DEVELOPMENT OF FURNITURE FOR SKÖVDE CULTURAL CENTRE

Bachelor Degree Project in Product Design Engineering G2E
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Abstract

Skövde Kulturhus is a cultural centre in Skövde that have been remodelled to incorporate new areas and to improve the old ones. The centre has different locals where different activities can be performed such as watching movies and theatre plays, dance, etc. In the art gallery, one of the new areas is the workshop, and for this, new furniture is needed. During the project, a set of a table and chairs have been developed for the workshop, following some specifications, set by the personnel of the Cultural Centre and by the conclusion from the different investigations.

This report covers the whole process from the different researches to the evaluation and the development of the final concepts; it follows a modification of the Cyclic Strategy Method process, which includes the research and different design tools to create the concepts, as morphological chart, braindrawing and a study of the form. User studies have been made to get a good understanding of the way a person uses this furniture using surveys; ergonomics research has been made to design furniture for all kind of people; and market research have been made to discovered what kind of furniture is usually used. All these researches have been investigated to create the optimal table and chair for the activities done at the Centre. The final solutions, which have been evaluated against other concepts, are a wooden table, whose design and modular form permits to join other tables to work in teams; and a wooden chair, which have been designed for different people size. Both would fulfil the requirements and fit in the new cultural centre.
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1. Introduction

1.1. Organisational environment

The Community Cultural Centre of Skövde is the largest cultural centre in Eastern Västra Götaland. Its location is near central Skövde, in front of the bus and train station and belongs to the Municipality of Skövde.

The building includes an art gallery, a workshop, a theatre, a library, a cinema, a ballroom, several cafés, and a restaurant.

The building (Figure 1.1) was built and designed by architect Hans-Erland Heineman and was inaugurated in 1964. The first remodelling was between 1993 and 1995, adding the new art gallery (Västsverige, n.d.). During the spring of 2013, a second remodelling is taking place, where some rooms will be improved to give a better reception to the visitors.

![Figure 1.1. Cultural Centre of Skövde](image)

1.2. Purpose

The purpose of the project consists of developing furniture for the Cultural Centre in Skövde, specifically for the workshop; an additional value would be if the workshop furniture could be adapted for a new area inside the art gallery, the lounge area. The furniture that will be developed is tables and chairs.

1.3. Problem definition

At the moment, some rooms inside the cultural centre are under construction but the area that this project will focus on will be only the workshop and the art gallery. These are two of the most visited areas in the building which needed an improvement since a long time ago, due to the design of the interior. In the case of the furniture and illumination of the art gallery, it was
not appropriate to perform activities as handcraft or contemplation of the art. The work team and the management decided to renovate the locals, furniture and installations.

To renovate the rooms and change the old style for a new one, the furniture has to be renovated as well, needing a new design for it that fulfils the management’s specifications. When a construction of this magnitude starts, it is important from the beginning to realise how the furniture is going to interact with the environment and with the users. Other main reason for remodelling the furniture is the bad condition of it; the furniture should be seen as new and innovative products as the place where it will be placed. The task to solve the problem was to develop furniture for the workshop that can be used as well in the art gallery.

The product should be designed for all kind of people, from kids to elder people; for this reason, it has to be light, to be easily moved every time the furniture has to be placed in other room. In addition, the furniture should be made using materials from the region and materials that are not harmful for the environment. The furniture should be easy to manufacture with a low cost and it should be possible to be placed into the workshop and into the lounge room, without losing its functionality. The first requirements are also explained in detail at the beginning of Chapter 2.7.

1.4. Structure of the report

The report is divided into seven parts: introduction, research, concept generation, final concept, result, discussion and conclusions, and recommendations.

The Introduction explains the topic of the project, the problems and the company/centre that the project is done in collaboration with. The Research includes the investigations made for the project about literature, market, users and ergonomics, which gives information about the methods, processes and steps to follow for the entire project. The specifications are also written and explained.

The third point, Concept generation, is where the methods (description and results) that have been used are explained as well as the concepts generated from those methods. On Final concept and Result, the concept that has been chosen is developed, with the explanation of how the process has been done, reaching the final results.

On the last chapters, a discussion section is made with some recommendations in case of further development.

2. Pre-study

2.1. Cyclic strategy Method

The research starts finding a methodology which will help to structure the process, allowing reaching the goals of the project. The design process that was used is called Cyclic Strategy Method (Jones, 1992) (Figure 2.1), whose guidelines suit the project. The purpose of this method is to work with linear stages, where the next stage is always started when the previous one is finished, with the possibility to return if the result is not satisfying; but a modification has been done to the method to adapt it to this project (Figure 2.2). The method
is also explained in detail in Figure 2.3, and this makes the method less simple than the original. The method and its modification are explained in the following paragraphs.

![Figure 2.1. Cyclic Strategy Method](image)

The method started with a literature research and a meeting with the company; in this case, with the Cultural Centre. In this part, the modification that was necessary to implement the method, because the literature research and the meeting were not linear stages, and they needed to be done simultaneously.

![Figure 2.2. Cyclic Strategy Method Modification](image)

For *Literature review*, an investigation was made about results of ergonomics studies about the creation of tables and chairs by different designers and engineers. An investigation about the users (Chapter 2.4) and ergonomics (Chapter 2.7) were complemented with the meeting
with the Cultural Centre, to clarify the roles of the different users. After finishing with the user part, the process moved forward to specify the first requirements and the demands and desires from the personnel of the Centre.

The market research (Chapter 2.5) followed in the process, which contains research about furniture of different contexts, similar to the Cultural Centre and existing furniture on the market that were suitable in those places. This investigation also covered the materials that normally were used on the furniture that will be developed in the future.

The design methods process was the next step to carry through, where different methods were used to generate ideas and obtain several drawings and sketches, which leaded to several concepts. Braindrawing and morphological chart were some of the used methods.

On the classification step, a discussion was made with the company where the concepts were shown to decide if any of them achieved set goals and could be developed until the end. If the conclusion of the discussion was negative and none of the concepts was suitable, a new strategy needed to be followed by going back to the design method process, and generate more concepts.

When one concept was accepted for all the parts, the next step of the process was to start developing that concept and obtain the final result.

Figure 2.3. Detailed Cyclic Strategy Method Modification
2.2. Background

The literature review covers different studies made by design engineers and anthropometry experts about how the ergonomics affect the design of chairs and tables; these obtained factors will be applied to the concepts and final designs of this project.

*The chair*

Helander (2003) determines that users cannot perceive small details in the design of a chair; they focus on the aesthetic aspect only. He defines comfort as “based on aesthetics and plushness of chair design and a sense of relaxation and relief” (2003, p.1315); therefore, he considers in his studies that the comfort is more important than biomechanics or ergonomics.

