bigger which feels better (fig. 48).
  o One felt that it didn’t make any difference with the extra padding.
+ One liked it because it gave full relief on his legs in this position and because he got more support while leaning forward than he does when sitting straight (fig. 49).
- One had problems getting into this position because of stiff legs.
- One liked the extra padding, but felt a little trapped when sitting backwards (fig. 50).

Modular seat
+ Three of the test persons liked the idea so they are able to choose a seat that fits their body.
+ One would like to be able to change the seat over time because she is learn-

3.10.3 Conclusion
- The solution should have lower back support when standsitting.
- The solution should have stomach and elbow support when leaning against the desk, but the depth of the elbow support needs to be studied.
- In the solution it should be possible to lean backwards on the furniture, but it should be easy to make the adjustments.
- All test persons would like to be able to stretch their arms during the day, but stretching their legs felt a little straining.
- If the solution will include some kind of tool for feet movement, it should be attached to the furniture and easy to use.
- The solution could have the possibility to stretch out the front thigh muscles by putting one knee on the furniture.
- All test persons would like to be able to put together a seat that fits their body and needs.
- Adding extra padding, or be able to tilt the seat so it follows the angle of the thighs was preferred by all test persons.
By giving the foot mat an angle, the feet will be in a better position and angle both standing and sitting.

It will also give the possibility to create a concave shape where the user can put their foot to fold the mat in and out without bending.

To get away from the traditional “chair expression”, sketches were done in a free shape without too much thought. To get inspiration to create more sculptural design.
3.11.3 Clay models

After the free form sketching, clay was used to continue the process and create shapes that are not necessarily associated with chairs, but more sculptural. The shape was in focus, not the function.

One shape was chosen to work further on to see what kind of positions are possible. It is a sculptural shape that also offers different functions.

3.11.4 Sketches - Concept

To give the furniture more functions, the seat and the back rest should be divided into two pieces that can be adjusted according to each other.

If the seat can slide back and forth and the back can be turned around, the user can choose if he wants to use the saddle seat or the straight seat with back support.

Since the back rest is attached to the side, it should be easy for the user to get into the backwards sitting position. Instead of having a pole in the middle that needs to be “climbed” around to reach this position, the user can slide in from the side. The back rest should also be able to adjust up and down.
3.12 User test 3 - Principles

3.12.1 Description

When: 02.04.2013
Where: Mid Sweden University
Who:

Esther, 40
• Two herniated discs
• Problems with the pelvic
• Experiences cramps and pain

Kristina, 49
• Hip replacement
• Back problems

Gunilla, 60
• Nerve damage in hand and arm
• Arthritis

Åke 1, 70
• Stroke
• Reduced function in right side
• Pain in legs and thighs

What: Testing different principles. Different heights, and shapes of backrest, different shapes of seats, different angles of foot support etc.

How: The test persons tested different support parts by trying three or more models with the same basic shape and function, but with small variations. The test persons were asked to compare the different versions and range them.

Foot support while leaning towards the wall

Foot support with three different angles were tested. One flat, one with a 12 degree angle and one with a 17 degree angle.

Foot support while sitting

The same foot support models were tested when they were sitting and the support was put on top of the wheels of the chair.

Shape of seat

Seats with three different widths of the saddle shape was tested. A seat that can be bent in different angles was also tested.
Length of back rests and stomach support

Two different lengths of back rest and stomach support were tested. One side had a harder padding, while the other side had a thicker and softer padding. The test persons each chose which side they wanted to test.

Placement of arm support

When the test persons tested the stomach support while leaning towards the desk, they also were asked where they would like to place the arm support if they wanted any.

Shape of back rest

The test persons were shown different shapes made from foam and other materials, and were asked to try different parts attached to the back rest to design the shape they felt was most comfortable and gave the best support for their bodies.
3.12.2 Results

Length between the feet and the wall
+ They all preferred around 20 cm from the wall to their heels (fig. 51).

Foot support while leaning towards the wall
+ They all preferred the soft mat over no mat (fig. 52).
+ All, but one preferred some angle on the support (fig. 53).
+ Two preferred the bigger angle because their feet were in a good angle and they got some relief on their legs.
+ One preferred the smaller angle because the bigger one was too much for her.

