EPS **Report**

Eco-Sustainable Fireproofing/Waterproofing Multifunctional Furniture

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Executive Summary

The team is composed of 4 students of different nationalities that worked together in the spring semester on the European Project Semester. This project offered the opportunity to meet new people, to make friends, to use each member's distinct educational background and knowledge and also to learn new things about other cultures and countries.

The project was conducted in partnership between University POLITEHNICA of Bucharest and The National Research and Development Institute for Textiles and Leather from Bucharest.

The main aim of the project is to design furniture using eco-sustainable materials. For this reason, the team decided to use leather, wood, foam and steel. The most ecological choice in terms of leather was the vegetable one. For this kind of leather, in the tanning process are used plants like tree bark or acorns. As type of wood, the team opted for walnut wood. This is a straight-grained hardwood, easy to work with. It is very strong and has good dimensional stability and shock resistance. As for the foam, the choice was High Resilience Foam because it has special comfort properties and advanced flexibility. The mechanisms and the metal structure are made of Hot-rolled steel. This type of steel is resistant and requires less heat treatment so it is therefore less expensive.

The requirements for the furniture were to make it fireproof and waterproof. These characteristics are obtained in the finishing process. The team added another advantage to this the furniture by making it also multifunctional.

The furniture is composed of a table and a set of five chairs.

The table converts into a desk due to a standard mechanism and it can also be used as a storage box. The inspiration for the design was the Romanian traditional dowry case. Other items of multifunctional furniture available on the market have been considered too.

The inspiration for the design of the chairs was a typical cubic chair. The set is made up of 5 distinct chairs. What is different about them are the legs. They are designed to fit one into another in order to save space.

The manufacturing process: The wood and leather are processed simultaneously. After both of these raw materials had gone through all the required processes, they are assembled together with the steel components. The preparation of leather implies the softening, the tanning and finishing. In this process, the rawhide is transformed into a resistant, high quality, waterproof and fireproof leather, ready to be cut in the required dimensions. The preparation of wood implies obtaining the wood panels, cutting the timbers and the wood panels in the needed dimensions, sanding, creating the joints and adding the protective coat.

The team also created a brand and a logo for this kind of furniture and made a catalog with different types of wood and various colors for the leather. These options make the product accessible and suitable for many possible clients.

The aim of the project was achieved by designing this transformable, compact and well looking piece that fulfills all the requirements.

Communication and a good management of the tasks were very important during the whole project. The team managed to break the language barrier and to organize the tasks efficiently so that the project was successfully completed.

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1. Introduction

1.1. Presentation

The team is composed of four students of different nationalities that worked together in the spring semester of the European Project Semester in Romania. This project offered the opportunity to meet new people, to make friends, to use each member's distinct educational background and knowledge and also to learn new things about other cultures and countries.

Table 1.1 presents every member of the team as they are pictured in Figure 1.1, from the left to the right.

Name	François Negrini	Ana Pascual Cascant	Mariana Mărăcineanu	Marie Bebon
Location in the picture	Left	Central left	Central right	Right
Country	France	Spain	Romania	France
University	École Nationale d'Ingénieurs de Tarbes	Universitat Politècnica de València	University Politehnica of Bucharest	École Nationale Supérieur d'Ingénieurs de Reims
Course of study	Mechanical Engineering	Industrial Design Engineering and Product Development	Industrial Design	Packaging Engineering

Table 1.1: *Team members*

Figure 1.1: *Team members*

1.2. Motivation

What motivates the team to carry out this project is the fact of being able to create a product in its entirety, from the beginning to the end. In addition, the opportunity given to participants to meet new people, from other countries, along with their cultures and different ways of working makes it even more attractive.

In particular, this project is very attractive for the team, due to the fact that it is the realization of a multifunctional piece of furniture likely to be used in any type of house.

This product presents a theoretical basis, but it is not ruled out that the field of multifunctional furniture is booming nowadays.

1.3. Problem

This piece of furniture is based on the fact that currently there are many young people (20-30 years old) who invest in their first houses or apartments (whether rented or purchased).

These people do not look for family homes, but rather small and comfortable spaces for one or two people, due to the fact that they have just started working and do not look for a family but, simply, become independent. Also, this kind of people keep in touch with friends and family, and they usually like to invite people to their homes. Therefore, they are facing a possible lack of space in their homes.

1.4. Objectives

The objectives of the current project are both general and specific.

The general objective is to create a piece of furniture that allows harmonization of space to the maximum.

The specific objectives are as follows:

1. To make sure the same piece of furniture has at least three functions.
2. To make it an eco-sustainable piece.
3. To make it waterproof and fireproof.
4. To give it a modern and careful appearance.
5. To ensure it can be customized.
6. To make it strong and with a high durability.