In spite of this, there are some important data that Helander (2003) cannot ignore. This includes avoiding the sharp edge that cut off the blood circulation of the legs, an appropriate back with 110 or 120 degrees of inclination, and a cushioned seat that distributes the pressure optimally (Figure 2.4).

According to Cranz (1998), there are some criteria about how a chair should and should not be designed, and this agrees with some data described by Helander:

- The seat should not be too high, see also Åkerblom (1948); for men, the appropriate height is 46 centimetres from the ground, and the knees should be lower than the hip instead of the opposite, Figure 2.4.

- The front rail of the seat must be curved to avoid cutting into the flesh under the knee, Figure 2.4.

- The dimensions of the seat should be 43 centimetres of depth and 43 centimetres of width, Figure 2.4.

- The weight of the body has to be distributed through the bones, and not the flesh, Figure 2.4.

- There should always be a space between the seat and the lower part of the back, Figure 2.4.

Cranz also discusses the possibility of not including a back support, leaving the debate without any clear answer.

Floyd and Roberts (1958) describe other characteristics or recommendations which would benefit the users and improve the design:

- It is important that the chair allows free movement to change the posture.

- A very short person should be able to sit correctly on the chair; the height of the seat should not be more than the distance from the popliteal to the floor, but the height has to be changed to fit tall people. Therefore, the chair should have two different heights.
• A back with a 5 degrees slope would be a good angle for users to change the posture and make different activities, and a plane seat is preferable with an inclined back.

![Chair Diagram]

*Figure 2.4. Conditions of a chair according to Cranz and Helander.*

**The table**

Floyd and Roberts (1958) determine that the vertical distance between the floor and the surface under the table, where the legs are placed, should allow the upper part of the knees and the thighs to access easily, without crashing with the table; hence, the distance from the table to the chair seat should be larger than the thickness of thighs. The horizontal distance underneath the table should not have any obstruction, allowing free movement of the knees.

Besides, the height of the user’s elbow should be positioned at the same level as the table height for a better relation between both heights: for a given arm position, the height of the elbows when the user is seated depends on the position of his torso and the height of the surface where one is seated; thus, there is a “necessity of considering the chair and table as a single unit” (1958, p.11).

According to Neufert & Neufert (2002), the dimension working area for a standard desk in a college is 600x600 mm² just for activities as writing, listening or reading; the activities does not require more working area to be done without any restriction. In this case, the desk for the handcraft workshop is different than the one used for hard works as manufacturing or assembling. For that reason, anthropometry data and data about wheel chair people have been used to set the dimensions of the table, which will be explained further in this chapter. All these research determine that the desk should not be more than 1200x1200 mm².
2.3. Study visit at the Cultural Centre

During the visit to the Cultural Centre (Figure 2.5), the details about the project to develop were settled. It was mentioned which parts will change in the art gallery and some of the ideas about the distribution and location of the workshop and the new lounge room were discussed.

In the meeting with the manager of the art gallery and the person in charge of the workshop, some of the topics to discuss were connected with the activities to do inside those areas and what were the ideas of the crew to restyle both rooms to understand how to focus on the project. For these two places, they will need new furniture; in the case of the workshop, they will need chairs and tables; and in the art gallery, they will need sofas and coffee tables. From here, the specifications began to be written (see Chapter 2.7).

2.4. User studies

The study about the user was divided into three different parts to correctly understand the interactions between the users with furniture and environment. From a meeting with the Cultural Centre management, a shared goal was created, considering the visitors of the workshop and the art gallery. The necessity of this information was to develop true understanding of the user, to do surveys, to identify the users and to make an ergonomics research.

Two surveys were made for three different target groups, where people had to answer simple questions, explaining with their own words or choosing between options. This survey method was used because it is simple to understand and a good option to gather the necessary information. The first survey was aimed at students from the University of Skövde where
they tested furniture to answer questions about function, and design, and also identify if the product was the correct one for the activities developed in the workshop or the lounge room. The second survey was focused on the Cultural Centre, reuniting people who usually visit the museum, answering what they would improve from the existing and the old furniture; and the third group consisting of people who have never visited the place, showing the improvements that could be done to involve more people in the art gallery and in the workshop. These surveys were two because they were focused on different aspects of the project. Chapter 2.5 will show results from both surveys and will explain the information obtained about the needs and the clarification of the problems.

Knowledge about the users’ identification was acquired from the first meeting with the cultural centre crew. The user need was defined by using a diagram called Concept development: the front-end activities (Ulrich & Eppinger, 1995). As a result of the user study four different groups were defined. The primary user is the visitor who will use the furniture for a short period of time; in the workshop, the people that usually do the activities are children and teenager, and in the lounge area, most of the people are adults and elder people. The second user will be cleaning the product after being used. In the case of the workshop, this can be the same as the primary user; likewise, there will be a professional cleaner in charge of this task in the lounge room. The third user is the cultural centre crew who uses the furniture during the office hours. The side user (Janhager, 2005), who do not use the product for its primary purpose, will be in the workshop without doing any work, e.g., children’s parents.

The ergonomic study informs about the interaction between furniture and the user, -shown in the first survey- and also about the proportions of the body and how that influences the design of the furniture, seen on chapter 2.7.

2.5. Surveys

A survey is a good tool to collect the opinion from people about different issues and to obtain, at the end, useful information which will be applied to the design. Following Fink & Kosecoff’s guide (1998), two types of surveys were done, which are shown in Appendix I.

The first survey was an interview with 10 people, who tested a table (72 cm height) and a chair (44 cm height) at the University of Skövde. The purpose of the survey was to understand how a person uses the objects and what they would improve. The results showed that the chair is fine and comfortable to do handcrafts, but it should incorporate more functions. It should be lighter, using a wooden material and the seat should be as colourful as the chair used during the survey was. According to the results, electric connectors do not need be included in the table. The materials, the colour and the dimensions of the tested table are correct for handcrafts.

The second survey was another interview aimed at Swedish people who have or have not visited the Cultural Centre; fifteen people in total. The purpose of this second survey was to know what improvements in the furniture and rooms, former visitors would like to see and what would change people who have never been to the museum to motivate them to go.
The results are in Appendix II. From that information, it can be summarized that people search comfortable, attractive, stable and functional furniture with neutral colours and smooth edges for safety.

2.6. Market research

After the research about the literature, the market research took part to approach understanding about the existing products and dividing the research into three different categories: cultural centres, chairs and tables.

This part contains a few examples of how existing furniture is placed on different types of spaces as art galleries, workshops and libraries. The following pictures show some points to consider during the design process.