Foot support while sitting on the chair
+ One preferred the smaller angle over the others, but she liked it better without because she likes to stretch one of her legs (fig. 54-55).
+ Two preferred the bigger angle because their knees and feet were in an angle that felt comfortable for them (fig. 56).
  o One didn’t test this.

Shape of seat
+ They all preferred the seat with the smallest width over the other models and the existing Capisco chair (fig. 57).
+ They didn’t feel any pain or pressure on the inside of their thighs, which they did when the width was bigger.

Seat with an angle
  o One preferred the seat when it had an angle of about 100 degrees because it gave support to her legs and felt soft (fig. 58).
  o One would like it to go all the way down to her ankles to get enough support (fig. 59).
  + If it was in a small angle; 90-110 degrees, it didn’t bother any of the test persons.
Length of back rest
+ Three preferred the longer back rest because it gave good support and they didn’t feel the edge of it (fig. 60).
+ For one it didn’t matter.
  o One preferred to place the seat a little higher so it supports his upper back (fig. 61).
+ One liked that it stopped right under her shoulder blades so she could lean back and stretch out.

Length of stomach support
+ For two it didn’t matter about the length.
  o Two preferred the shorter one because they felt it gave more support than the longer one (fig. 62).
+ One felt like he could stand much longer while leaning towards the support than without, because he could stand without holding on to the table (fig. 63).
+ It gave some relief on the back and the legs.

Placement of arm support
+ Two preferred the arm support to be a little forward tilted, so it follows the angle of the under arms (fig. 64).
  o Two didn’t want arm support at all, because they liked to have the arms free.

Shape of back rest
+ They all liked some kind of lower back support, but in different sizes and shapes, because it gave nice support for their backs (fig. 65-66).
+ They all liked the support on each side of the spine because it gives support for the back and some relief to the upper back (fig. 67).
  - One would like different support for different positions; lower back support when forward tilted and switching between a flat back rest and support on each side of the spine when sitting straight or reclining.
3.12.3 Conclusion

- The foot support should start about 20 cm out from the back rest.
- They all preferred some angle on the foot support.
- The foot support should be able to not be used while sitting.
- If the solution has a saddle seat, it should be narrow in front, about 11 cm.
- If the solution has a seat with an angle, the angle should be small 90-110 degrees, or adjustable.
- The length of the back rest should be around 45 cm and it should be adjustable in height.
- The stomach support should give enough support for the whole stomach/chest.
- If the solution has arm rests while leaning towards the desk, it should tilt forward.
- The solution should have adjustable support on the back rest - either when purchased or as a function.
- The back rest should give support at the lower back and on each side of the spine.
A furniture that offers five different positions;

1: Sitting with a normal, deep seat with back support
2: Sitting in a saddle position with back support
3: Sitting backwards with stomach support, on saddle or normal seat
4: Leaning backwards with back support while standing
5: Leaning forwards with stomach support while standing

By narrowing the backrest on the top, it can give some arm support. Arm rests could also be added to give arm support, but they should be foldable or slide back and forth to make every position possible.

By having a hole in the seat, the pole that is attached to the backrest can go through the seat to give back support when you sit in a saddle position. Because the width of the saddle seat is so narrow, it is possible to sit normal on the seat without having the saddle seat disturb you.

The backrest can be turned around to offer two different back supports. Since the seat continues in an angle, it gives some extra support when you lean your back towards the back of the furniture. This also offers a different position that is something between standing and standsitting.
3.14 User test 4 - Concepts
3.14.1 Description

When: 23.04.13
Where: Mid Sweden University, Sundsvall
Who:

Esther, 40
- Two herniated discs
- Problems with the pelvic
- Experiences cramps and pain

Åke 2, 51
- Herniated discs
- Hip problems

Yvonne, 53
- Sciatica
- Lumbago
- Arthritis

Gunilla, 60
- Nerve damage in hand and arm
- Arthritis

Violetta, 48
- Herniated discs
- Soft skeleton
- Painful joints

Magnus, 35
- No back or hip problems

Niklas Ö, 38
- No hip or back problems

What: Testing two concepts by trying the different functions and by testing different shapes of the back rest. Also testing different handles.

How: The test persons tested the furniture in every position and with three different back rests, and ranked them. They also tested three different seats. At the end they were asked to “build” their own seat by adding different shapes with different hardness to a basic seat, to find the combination they preferred. The test persons also tested different handles and answered to where they want to place them and how they want to make the adjustments. By turning, pushing etc.