1.5. Requirements

Regarding the requirements, that is, the specifications or the characteristics that the system must have to comply with the objectives mentioned above, we could define the following:

1. Use natural skin with vegetable tanning.
2. Use sustainable and resistant wood.
3. Make a catalog with at least three variants of wood, and upholstery.
4. Give a polished and basic finish that fits in almost every home.
5. Occupy the minimum possible space.

2. State of the Art

The inspiration for the design came from both past and present. It is meant to be a fusion between these two, a reinterpretation of the old style.

Considering that the project was developed in Romania, the team went to the National Village Museum in Bucharest to find inspiration. The first ideas were connected with the traditional furniture as the one presented in Figure 2.1. What was inspiring was that object, the dowry chest, which can be more than a storage place. A dowry chest is a piece of furniture traditionally used to collect items, such as clothes or expensive dishes, by unmarried young women in anticipation of married life. They usually had different decorations carved or painted on them.

Figure 2.1: *Romanian traditional furniture*

Nowadays, there are several multifunctional furniture items available on the market. Some of them were used as inspiration in this project due to their smart and useful design.

In Figure 2.2 is presented a cubic black and white table with adaptable dimension and two compartments for storing objects. One side of it slides and allows the owner to access to the storage place and the possibility to increase the length of the table according to his necessities.

This table showed how helpful would be to include a storage place inside the furniture developed in this project.

Figure 2.2: *Multifunctional furniture- Table and storage unit* [1]

The mechanism used in this project to convert the table into a chair will be similar to the one used in Figure 2.3 to transform the top part of the printer storage cabinet into a support for the laptop.

Figure 2.3: *Multifunctional furniture- Printer storage cabinet and desk*[1]

In Figure 2.4 is a sofa that turns into a full 6-person dining table with seating. It was created by an Ukrainian designer, Julia Kononenko. To transform into the dining table form, the cushions detach to become comfortable stools and floor cushions. The backrest folds and transforms into an extended countertop, while the main base becomes the table platform.

Figure 2.4: *Convertible Sofa That Changes Into A Dining Table*[2]

In figure 2.5 is displayed a quite compact contemporary dining set of wooden materials. A round table with 2 crossed frame supports (a) or 4 ordinary legs (b) is finished in light brown. Underneath it are hidden four stools designed in a matching style, with a curved panel back, fitting in perfectly with the piece. Each chair is covered in black (a) or beige (b) leather.

Figure 2.5: *Space optimizing furniture: table and chair*[3]

The furniture items presented in Figures 2.4 and 2.5 suggested the idea of storing the chairs inside the table. It is a very good solution for optimizing the space.

Figure 2.6: *Dining room furniture*[3]

Figure 2.7: *Heather Brown Poppin Box Seat*[4]

The design of the chairs was inspired by the furniture items presented in figures 2.6 and 2.7. The first one is a space-saving set of dining room furniture, consisting of a small square dining table and two chairs, all made out of oak wood. When folded together, the chairs are hidden under the table creating a solid cube. The second one is a cubic seat made of MDF (Medium Density Fibreboard) that can support up to 275 pounds. It can be used also as a storage box. They inspired by their shape and the way the pieces fit one into another.

2. Project Management

This section breaks down into:

- Scope
- Time
- Cost
- Quality
- Human Resources
- Communication
- Risk
- FLAP Analysis

3.1. Scope

This tool shows what subjects are parts of the project and what are not. The scope of this project is represented as follows:

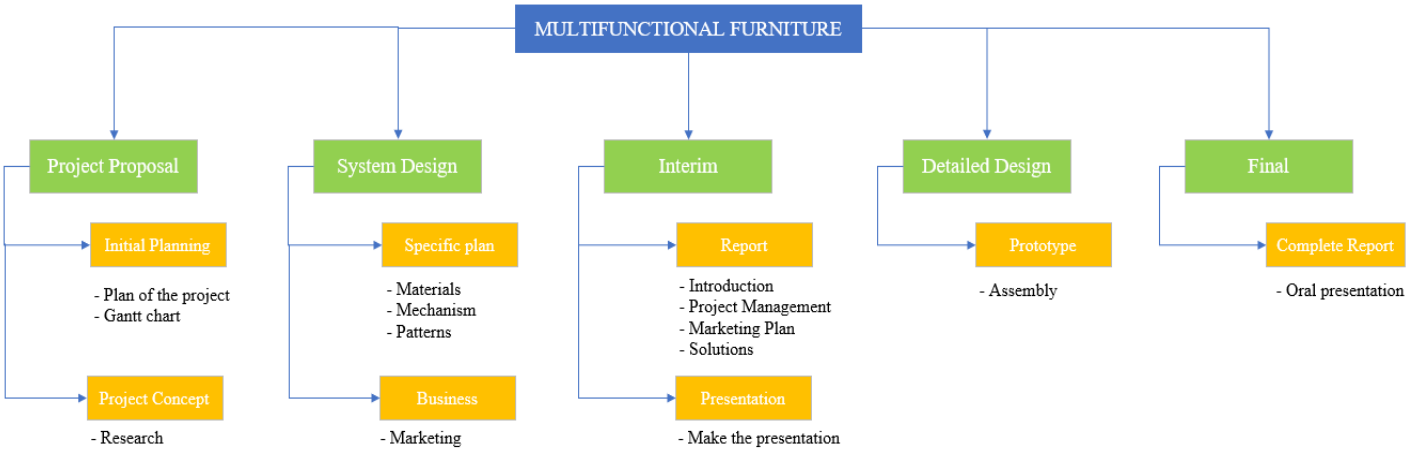


Figure 3.1: *The scope of the project*

3.2. Time

During the project, the team have deadlines and many tasks to do. It is therefore very important to manage the time of the project effectively.

One of the tools that was used was the creation of a Gantt chart. This Gantt chart allows to divide the different tasks in relation with the duration of the project.

The Gantt is available in the appendix A of this report. The duration of the EPS project is from the 19/02/2019 to the 06/06/2019. The Gantt diagram illustrates the tasks and their corresponding duration marked with a color code.

3.3. Cost

Cost management is really important in any project. There are no budgets allocated to the project. However, we had to choose materials for the furniture and we also made a prototype. The table 3.1 summarizes all the costs of the project.

Materials	**Quantity**	**Price (€)**
Walnut wood	0.125m3	620,32
Foam board	2 panels (100 X 70 X 5mm, 100 X 70 X 3mm)	4,4
Glue	1	3,83
PLA (White)	1 (1kg filament)	20,78
Spray (Wood)	1	3,57
Component		
Mechanism	2	22
Latch	4	4.48

Nickel Plated Connecting Screw	20	11.15
Steel bar	1(Ø1.3X100cm)	0.5
Fabrication		
3D Printing	1	404,81
Leather and patterns	2.5 m²	75 (30 € per m²)
Furniture assembly	1	10

Table 3.1: *The cost of the project*

Thanks to this table, the theoretical cost of our project amounts to 1180,84 € without mentioning the price of labor for the students working on the project. The division of the cost between all the different parts can be found in the diagram from figure 3.2

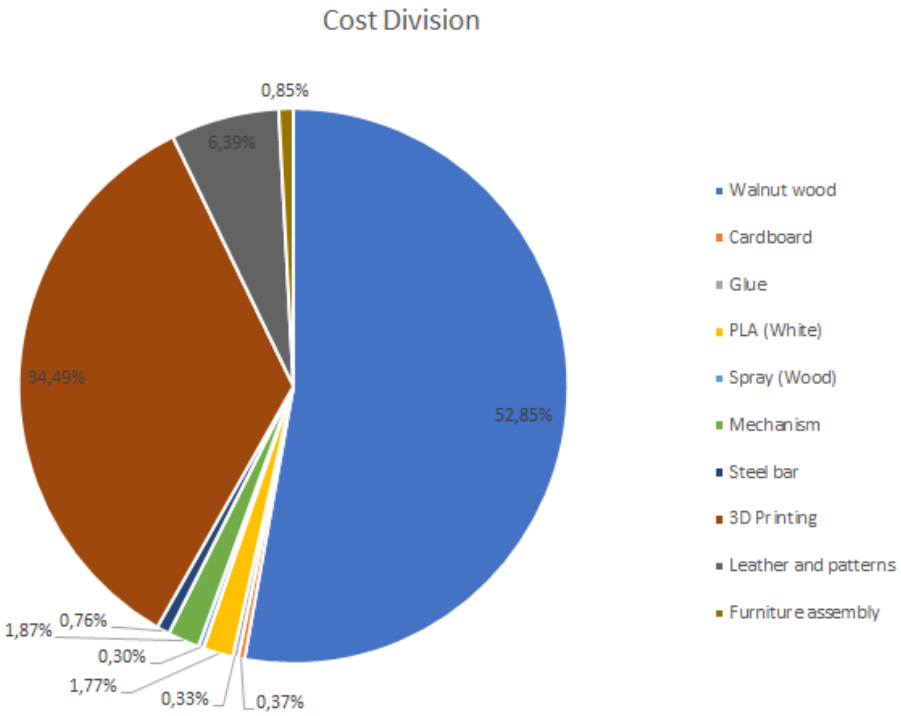


Figure 3.2: Cost division

The biggest cost is the wood, which makes sense considering the fact that it is the most used material in the manufacture of the product. Another important cost is for the 3D printing. A simulation of the cost of the 3D printing for the chairs was made after creating the pieces in CATIA and saved them as STL. Thanks to that, an idea of the price of printing each chair is given, as can be seen from the two examples in figures 3.3 and 3.4.