- Art galleries:

  ![Figure 2.6. Museum of Contemporary Art, Denver, USA](image)

  In every art gallery, it is important to show the art pieces to the visitor and three factors that helps to attract all the attention to the artworks are the lightning, the spaces and the furniture; in a few words, the interior design. Sometimes, it is important to have benches on the locals where the visitors can make a pause during the visit. In most art galleries, furniture can be integrated with the design of the wall, using the same material to keep the looks into the artworks. One example is one of the rooms of the Museum of Contemporary Art of Denver (Figure 2.6). More examples on Appendix I (Fig. 1 & 2).

- Libraries / Lounge rooms:

  A library can be considered as a different environment but in some cases (Fig. 2.7), library furniture has some points in common with lounge room furniture and this makes both environments similar. Good library furniture creates an environment to for visitors taking a pause during the visit in the art gallery or having a conversation.
with other visitors about the art. More examples can be seen on Appendix I (Fig. 3, 4 & 5).

Figure 2.7. The Arch Cultural Centre, Mandal, Norway

- Workshops:

In the workshops, people of all ages are able to attend courses where they have to create figures, decorations or any kind of hand crafts. For these activities, it is necessary to use materials and tools, so most of the time, furniture can be damaged.

As well, furniture for the workshop has to be designed for both children and adults, so the ergonomics is fundamental, as it is shown in Figure 2.8, where both are using the same furniture. Other examples of workshop are on Appendix I (Fig. 6, 7 & 8).

Figure 2.8. Cultural Centre Komedianten, Varberg, Sweden.
The chosen seats in this research (Appendix I, figs. 9 to 18) are furniture which are used inside the investigated rooms or can be fit easily in those environments. The seats (chairs, armchairs and sofas) are made in wood, light metals and plastics, which gives light furniture. Most of them have a padding part, which gives them comfort.

The tables (Appendix I, figs. 19 to 22) in this research are focused on modularity. All of them are tables that can be put together with other similar table to create a longer table. As it is shown, the tables can be wooden or plastic, giving a sort of light aspect.

2.7. Ergonomics

The ergonomic research in the present study includes the anthropometry data of the Swedish users of the Cultural Centre (children and adults) and a method called Personas. This research complements the literature review, in chapter 2.2

Personas

A persona “consists of a description of a fictional person who represents an important customer or user group for the product, and typically presents information about demographics, behaviour, product usage, and product-related goals, tasks, attitudes, etc.” (Chapman, et al., 2008, p.1). Distinct examples of users, which are extremes inside the user population, are chosen to create the characters, often referred to as personas (Buur & Nielsen, 1995); hence, the objective is to investigate the needs of these characters, designing scenarios where the personas can interact with the furniture to obtain information about how the design must be adapted for anyone between the extremes.

Although furniture design tries to bring together most of the population (from children to adults with different statures), it is difficult to include all the different users out of the standard range; the personas have been created to include more people out of the range and to increase the percentage of people who will be able to use the furniture. The range is usually between three and seven people for this method; in the present study, three different characters have been made.

First character: Tallest male

**Wolter** is a 38-years-old father. He is 2.10 m tall and is 90 kg. His little child likes handcrafts and every week participates in the course at the Cultural Centre. He is from Sweden and he likes to spend time with his children.

*Figure 2.9. Data of the tallest male*
For Wolter, (Figure 2.9) it is sometimes arduous to find furniture which he can feel comfortable with. The main problem for him is the dimensions of the table and the chair; they are usually standard and he is over the standard dimension.

This problem is related with the height of the chair: if the chair is too low for him, the knees will be over the seat, and this is not a good posture.

The problem is also related to the height of the table: if the table is too low for him, the posture of his spine will change, and he will not be able to sit close to table, seen in Figure 2.10.

![Correct height for the table](Image)

*Figure 2.10. Correct and incorrect height for the tallest male*

**Second character: Shortest female**

For children like Tina (Figure 2.11), the height of the table is very important; children stand up to reach objects on the table, and this makes the chair useless and dangerous.

![Tina's height](Image)

*Tina* is a 7-years-old child. Her weight is 36 kg and she is 1.17 m tall. She is starting the handicrafts course. She is mischievous and she is never quiet.

*Figure 2.11. Data of smallest female*

In this case, if the chair is too high for Tina, she will be forced to use the chair in an incorrect way and her feet will not reach the floor.
Figure 2.12 shows how the child is sitting on the edge of the chair to be able, to reach the object on the table; however, the edge of the seat will be painful for her thighs.

One possible solution to the problem is to add a stretcher or a spindle on the chair in the correct height, and short users will be able to relax their feet on it and the chair will still be suitable for tall people.

![Diagram showing problems of chair height with a short person](image)

Figure 2.12. Problems of chair height with a short person

**Third character: Boy in a wheel chair**

Bran is a 14 year old boy. He uses a wheel chair because he has a problem with his hips.

**Bran** is a 14-years-old teenager who likes to make all kind of handicrafts and his passion is music. He is 1.68 m tall and his weight is 67 kg. He has been using a wheel chair for 8 years and he is used to using it. He also practices basketball. He is a very active child and most of the time does not need help to do his activities.

![Diagram showing data of the boy in a wheel chair and his mobility](image)

Figure 2.13. Data of the boy in a wheel chair and his mobility
The distances that Bran can reach depend on two different postures: the first posture is sitting upright, reaching a close area (yellow area in Figure 2.13); and the second posture is leaning forwards, reaching a larger area on the table (red area in Figure 2.13).

It is important to integrate functionality to allow the chair to fit under the table; moreover, the arms of the chair should not touch the edge of the table, shown in figure 2.14.

![Chair and table diagram](image)

*Figure 2.14. Height of the table for a user with a wheel chair*

**Anthropometry Data**

Peebles and Norris (1998) and Norris and Wilson (1995) have collected anthropometric data from different sources of children and adults from diverse countries. The selected data was the thigh height (measurement of the thigh), the popliteal height (distance from the ground to the back of the knee with the user seated) and the underside of the elbow height (distance from the seat to the elbow with the user’s forearm parallel to the floor).

For these measurements, some nationalities were chosen facing the impossibility of finding all data for the Swedish population. Norwegian (Waaler, 1983), British (Pheasant, 1986), Dutch (Steenbekkers, 1993) and Swedish (Werner, 2007) data for children was chosen; the Dutch data was finally deleted for being out of proportion with Swedish data. For adult data, only Swedish data was needed. (Pheasant, 1996).