Five positions

The model was tested in all five positions;
- Sitting with normal seat and back support
- Sitting with saddle seat and back support
- Sitting backwards with stomach support
- Leaning towards the desk with stomach support
- Leaning backwards while standing
Back rests

Three different back rests were tested that vary in height and shape. The back rests were tested in all the five positions. Both the front side and the back side of the back rest. The first one is taller than the other two and has a flat shape with extra lower back support. The second is the same as the first, but shorter. The third one has the same height as the second, but it is curved, has less lower back support, and has arm rests.

Seats

Three different seats were tested. One seat with a saddle seat on one side and a normal, straight seat on the other side. One that is similar, but with a “hole” in it. The last seat has a saddle seat on one side and a 110 degree angle on the other side.

Seat and handles

The test persons built the seat that they prefer by adding different padding and support cushion to get the right hardness and support for their bodies.

The test persons tested handles in different shapes to find the one they prefer. They also decided where they wanted the handles to be placed and how they should be distinguished from each other, for example by difference in texture, shape or symbols.
3.14.2 Results

Back rest one
Towards the back
+ The extra lower back support felt good (fig. 72).
- No one preferred this back rest in any of the positions where the back rest supports the back.
- Most of the test persons didn’t use the upper part of the back rest (fig. 73-74).
- For some the back rest was too high when leaning against it while standing, because it presses against the shoulder blades (fig. 75).

Towards the stomach
+ A few liked it against the stomach because of the height, because they could rest their chin on it (fig. 76).
+ The width was good.
- Most test persons would like some arm rest when leaning the stomach against it, when standing and sitting (fig. 77).
- For most of them this one was too high in these two positions (fig. 78).

Back rest two
Towards the back
+ This one has good height and gives good support (fig. 79).
+ It is mostly the same as the first, since no one really used the upper part of number one.
+ A few have this one as their favorite in every position.

Towards the stomach
- For a couple of them the lower back support was a little disturbing against their stomach (fig. 80).
- Most of them would like some kind of arm rests (fig. 81).
+ The width is good (fig. 82).
Back rest three
Towards the back
+ It has a good height and gives good support (fig. 83).
+ Feels good against the shoulder blades (fig. 84).
+ Feels stable because the shape follows the back.
+ Less pressure on the spine because of the curved shape (fig. 85).
+ Don’t need neck support because you can rest your arms on the arm rests (fig. 86).
+ Most of the test persons preferred this back in most positions.
- Could be some more lower back support, like the first two.

Towards the stomach
+ Give some relief for the elbows (fig. 87).
+ Feels good against the stomach/chest because of the curved shape (fig. 88).
+ Can relax the back in these positions (fig. 89).
- Would like the elbow support to be wider (fig. 90).

Seat one
Normal position
+ Most of them thought the shape felt good (fig. 91).
- A few wanted a longer seat (fig. 92).

Saddle position
+ All of them liked the wideness of the saddle nose (fig. 93).
+ It felt good, without pressing on the inside of the thighs or on the hip bones.
Seat two (hole)

**Normal position**
+ Most of them could sit like normal, with their legs straight *(fig. 94)*.
+ Most of them could cross their legs *(fig. 95)*.
+ No one felt the “hole” in the seat.
- One thought the saddle nose was disturbing *(fig. 96)*.

Seat three (angle)

**Normal position**
+ For some it wasn’t disturbing in the normal position *(fig. 97)*.
- For most it was disturbing *(fig. 98)*.

**Leaning towards**
+ For some it gave an extra support and relief *(fig. 99)*.
- For some it didn’t matter.

Free shape seat
- This was hard to test and didn’t give good results.
+ The few who managed to test this, chose extra support on the side of the thighs *(fig. 100)*.

Handles

**Shape**
- For the ones without hand problems, the shape didn’t matter.
+ All of those with hand problems wanted soft shapes with no edges *(fig. 101)*.
+ All, but one wanted quite big handles for a soft grip.
- One wanted a thinner shape for better grip.