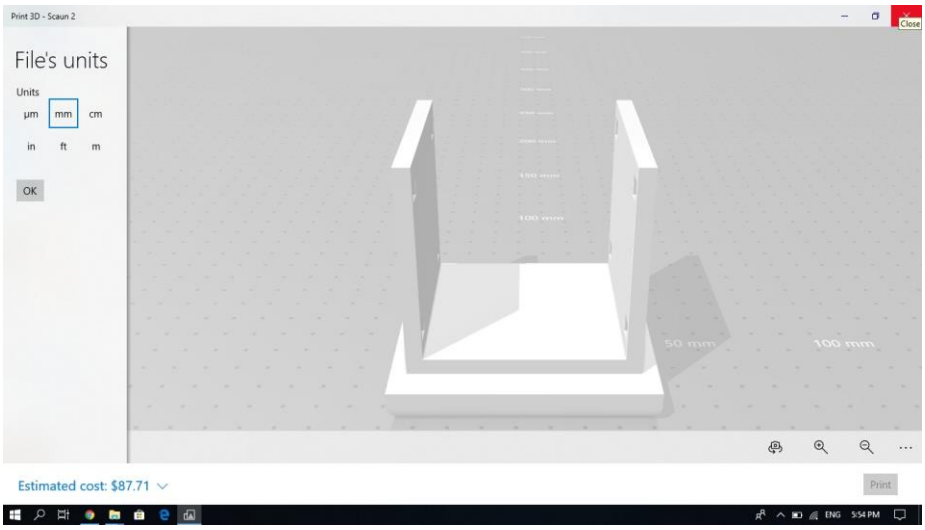


Figure 3.3: *Chair number 2. Estimated cost for 3D printing*

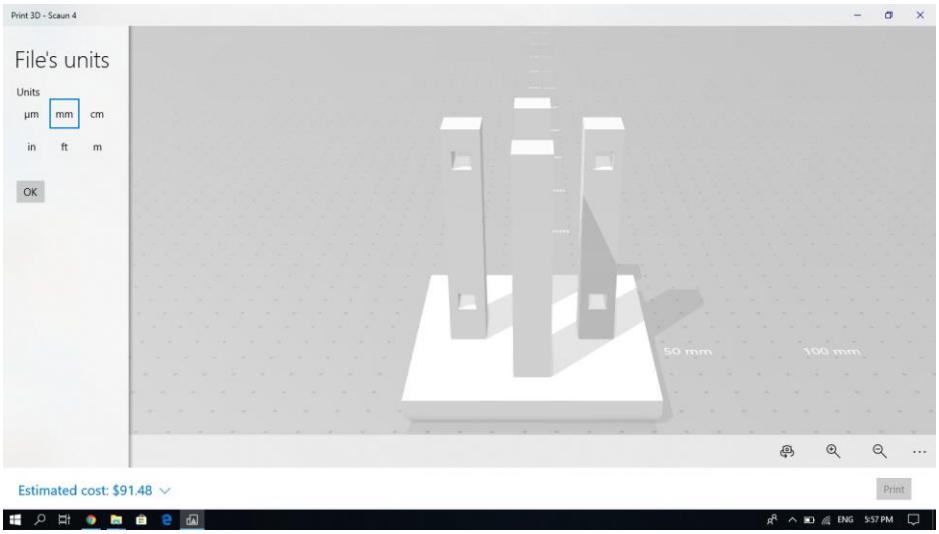


Figure 3.4: *Chair number 4. Estimated cost for 3D printing*

There is a difference of prices between these two pieces. Indeed the shape of the second one is more complicated to realize than the first one, therefore one of the reasons is the holes in the legs of the chair.

3.4. Quality

It is necessary to create a model to show the different parts of the product.

First of all, the model was made of foam board but it was difficult to have precision with this type of material. It is very important to have quality for the prototype because the different pieces of the chairs have to assemble well. In that case, the first model does not fulfill this function. Hence, it is necessary to improve the material likely to be used for this model.