The acquired data was useful for doing analyses of the Swedish population and to create some graphics and tables. This information shows the measurements of the popliteal height and the thigh height for men and women of different ages; every age has the mean value and two percentiles values (5% and 95%), which forms a confidence interval that includes most of the inhabitants of Sweden (Table 2.1).
Table 2.1. Anthropometric data for Swedish population (measurements in millimetres)

<table>
<thead>
<tr>
<th></th>
<th>Popliteal Heigh</th>
<th>Thigh Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>5%</td>
</tr>
<tr>
<td><strong>FEMALE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 years</td>
<td>310</td>
<td>275</td>
</tr>
<tr>
<td>12 years</td>
<td>385</td>
<td>345</td>
</tr>
<tr>
<td>18 years</td>
<td>405</td>
<td>365</td>
</tr>
<tr>
<td>Adult</td>
<td>400</td>
<td>350</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Popliteal Heigh</th>
<th>Thigh Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>5%</td>
</tr>
<tr>
<td><strong>MALE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 years</td>
<td>315</td>
<td>285</td>
</tr>
<tr>
<td>12 years</td>
<td>390</td>
<td>350</td>
</tr>
<tr>
<td>18 years</td>
<td>445</td>
<td>405</td>
</tr>
<tr>
<td>Adult</td>
<td>430</td>
<td>385</td>
</tr>
</tbody>
</table>

Female data are lower than male data, so the first one is useful to find the person with a low popliteal height, which is a 7 years old girl (which is the lowest age in the workshop courses). This measurement belongs to 5% percentile and is 275 mm, which determines the height of the stretcher of the chair (Figure 2.15).

Figure 2.15. Popliteal height for 7-year-old females (measurements in millimetres)
In case of the male data, it can be used to determine the height of the table (from the floor to the underside of the table), because the values are higher; it is necessary to put together both measures to choose the higher one. The chosen person is the 18 years old male, in a 95% percentile, with 485 mm of popliteal height and 185 mm of thigh height. The minimum height should be 670 mm (Figure 2.16).

![Figure 2.16. Popliteal height and thigh height for 18-year-old males (measurements in millimetres)](image)

2.8. Specification of requirements

After the first meeting with the management of the Cultural Centre (Chapter 3.1), the main specifications were selected, which are:

- Furniture should be light and easy to move.
- The material should be from the region and produce locally.
- Furniture should be able to do more than one function.
- The design must be related with the environment.
- Furniture suits all kind of people.
- Furniture will be easy to assemble and manufacture.

These specifications were updated with other specifications, which were obtained from the surveys.
Table 2.2. Table of specifications of the table

<table>
<thead>
<tr>
<th>TABLE</th>
<th>Need/Desire</th>
<th>Specification</th>
<th>Definition</th>
<th>Goal</th>
<th>Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Function</strong></td>
<td></td>
<td>Modular design</td>
<td>Groups of X tables can be made</td>
<td>3 or more</td>
<td>2 or more</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>Adjustable height</td>
<td>The table will have X different heights</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>Wheel chair access</td>
<td>A person with a wheel chair should be able to use the table correctly</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>Multifunctional</td>
<td>The table will be placed in X Workshop / Lounge room</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Production</strong></td>
<td>N</td>
<td>Design for handcrafts</td>
<td>The dimensions for the table will not exceed X metres long and X metres wide</td>
<td>0.6 x 0.60.</td>
<td>1.20 x 1.20</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>Table height</td>
<td>The height of the table should be higher than the distance from the upper thigh to the floor</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>Smooth edges</td>
<td>All the edges should be 10 mm of diameter to avoid hurting children</td>
<td>All edges are smooth</td>
<td>Visible edges are smooth</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>Friendly with the environment</td>
<td>The product should be recycled in a X%</td>
<td>100%</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>Parts replaced</td>
<td>X% of the parts of the table will be able to be replaced</td>
<td>100%</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>Made from regional materials</td>
<td>A X% of the material will be produced in the region</td>
<td>100%</td>
<td>-</td>
</tr>
<tr>
<td><strong>Assembling</strong></td>
<td>D</td>
<td>Build it by yourself</td>
<td>The product should be assembled without using tools</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>Minimum fastens pieces</td>
<td>The table has to be assembled with not more than X fasteners</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td><strong>Others</strong></td>
<td>N</td>
<td>Attractive product</td>
<td>The table must be attractive for…</td>
<td>Children and adults</td>
<td>Children</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>Easy to clean</td>
<td>The product can be cleaned with usual cleaning products</td>
<td>Yes</td>
<td>Other cleaning tools</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>Low cost</td>
<td>The table should cost less than X SEK</td>
<td>200</td>
<td>400</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>Low weight</td>
<td>The table will be able to be moved by…</td>
<td>Two children</td>
<td>One child and an adult</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>Prevent to slide</td>
<td>The material will prevent the sliding</td>
<td>Yes</td>
<td>-</td>
</tr>
</tbody>
</table>

All the requirements are explained in detail and organised into two different tables, due to the development of two different products: a table (Table 2.2) and a chair (Table 2.3).

The table is a need/desire table, quite similar to Ulrich & Eppinger’s tables of specification (1995). The requirements are divided into four groups: function, manufacture, assembling and others factors. Each group contains the requirement and its definition, order by its importance, and what are the goals (the objective to reach) and the demands (what will be enough if the objective is not reached) of each specification.
<table>
<thead>
<tr>
<th>CHAIR</th>
<th>Need/Desire</th>
<th>Specification</th>
<th>Definition</th>
<th>Goal</th>
<th>Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function</td>
<td>D</td>
<td>Adjustable height</td>
<td>The chair will have X heights</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>Multifunctional</td>
<td>The chair will be placed in X</td>
<td>Workshop / Lounge room</td>
<td>-</td>
</tr>
<tr>
<td>Production</td>
<td>N</td>
<td>Design for comfort</td>
<td>The chair has to be comfortable for a X hours of work</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>Friendly with the environment</td>
<td>The product should be recycled in a X%</td>
<td>100%</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>Edge of the seat</td>
<td>The edge of the seat has to be rounded.</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>Stretchers added</td>
<td>The stretches should be placed for the ones who do not reach the floor with their feet.</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>Smooth edges</td>
<td>All the edges should be 10 mm of diameter to avoid hurting children</td>
<td>All edges are smooth</td>
<td>Visible edges are smooth</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>Parts replaced</td>
<td>X% of the parts of the chair will be able to be replaced</td>
<td>100%</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>Made from regional materials</td>
<td>A X% of the material will be produced in the region</td>
<td>100%</td>
<td>-</td>
</tr>
<tr>
<td>Assembling</td>
<td>D</td>
<td>Build it by yourself</td>
<td>The product should be assembled without using tools</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>Minimum fastens pieces</td>
<td>The chair has to be assembled with not more than X fasteners</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>Others</td>
<td>N</td>
<td>Attractive product</td>
<td>The chair must be attractive for…</td>
<td>Children and adults</td>
<td>Children</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>Easy to clean</td>
<td>The product can be cleaned with usual cleaning products</td>
<td>Yes</td>
<td>Other cleaning tools</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>Low cost</td>
<td>The chair should cost less than X SEK</td>
<td>100</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>Low weight</td>
<td>The chair will be able to be moved by…</td>
<td>One child easily</td>
<td>One child hardly</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>Prevent to slide</td>
<td>The material will prevent the sliding</td>
<td>Yes</td>
<td>-</td>
</tr>
</tbody>
</table>
3. Concept generation

This chapter gather the technics or tools used during the project to generate ideas that inspire the creation of the final concepts. The concept generation includes a morphological chart to obtain a perspective of how many possibilities are possible for the furniture. Braindrawing and right-braining are tools which inspire to create new ideas with simple sketches. Finally, every part of the furniture was analysed to obtain all the possible solutions of how the product can be develop for complementing the data obtained from the morphological chart.