**Placement**
+ Everyone wanted the handles to be as straight down as possible, as close to the bottom of the seat as possible *(fig. 102)*.
3.14.3 Conclusion

- If the back rest has some arm support, no one needed a higher seat than 40 cm for any positions.
- The back rest should have lower back support as in the first two back rests.
- The back rest should follow the curve of the back as in the third back rest.
- If the back rest feels good against the back, it doesn’t matter that much how it is shaped against the stomach.
- The back rest should have some wider arm support.
- The seat could be a little longer.
- It is possible to sit normally with the saddle nose in the front.
- The hole in the second seat was not a problem.
- The angle seat was not comfortable in the normal position.
- The seat could have some extra support under the sides of the thighs.
- The handles should be soft and have a little thickness to them.
- The handles should be placed straight down from the arms, so it is natural to reach them.
- The handles should have some texture to tell them apart, but not anything sharp that feels painful.

3.15 User test 5 - Final product

3.15.1 Description

**When:** 16.05.2013

**Where:** Mid Sweden University, Sundsvall

**Who:**

- Esther, 40
  - Two herniated discs
  - Problems with the pelvic
  - Experiences cramps and pain

- Åke 2, 51
  - Herniated discs
  - Hip problems

- Gunilla, 60
  - Nerve damage in hand and arm
  - Arthritis

- Yvonne, 53
  - Sciatica
  - Lumbago
  - Arthritis

- Lennart, 68
  - Blind from birth

**What:** Testing the final concept and model by using the Design for all scale (see 3.6.1).

**How:** The test persons were first asked to describe the furniture and the feelings connected to it with three words, by looking at the model and a 3D drawing. Then they were asked to judge different features of the furniture by using the Design for all scale. They were also asked about the emotional aspect connected to using the furniture.
The test model has a 200 mm lift, height adjustable back rest, sliding seat and a foot board that can be folded up and down. The model has a little different shape than the final model should have, because of some difficulties in creating the test model, but the differences should not matter for the testing.

The test persons tested two adjustment handles that had different textures and symbols to separate them from each other.

The test persons were also shown 3D renderings to see how the end result should look like. After looking at the 3D renderings and the model, they were asked to describe the product and the feelings they associate with it, with three words.

The questions the test persons were evaluating by using the Design for all scale, were:

1. How safe do you feel when sitting in the furniture?
   - If they feel any risk of falling down or a lack of support or not.
2. How does the furniture promote the image of yourself?
   - Does the visual design and function fit with their image of themselves. Ex: Is the shape and colour too controversial or too boring?
3. How is it to change the position of the foot board?
   - By using their feet without bending down.
4. How is it to grip the adjustment handle?
   - How does the shape feel in their hands? Is the texture too sharp?
5. How is it to tell the difference between the handles?
   - Is the markings and texture enough to tell the difference?
6. What is your overall opinion of the furniture?
   - About the visual design, functions and comfort.

In addition, the test persons were asked whether they feel like the furniture and the foot board look and feel like an aid or not. They were also asked to test the different positions and discuss them and to choose which ones they think they would use regularly.
3.15.2 Results
3.15.2.1 Design for all scale

Figure 103 & 104

- Yvonne, 53, sciatica and lumbago, arthritis in hands
- Åke 2, 51, herniated discs and hip problems
- Esther, 40, herniated discs and pelvic problems
- Gunilla, 60, nerve damage in hand and arm, arthritis
- Lennart, 60, blind from birth

Average of all the test persons

Figure 103:
The results from six of the questions asked during the fifth test. Each person is represented by a coloured dot to show their results on a scale from 0 to 5, where 0 is “impossible”, and 5 is the highest score; “very much” etc.

Figure 104:
The average of all the test persons is shown.
3.15.2.2 Describing the product

These are the words that were used when the test persons were asked to describe the furniture by looking at a 3D rendering and the test model. The words that are enlarged were chosen by more than one test person.

The test persons were asked to place the furniture, including the foot board, on a scale to show how they look at it. On one side is the office chair that is meant for everyone, and on the other side is the helping aid that is especially made for people with disabilities.

Neither of the test persons associated the product with a helping aid or something that is especially meant for people with disabilities. They thought it looked exciting and different, but not in a way that can be associated with a helping aid.

“What is the difference between sitting with the feet on the wheels and on the foot board?”
- Gunilla

“The chair does not stand out as a helping aid”
- Åke

“If the foot board is the same colour as the back rest and seat, it looks like it is a natural part of the chair”
- Esther

“The most important thing is that you are **happy and healthy**”
- Gunilla

“If I don’t have a chair that fits me, I get in a bad mood”
- Esther
3.15.2.3 Positions

The test persons tried the different positions and to give negative and positive feedback on them. Then they chose the different positions that they think they would use regularly. The colours represent the five different test persons.

- Comfortable position
- Good support for feet
- Good back support

- No arm rests
- Easy to slide in
- Good support for stomach
- Comfortable
- Possible to rest
- Relief on back
- Good position to watch TV
- Hard to slide in

+ Nice with feet support
+ Nice with back support
+ Relief on calves when using feet support
+ Comfortable position
- Not that useful if you don’t work in front of PC

+ Good position for stretching the arms
+ Good size on the foot board
+ Comfortable for back
- Feels like you fall backwards

+ Comfortable position
+ Relief on back
+ Good arm support
+ No problem to write in this position
+ Can use when working in the kitchen at home
3.15.3 Comments

“You can feel the difference right away”
- Yvonne

“This is perfect for stretching”
- Yvonne

“You can have a rest in this position”
- Yvonne

“I did it on the first try!”
- Lennart, blind

“The handle could be a little thinner so you get a smaller grip”
- Esther

“It is like hugging someone”
- Åke

“You can have a rest in this position”
- Yvonne

“The foot board should be made of a material that doesn’t make too much sound when you unfold it”
- Yvonne

“I would have this at home for working in the kitchen and watching TV”
- Gunilla

“I would prefer to have armrests”
- Esther
3.16 Design psychology

3.16.1 Sitting positions

Through the user studies and user tests earlier in the process, it became visible that men and women sit differently. While women often change positions and often use their legs in different ways by for example sitting on them or putting them on another chair, the men often sit straight with both their feet on the floor. One reason for that might be that men more often wear suits and formal clothing, which makes it feel inappropriate to sit on their legs in the chair. Another reason might be that their bodies are stiffer than women’s, which makes it hard for them to sit like that. Whatever the reasons are, the results are the same; according to the studies earlier in the project, the men don’t change positions as often as women, and they change between fewer positions than the women do. With this furniture, it is possible to change between different positions without sitting on your legs or putting them on top of something and without feeling inappropriate.

The saddle position has become popular over the last years, but there are some issues connected to this position. When it comes to the widest saddle chairs, some women might not feel very ladylike and comfortable when sitting with the legs so widely spread, especially if you are wearing a skirt. And if the skirt is tighter, it might not even be possible to sit in it. By having a narrower saddle seat and the option to choose between a straight seat and a saddle seat, it is not a problem if you wear a skirt to work.

3.16.2 Emotions connected to the furniture

The results from the last user test show that neither of the test persons felt that the furniture looked like an aid or something especially made for persons with back problems or other injuries. They were not worried of being stigmatized or feeling different because of the furniture or the foot board. Some said it looked exciting and different, but not in a way that makes it look like an aid. For some people it might be a sensitive topic that they need different equipment because of their conditions, but since this furniture is meant to be used by people without any back problems as well as those with, they don’t have to worry about that.

It is always important that the chair you use makes you feel secure and safe, so that you are not afraid that you will hurt yourself while using it. The last user test shows that all the test persons felt safe while using the furniture. They didn’t feel any risk of falling down or hurting themselves in any way. However, one person said that it felt a little scary to lean backwards on the back rest while standing, because he felt like he would fall backwards, but in the other positions he felt safe.

The chair you use should promote the image that you have of yourself. It should suit your personality and send the signals that matches you as a person. The results from the last user test show that all test persons felt that the furniture matched their personalities and the image they have of themselves. Both when it comes to the visual design and the functions and positions that are available.
3.17 Environmental impact
The foot base of the furniture could be made of 100% recycled aluminium. As well as the back profile. The seat and back could be made of PUR foam and the plastic parts could be made by 100% recycled PP.

HÅG Capisco 8106, which was tested in this project, has a total amount of 36 kg CO2 emission, if the chair is used for 15 years (CO2-Kalkulator, HÅG website). The furniture developed in this project should have the same foot base and consist of the same materials, but since the seat and back have a bigger volume, some more CO2 emission should be expected. The back profile should also require more material because it is holding up the back rest from the side, which leads to more pressure on the profile. Therefore, it should be thicker than the back profile on Capisco. The foot board also requires extra material.

However, since many of the test persons use more than one chair today because of their back problems, for example one saddle chair and one traditional chair, they may replace the two chairs with one. Since the furniture offers more positions than regular office chairs, it might reduce the number of chairs needed for persons with back problems.