3.1. Morphological chart

Smith (2007) defines a morphological chart as “a table of functions and solutions for each function”. The morphological chart which has been used in this project is a variation of the original one; instead of a table of function with its solutions, the table consists of the different parts of the products and its solutions regarding how the parts can be designed and can interact with the others.

The chart contains all the parts that a table or a chair can include. For the chair, the parts are the seat, the back, the stretchers and the arms; and, for the table, the legs, the stretchers, the surface table and the skirt. It also contains characteristics that these parts of the furniture can have, as the padding, the apron, the shape and section, the material, the height or the number of each part; there are parts that could be not included in some concepts, and this can be seen in column Yes/No from the chart.

The parts are placed in rows and the characteristics are placed in columns with the purpose of having all the possible solutions to design the furniture.

This chart is useful to create different scenarios where, for example, the back of the chair can be of different shapes and uses, for example, how the number of legs can be placed under the seat area and how to combine the multiple solutions to reduce the number of parts, e.g., legs and arms can be the same piece.

The chart can be found on Appendix III.

Figure 3.1. Results from the Morphological Chart

The ideas on Figure 3.1 were some of the results obtained from the morphological chart. These sketches are a small selection of a thousand possibilities that can be formed. Some of them were developed further and they were developed into concepts such as the “C chair” or

José Antonio Gallego Díaz
Francisco Valerio Trujillo

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the “A chair”. They were chosen because of their shapes and the future possibilities of the design.

3.2. Braindrawing

Braindrawing is a method that consists of drawing pictures instead of using words (Gause & Weinberg, 1989). Each member of the group has a paper divided in rows (as many rows as concepts) and columns (as many columns as participants). Each person draws whatever they want about the topic; when the time is finished (about two minutes), each paper passes to the next person, who has to add another drawing, inspired by the previous sketches.

In this case, three people participated, drawing 27 ideas (nine from each paper). Two participants connected to the project and a third one, unconnected to the project, who gave the sketches a different perspective.

3.3. Right-Braining

The right-braining is a tool for design concepts using symbols as representations of the requirements (Gause & Weinberg, 1989). Eight requirements are chosen and eight symbols corresponding to each requirement are created. The symbols are put in pairs, mixing each pair of symbols, creating a new sketch. This process of combining symbols is always the same until there are only two sketches left. The method concludes when, from these last two symbols, one final concept is generated, which contains all the requirements, used as symbols. It is a tool, which allows the designer to spread his mind and search other alternatives. The tool was used to obtain both table and chair, as seen on Figure 3.2.

Figure 3.2. Results from the Right-Braining: Table (left) and Chair (right)
The selected requirements were: low weight (1), made from regional materials (2), for all kind of people (3), modular design (4), comfortable (5), safe design for kids (6), resistance (7) and easy to clean (8). The requirements were the same in each sketch, but the symbols were changed to not obtain a similar result. The symbols were: (for the table) a scale, the Swedish flag, the Earth, a jigsaw part, a pillow, a key, a rock and a cleaning product; a feather, a tree, a family, a domino part, a bed, a padlock, a hammer and a broom were the symbols for the chair.

Both chair and table were taken under consideration for the final concepts, although only the chair was developed further, which is similar to “A chair”.

3.4. Study of the form

Considering the multiples results that could be obtained from the morphological chart, a study of the form was accomplished to know about the possible shapes that each part of the furniture can acquire. All the parts were drawn independently, without taking under consideration the joining between them, except for the legs.

On the chair, the study was focused mostly on the seat, being the most important part on the chair and the one with more possibilities to have different shapes; the legs, the arms and the backs were studied too. On the table, the surfaces (Figure 3.2) were the main focus, because the legs could be taken from the study of the chair.

Figure 3.2. Surfaces for the table (Left) and Figure 3.3. Seats for the chair (Right)

The seats (Figure 3.3) have different shapes which were mentioned on the morphological chart as circular or square; and were not mentioned as cross or pentagonal. Some of the shapes have also the padding added.

There are several options for arms and backs too (Figure 3.4), but not more than the seats, due to the possibility of not including this parts in the final design. For the legs, the study focused on the different alternatives to place the legs under the seat and how many legs would be on the chair. (Figure 3.4)
There are too many possibilities to design a seat without considering other aspects. The same happens with the other parts. For the chair, this study provided some ideas to start the design, but it was not so relevant.

On the other hand, the study of the table supplied more information and several concepts were designed from this study of the form. The only part considered about the table was the top surface. The other elements of the table, such as the legs, would be placed depending on the shape of the surface.

The main characteristic about the shapes was conditioned for the requirement of having a modular table; so, the drawn shapes had the possibility of creating a bigger shape, joining the same shape together several times.

3.5. Concepts

The concepts are the final result of the creative phase where the sketches are defined and shown to the Cultural Centre for an after evaluation. They are divided into table concepts and chair concepts.

**Table Concepts**

**Concept 1. D Table**

It is a table with a d-shape surface with five legs that support it, and a stretcher that connects the legs. On Figure 3.5, the different groups are shown.
Concept 2. Double Table

The Double Table is two rectangular surfaces connected. Each surface has a tubular leg in the middle, which ends in four feet. The chair can be also put into groups, creating a bigger surface, as in Figure 3.6.
Concept 3. Ruby Table

Ruby Table consists in a sort of triangle-shape surface with three tubular legs, connected by three stretchers. Figure 3.7 shows how the table looks and how it can be connected with other tables.

![Ruby Table](image)

Figure 3.7. Ruby table

Concept 4. Tetris Table

Last table concept is the Tetris Table. It has an L-shape or J-shape surface, supported with three legs with stretchers connected to them. It is the table with more different ways to group it. The pictures are in Figure 3.8.

![Tetris Table](image)

Figure 3.8. Tetris table
Chair Concepts.

Concept 1. Bench Chair

The Bench Chair is a stool with a circular-shape seat, held by three tubular legs which are connected by a central tube. The stool allows adjustment of the height, turning the seat (shown on Figure 3.9); and the stool has a circular spindle for people who do not reach the floor with their feet.

![Bench Chair Concept](image)

Figure 3.9. "Bench" chair

Concept 2. Box Chair

The Box Chair is a small stool or bench with a rectangular seat and two foldable and rectangular legs. The chair can be folded when it is not being used, doing the storage easier. It can also be stored on top of each other, as in Figure 3.10. To carry it with a hand is easy, using the hole that the chair has.

![Box Chair Concept](image)

Figure 3.10. "Box" chair
Concept 3. A Chair

The concept 3 is the A Chair. It has four legs that, connecting in pairs on the top, create the arms. The seat surface is a rectangle. The chair has a spindle, where the user can place his feet. It can be moved using the two arms and several chairs can be put together to form a long queue of chairs. (Figure 3.11)

![A Chair](image1)

Figure 3.11. “A” chair

Concept 4. C Chair

C Chair is a cantilever chair, which consists of a seat and a structure that holds it in only one piece that allows moving it from one place to another. The chairs can be stacked in pairs, creating a cube form that allow them be stored easier. (Figure 3.12)

![C Chair](image2)

Figure 3.12. “C” chair
Concept 5. Chair Chair

The “Chair” Chair is a chair with an antique style, the common one in a house. It has four legs, which are connected with the arms and the back. The chairs could be, with some modifications in the shape of the armrest, stored one on top of the others, with a result as in Figure 3.13.

![Chair](image)

Figure 3.13. “Chair” chair

3.6. Evaluation of the concepts

All concepts were evaluated with an analysis of the specifications. The concepts were divided into two groups: tables and chairs (see Table 3.1.), and to every concept, a yes (Y) or a no (N) were assigned, depending on if the requirements were fulfilled or not. In case of the evaluation of a need, the yes is double (YY), because it is a more important requirement than a desire. Some of the spaces were not filled because they did not depend on the design of the concepts or on the type of furniture being evaluated.
### Table 3.1. Evaluation of the concepts

<table>
<thead>
<tr>
<th>SPECIFICATIONS</th>
<th>CHAIRS</th>
<th>TABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bench</td>
<td>Box</td>
</tr>
<tr>
<td>Modular design</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Adjustable height</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Wheel chair access</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Multifunctional</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>D. for comfort //</td>
<td>YY</td>
<td>N</td>
</tr>
<tr>
<td>D. for handcrafts</td>
<td>YY</td>
<td>N</td>
</tr>
<tr>
<td>Table height</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Edge of the seat</td>
<td>YY</td>
<td>YY</td>
</tr>
<tr>
<td>Stretchers added</td>
<td>YY</td>
<td>N</td>
</tr>
<tr>
<td>Smooth edges</td>
<td>N</td>
<td>YY</td>
</tr>
<tr>
<td>Environ-Friendly¹</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Parts replaced</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Regional materials</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Build it yourself</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Minimum fasteners</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Attractive</td>
<td>YY</td>
<td>N</td>
</tr>
<tr>
<td>Easy to clean</td>
<td>YY</td>
<td>YY</td>
</tr>
<tr>
<td>Low cost</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Low weight</td>
<td>N</td>
<td>YY</td>
</tr>
<tr>
<td>Prevent to slide</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>9</td>
</tr>
</tbody>
</table>
The environ-friendly part was voted thinking about the waste of material got involved when the different pieces are being made.

The concepts with most “Yes” were the “A chair” in the group of chairs and the “Tetris table” in the group of tables. This makes both concepts the chosen ones to be developed further.

4. Final concept

Once the two final concepts were chosen, they were further developed, identifying the materials, calculating the structure and the costs and analysing the production and assembling.

4.1. Materials

The material choice is connected to the requirements. The table and the chair should be environmentally friendly and they should also be produced in Sweden, close to Skövde. Considering those terms, wood is the best option because it is a natural and very abundant material.

The most common types of tree in Sweden are birch, beech, aspen, oak and ash in the Southern part of the country; and pine and spruce in the North (Sveaskog, 2013). All the different species of each tree was evaluated by all their characteristics and by their availability in Sweden. Then, they were classified by their density (Zanne, et al., 2009) because furniture has to be light; and by their bending stress. Some woods can be treated by multiple processes that change their colour and some of their properties: heat treatment (Wood of Sweden, n.d.), and stained and lacquered treatments (Martela, 2013a &b).

The chosen material was the (Silver or European) birch, which is a hardwood, for both table and chair. It is a material commonly used for furniture manufacturing. Its properties, which fulfil some requirements, are (Wood for good, 2013) (Trada, 2008) (Finnforest, 2011):

- Strong, rigid and with high-impact resistance.
- Smooth, hard and durable surface.
- Attractive decorative appearance.
- Easy to machine and fasten with conventional tools.
- Treatability moderately easy (glued, stained, polished, etc.).
- Low price.
- Environmentally friendly.

4.2. Manufacturing

The manufacturing process of the chair is established in two parts: the first one to obtain small pieces of wood from sheets using machines to cut the pieces and the second one is a handmade process to join the two half parts of the legs to make one part.
To manufacture the chair, a sheet of the birch plywood is cut with a power saw. The leg parts could be cut by half for the dimensions. Then, both leg parts would be glued to form a whole piece; other method to do them would be making a whole leg from a sheet, but this would waste more material. The seat is obtained with correct dimensions, set in the drawings, by the same method. A sanding machine is used for the smooth edges and a drill machine to do the holes for the screws and the stretchers.

The production of the table is similar to the production of the chair. The surface is cut from a plywood birch sheet; then, the skirt or the support of the table is attached to the surface with screws at the manufacturing company. This would make the assembly easier for the users. The legs are also cut from wood and its edges would be rounded.

For both cases, the screws and the anti-slip rubber are standards with a minimum cost in their production.

**DFM**

The manufacturing process of the parts is simple. The few parts are manufactured with common machines as power saws and sanding machines. The material is from the region, so obtaining the material and delivering it to the company is easy and fast.

### 4.3. Structural analysis

To calculate if the chair breaks, it is necessary to check the bending stress (\(\sigma\)) of the material. The modulus of rupture or bending stress of the plywood birch is 249 MPa (Verkasalo, E. & Heräjärvi, H., 2008). This data will allow finding the maximum weight allowed for a person to sit on the chair. To analyse the structure, it will only take a leg of the chair and half seat.

\[
\sigma = \frac{M \cdot z}{I_x}
\]

\(I_x\) is the inertia moment:

\[
I_x = \frac{b \cdot h^3}{12} = \frac{290 \cdot (25)^3}{12} = 377604.17 \text{ mm}^4
\]

\(z\) is the distance between the neutral fibre and the extreme fibres:

\(z = 12.5 \text{ mm}\)

\(M\) is the bending moment, which contains the value of the weight of the person who sits on the chair:

\[
M = \frac{\sigma \cdot I_x}{z} = \frac{249 \cdot 377604.17}{12.5} = 7521875.07 \text{ N} \cdot \text{mm}
\]

The load (\(q\)) is:

\[
M = \frac{1}{2} q \cdot l^2; \quad q = \frac{2 \cdot M}{l^2} = \frac{2 \cdot 7521875.07}{220^2} = 310 \text{ N/mm}
\]
Dividing the load by the gravity constant and multiplied by the number of legs that would support the weight, the maximum weight is approximately 127 kg.