Removable covers on seat and back rest may give the furniture longer lifetime because it is possible to change it if it becomes worn out or if the user becomes tired of the fabric or colour. It is also easier to keep clean that way.

3.18 Material and colours
The furniture should fit in with HÅG’s existing product line, so it should be available in the same colours and materials as their other chairs.

To show a selection of the colours, renderings have been made with three of the colours that are available;

The furniture should be available in bright, energetic colours, as well as more neutral, discreet colours to suit all kinds of personalities.

The foot base should be available in black or silver-lacquered aluminium. The foot board should be available in the same colour as the seat and back, or the same colour as the foot base.
3.19 Final product

Optional foot board

Different textures on the bottom side and a symbol on the top of the adjustment handle to separate them from each other.

Different colours to underline the difference.

A narrow saddle nose to reduce pressure on the inside of the thighs.

Different colours to underline the difference.

Standing position, leaning towards the back of the back rest.

Saddle position with foot board unfolded

Turning seat for different positions
3.19 Final product - Functions

The furniture is available with different lift heights

Turning seat

Height adjustments

Optional foot board

Soft material for cushioning for your feet

Texture for anti skid

Tilt function

Sliding seat

Optional arm rests

Height adjustment for back rest
3.19 Final product - Positions
Here are some of the positions that are possible with the furniture. In sitting, standsitting and standing, one can choose to sit forward with support in the back, or to sit backwards with support on the front. It is also possible to choose whether one wants to use the foot board or not in the different positions.
4. Conclusion

The furniture felt safe and secure for all the test persons, and they felt that it promotes the image of themselves. None of the test persons felt that it looked like an aid, not even the foot board, and they had no worries of being stigmatized or anything like that.

They were all able to flip the foot board without bending, the only concern for some were that it should be made of some material that doesn’t make too much sound when flipping it down on the floor.

The handles had good grips and no sharp edges, but one person wanted a thinner handle to get a more closed grip. Because some persons with hand problems like arthritis prefer a bigger grip, while others prefer smaller, the handles could be made a little thinner to find the average, or there could be two sizes available when you buy the furniture. The texture and the symbols were clear for all the test persons.

Only one of the test persons wanted arm rests in the furniture. The back rest has a shape that allows you to rest your arms in some of the positions, but not in all. Arm rests should be available as an option, but they should be foldable or sliding somehow so they don’t interfere with the different positions.

Even though blind were not part of the target group from the beginning, the last user test showed that they are also included. The blind test person had no problems with getting into the different positions, flipping the foot board and telling the difference between the handles.

Not all test persons would use all the positions, but all of them would use four or more, and all the positions would be used by at least three of the five test persons. This shows that there is a need for such a furniture and the possibility to change between more positions than what is common in a traditional office chair. Sitting normally with a straight edge and standing while leaning forward would be used by all test persons.

Even though the furniture is meant to be used in the office, some of the test persons saw other places where it can be used. For example when working in the kitchen, one would like to stand while leaning forward on the back rest. Some others wanted to use it while watching TV at home. So even though it was primarily developed for office use, it has a value in other places too, like the home.

5. Discussion

One of the most important things in the Design for all approach is to include the users in the development. For each test there were between 4 and 7 test persons, mainly with back and hip problems, but also persons with arthritis, blind people and healthy people participated in the user tests. The more test persons that participate, the more accurate the results are. Especially in the final test, more people should participate from each user group. There was only one blind person, so to get a more accurate result, more people from this group should be included, as well as a group of healthy persons without any back problems.

It is important to choose test persons with different backgrounds to get an accurate result. The test persons chosen in this project have different backgrounds when it comes to health, but they all had the same nationality. For further tests, persons from different nationalities should participate.

There should also be made a proper prototype to test. The furniture had height adjustments, sliding seat, height adjustable back rest and foldable foot board. These functions were enough to test all the positions separately, but they were not able to make the adjustments for each position the way it is supposed to be done. So this part of the functions were not tested. The seat and the back rest had a little different shape than the final product, but it should not affect the physical feeling of the furniture, but it might affect the emotional feeling of it.

Even though the last user test shows that the furniture was well received by the users with different back problems etc., it is also meant for those without any, for preventing damage to their bodies. One concern connected to this user group is to make them understand the need to move their bodies and to make sure that the functions will be used. In further development this should be taken into consideration.
6. References


All pictures and illustrations are made by Linda Falang