4.4. Cost

To calculate the approximate cost of the final chair and table, data, such as the prices and the measurements of standard wooden pieces, from companies that sell wooden products, were used. The dimensions of the birch plywood sheets are 2500 mm x 1250 mm and the thickness depends on the part that will be cut off the sheet: for the seat, the thickness will be 25 mm; for the legs, the thickness will be 30 mm, and 20 mm will be the thickness for the surface table.

The number of legs taken from the sheet is 7 and one half legs will be not needed. Figure 4.2 shows the best orientation to use as much material as possible.

The parts that are showed in Figure 4.2 with color red are considered material waste and, in some of the sheets, the parts that are not included can be used for small pieces as the stretchers or the skirt. The approximate cost, according to the companies (Bygghemma, 2013), each sheet will cost between 1100 Kr and 1335 Kr, depending of the thickness.

![Figure 4.2. Distribution of the parts of the furniture in Birch plywood sheets.](image)

For the rest of the used parts on the table and the chair as the screws and anti-slip rubbers, are shown in Table 4.1.
<table>
<thead>
<tr>
<th>Item</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screw M5 x 50</td>
<td>2.49 Kr</td>
</tr>
<tr>
<td>Screw M10 x 35</td>
<td>5.72 Kr</td>
</tr>
<tr>
<td>Rubber piece for table</td>
<td>3.28 Kr*</td>
</tr>
<tr>
<td>Rubber piece for chair</td>
<td>2.28 Kr*</td>
</tr>
</tbody>
</table>

*Depending of the geometry form.

5. Result

Table

The final result of the table (Figure 5.1) was obtained by a mixture between the two concepts that fulfil most requirements, instead of developing the first one. These concepts were the “D Table” and the “Tetris Table”. The “D Table” was included in the final result because of the position of the legs, which make the table more stable; the “Tetris Table” was selected because of the possibility to create different groups of table.

The parts of each concept that were good in each requirement were included in the final concept, developing the final result, called Detris Table.

![Detris Table](image)

*Figure 5.1. Final result (Detris Table)*

The Detris table stands out by the geometrically shape like an arrow head. The table can be put together with other Detris tables in different ways, depending on the activities that are made at the workshop.
The 90° interior angle of the surface was changed, according to the requirements, to smooth edges for children safety. It was also necessary to have a part that supports the legs and keep the table more stable yet; this part is the skirt, which is under the table, assemble to the legs and avoid the use of stretchers that would interrupt the access of the wheel chair (Figure 5.2).

![Figure 5.2. Wheel chair data](image)

<table>
<thead>
<tr>
<th></th>
<th>PANTHERA</th>
<th>HANDICARE</th>
<th>INVACARE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total height</td>
<td>D</td>
<td>64-84</td>
<td>80</td>
</tr>
<tr>
<td>Backrest angle</td>
<td>J</td>
<td>20-45</td>
<td>29-42</td>
</tr>
<tr>
<td>Total Length</td>
<td>C</td>
<td>78-89</td>
<td>84-90</td>
</tr>
<tr>
<td>Seat-to-Floor Height</td>
<td>G</td>
<td>47</td>
<td>48</td>
</tr>
<tr>
<td>Arm height</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Figure 5.3. Table divided in areas

Applying ergonomics, the dimensions of the table are more than 1.20 x 0.60 m, which are the adequate measurements to do handcrafts. Nevertheless, an extra area was needed to place the tools or the material that is not being used and to not disturb the users while they work, and for these reasons, the table has this extra space which makes the table to be 1.20 x 1.20 m. (Figure 5.2).
The tables can be formed in groups as in Figure 5.4, in which a number of people could always use a work area and a close material area to avoid disturbing other people’s work. Every distribution has a purpose, depending on the activities. Some of them are “circular”, in line or “face to face”. On Figure 5.4, it is also illustrated how many people can use a certain number of tables.

![Table Groups](image)

*Figure 5.4. Number of people seated in every composition of tables*

The table has also been designed for people who use a wheel chair; the measurements of standards wheel chairs, sold in Sweden, were kept in mind for the height of the table, whose data is Figure 5.2. There is no problem with the arms of the wheel chairs because they are built nowadays to avoid that the wheel chair cannot fit under the tables. This dimension was also evaluated by the thigh height and the elbow height. The thigh height is lower than the under-surface of the table, which is 660 mm, and the table height, which is 720 mm, is good for the user to do handcrafts and support the arms.

*Chair*

The final concept chair which was developed was the “A-Chair”, which was the one that fulfilled most requirements (see Figure 5.5).

The chair is formed by simple geometric shapes; it has four legs, connected in pairs, which form the arms that are the parts where the chair can be grasped to move it.

To avoid hurting the legs, the edge of the seat is rounded on both sides, so the chair can be used in one way (front) or another (back).

For the height of the seat (405 mm), anthropometric data (Chapter 2.6) was evaluated to fit most of the users. For those ones who are below the comfort zone, a stretcher 100 mm from the floor to the stretcher was placed in the chair to support the feet for the children that cannot reach the floor with their feet. In relation with the table height (700 mm), the total height of the chair is 480 mm, having a space between the skirt from the table to the seat height of 295 to fit in all the different users from the smallest child to the tallest person and some people who use wheelchairs. The choosing of birch as the material allows the possibility to change the colour of the seat which was an important data from the survey.
Figure 5. Final result (A-Chair)

Figure 5.6 shows how the table and the chair looks together inside the Cultural Centre.

Figure 5.6. Final furniture inside one of the rooms of the Cultural Centre

5.1. Assembly

The assembly of the chair (Figure 5.7) is performed by three different kinds of pieces: one seat, two legs and four screws “5x50mm”. Firstly, the seat is screwed to one of the legs, using two screws. Then, the stretchers are placed into the holes of the leg. Finally, the second leg is screwed to the rest of the chair, following the same steps as the first leg.
The table (Figure 5.8) has four parts: the base or surface, five legs, five screws “10x35mm” and four optional rubbers. First, the base is placed face down on the floor and, then, all the legs are screwed one by one to that surface. Finally, the rubbers are put at the end of the leg to prevent the sliding and a scratching floor.

All the assembly can be done with a simple screwdriver.

\textit{DFA}

The design has been planned to reduce the time of assembly, using few parts and an easy way to assemble them. The connection between the legs and the arms of the chair helps the user to not assemble many parts.

The surface of the table has attached the skirt; thus, the unique pieces to assemble were the five legs and the anti-slip rubbers.
6. Discussion and conclusions

The objective in this project was to develop a set of a table and a chair which could be used in the new workshop, where people from all ages (mostly children) could use them to do handicrafts and other activities.

The result was the design of a table and a chair that fulfil the requirements that have been set during the meetings with the personnel of the Cultural Centre and with the different researches.

Theoretically, all or most of the requirements are being fulfilled. The chair has not an adjustable position, because the cost would be high, and the furniture is difficult to fit into the lounge area, because of the height; but these problems do not affect the project too much because these unfulfilled specifications are a minimum part of the list of requirements. A prototype would have been a good way to prove the furniture, but its production has been not possible because of lack of financial resources and time.

The investigation of the user, the market and the ergonomics has been the pillars of this project because they have taken more time than other parts and they have needed a greater amount of work; and all the designs are being focused on the result of these researches. Due to the effort that has been put on the research, all the specifications have been gathered and included in the design of the final results.

The application of the method to evaluate the concepts was improvised and it was analysed if the concepts achieved the requirements; the opinion of the personnel of the Cultural Centre would have been more rewarding for the development of the final furniture if they would have participated in the process.

7. Recommendations

For a further development, another concepts or alternative could be improved, with the application of some specifications that, nowadays, the concepts do not fulfil, such as, the furniture cannot be placed in the two different room at the Culture Centre, the table and the chair cannot change their heights, and the legs of the chair needs a special assembling process to be build, already mentioned in the Manufacturing Chapter, raising the cost in the assembling process.

Other functions could be also added to increase the value of the furniture, such as, change the colours or using plastic or textile materials for the seat. These changes could increase the attention to the furniture and to make it more attractive for the kids, but it would also increase the cost.

A prototype could be created to test if the products achieve the needs of the users; the mistakes could be also solved if there would be anyone and improve the original furniture.
References


Image References


[IS Sofa] n.d. [Image online] Available at: <http://www.designboom.com/wp-content/dbsub/118454/2013-02-19/img_1_1361280567_547_8a624f7a53c4e413e24b1e521588d.jpg> [Accessed 19 March 2013]


[+++ Table] n.d. [Image online] Available at: <http://www.designboom.com/wp-content/dbsub/371472/2013-03-14/img_10_1363273257_e_48ffc5172f58952c0f014a0d713d5f2.jpg> [Accessed 19 March 2013]
APPENDIX I

Cultural centres

*Art Galleries*

*Figure 1. Art Museum of Tampa, USA*
Figure 2. Art Museum of Umeå, Sweden

Lounge Rooms / Libraries

Figure 3. Cultural centre and media library Arthur Rimbaud, Antony, France
Figure 4. Komedianten Cultural Centre, Varberg, Sweden

Figure 5. Cultural Centre Gabriela Mistral, Santiago de Chile, Chile
Workshops

Figure 6. Ana Maria Matute Municipal Library, Madrid, Spain
Figure 7. Cultural Centre El Claustro, Alicante, Spain

Figure 8. Cultural Centre Cap Vermell, Majorca, Spain.
Seats

Figures 9 and 10. IS Sofa by Inoda & Sveje Studio
Figure 11. Sealed chair and armchair by Francois Dumas

Figure 12. Cape chair by Nendo
Figure 13. Chair 330 by Läufer & Keichel

Figure 14. Clip chair by S. Herkner

Figure 15. Superkink sofa and armchair by Osko & Deichmann
Figure 16. B Curve chair by K. Jiyoun
Figure 17. Arc chair by Yonoh Creative Studio

Figure 18. Pallares chair by Carlos Córdoba
Tables

Figures 19 & 20. +++ Table by Fraaiheid
Figure 21. Aqueous modular table by UNOAUNO Studio

Figure 22. Hexagon wild table by Coordination Berlin
APPENDIX II

Surveys

Table Survey

1. Do you think this table is appropriate to do handcrafts?
   • Yes, because…
   • No, because…
   • Other:

2. For the table, do you think the height is appropriate to do handcrafts?
   • Yes, because…
   • No
   • Other:

3. Which number of people do you recommend to work in one table?
   • One person
   • Two people
   • More than two people

4. Which parts of the chairs will you change?

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Explain with details the options that you will change.

5. Do you think the color and materials are appropriate for the activities made on this table?
   • Yes, because…
   • No, because…
   • Other:

6. Which material do you think can be better for the table?

7. Do you think the weight is suitable for a child who wants to move the table?
   • A child can move it but with difficulty
   • A child can move it easily
   • A child cannot move it
Chair Survey

1. Do you think this chair is appropriate to do handcrafts?
   • Yes, because…
   • No, because…
   • Other:

2. For the chair, do you think the height is appropriate to do handcrafts?
   • Yes, because…
   • No
   • Other:

3. Which number of seats do you recommend to do handcraft?
   • For one person
   • For two people
   • For more than two people

4. Which parts of the chairs will you change?

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Explain with details the options that you will change.

5. Do you think the color and materials are appropriate for the activities made on the chair, considering the cleanliness of the chair?
   • Yes, because…
   • No, because…
   • Other:

6. Which material do you think can be better for the chair?

7. Do you think the weight is suitable for a child who wants to move it?
   • A child can move it but with difficulty
   • A child can move it easily
   • A child cannot move it

8. If you have to use the chair for one hour, do you consider it…?
   • Comfortable
   • Uncomfortable
   • Other:

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2013-07-17
1. Have you ever been in the Cultural Centre? *If you have been in the Cultural Centre, go to Question No. 6.*
- Yes: *(25%)*
- No: *(75%)*

2. Why you had never been in the Cultural Centre?

3. What you will change from the *Kulturhus* to motive you to visit it?

4. Nowadays, they are building a new lounge in the art gallery and a new workshop. What will you suggest to make it more interesting for the visitors?
5. What kind of furniture you will like to use in those places?

If you answer No to the first question, go to Question No. 9

6. Do you consider the existing furniture is the appropriate for the art gallery and the workshop?
   All interviewed people answered “No.

7. What you will change from the furniture to improve it?
   Most of people answered the appearance, the looks, the aesthetic part, etc.

8. What kind of style would you like the furniture have?
   Modern style and Familiar style were the answer more common.

9. What functions/characteristics do you think a chair and a table should have to be in a workshop?
10. What do you think the furniture would have to have to be safer for children?

- Smooth edges
- No small holes
- No attached to the floor
- Soft
- No moving parts
- Small height
- Pillows
- Easy to use

11. Which colour would you prefer for furniture?

- Wood: (2%)
- White: (24%)
- Black: (48%)
- Brown: (15%)
- Other:
  - Blue: (11%)
### APPENDIX III

**Morphological Charts**

#### Chair

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José Antonio Gallego Díaz
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APPENDIX IV

Braindrawing
APPENDIX V

Drawings