The team decided to use a 3D printing technique for the second prototype. Thanks to this technology, the prototype will be better because the precision is better and human error is eliminated.

There are different types of filament that is used for 3D printing. The quality of the filament depends on the materials and the field of application of this one. For example, you can see below three examples of filament that it can be used for the 3D printed prototype:

- “PLA : this material is the most common plastic in 3D printing. It has the particularity to be very little subject to the phenomenon of warping (phenomenon of detachment of plastic) and does not deform. This plastic allows to have impressions without loss of dimensions during cooling and it is very easy to use. However it is to be avoided for objects that must withstand high temperatures because it deforms beyond 60°C. PLA is also a biomaterial based on corn starch. This material is used in 3D printing for manufacture of models of visual prototype.
- ABS : it is the second most popular plastic in 3D printing after PLA. Compared to PLA, ABS can support high temperature it has a long durability and is suitable for objects subject to mechanical stresses. This plastic is made with petroleum and it is a cheap material. This plastic is used in engineering for mechanical pieces and for functional prototype.
- Polycarbonate (PC): this plastic is very solid and it is used in the automobile industry because it has an excellent mechanical strength, it is impact resistant and hardly flammable. However, polycarbonate is subject to delamination and only experts in 3D printing can work with this plastic.”[5]

PLA was used for the second model because the school had it in their printer. Also this plastic is in accordance with our project because it is a bio-material. Thanks to this technology, all the seats can be assembled together. The team has improved the quality of the prototype.

3.5. Human Resources

During the project, many time was dedicated to the manufacturing part. Indeed, the first prototype was made by cardboard and was faster to manufacture than the second which was made with 3D printing. Also leather took time to be prepared.

The table 3.2 resume the time of manufacturing for the models:

Product	Time of manufacturing	Human resources
Foam board Model	1 Afternoon	4 people
3D Printed Model	3 Days	1 person
Leather	2 Month	Institute

Table 3.2: *Time of manufacturing the models*

Leather takes longer to be made. Indeed, a vegetable leather is used for the prototype and it takes more time to be prepared. The estimation of this time is about 2 month. This leather was made by the institute because they have the knowledge to make leather.

Also a calculation for the cost of each member of the team was made. The group members have the same amount of work on the project. An estimate of the cost of this project is 10,000 euros for the work of 4 engineers. Each member of the group take 25% of that cost, so finally, one member costs 2500 €.

3.6. Communication

During the project period, the team worked in collaboration with the institute. Thanks to that, the team and the institute could define a project that is in line with the skills of each member of the team and of the needs of the institute.

All the work was distributed between every member of the team. The institute was able to prepare the leather but the team work with them to define the patterns that they want to use for the furniture.

3.7. Risk

There are different risks to the successful completion of the project:

3D printing goes wrong

The realization of a prototype is an important element of the project because it allows to show to the customer the different functionalities of the product and the product esthetic.

The model was first realized in foam board. However, this material was not suitable for specific work. So we chose to make a new model using 3D printing. There is always a chance that the 3D printing can go wrong. In this case it will be necessary to print a new model, this will result in a delay. This risk can appear because the models must join perfectly to be functional and some forms are difficult to realize. This risk can be limited by using the skills of a 3D printing professional.

Problem on the leather

There is also a risk with the leather. During the fabrication process, the leather may suffer damage and may change its visual appearance.

Also, during the painting process, the different patterns can be modified. This risk can be eliminated by using the skills of professional people working in the domain of leather like the people from the institute.

3.8. FLAP Analysis

The FLAP Analysis is a tool that is used to visualize the positive and negative aspects of the project. FLAP is an acronym for:

- Future Considerations
- Lessons Learned
- Accomplishments
- Problem Areas

***Figure 3.5**: FLAP Analysis*

3.9. Conclusions

It is very important, during a project, to be effective and to organize the project well in order not to waste time. This is why the team did a project management study. Thanks to this study, all the tasks were organized by a Gantt chart. With a risk analysis the team was able to find the different problem which can intervene during the project, and limits them. During a project, it is also important to know the different cost of the materials that is used. This is why a cost study was made. Thanks to this study, the team is able to tell which part of the project is the most expensive.

The team fulfilled the different objectives with a multicultural teamwork. During the project, different patterns were chosen for the furniture. Because the project takes place in Romania, the team decided to choose traditional Romanian patterns for the furniture. Also, the shape of the furniture looks like a traditional Romanian one.

This study allowed the team to determine an optimal management strategy. However the study can be improved in different ways. Other materials can be chosen for the model, for example, ABS or Polycarbonate. Furthermore, the leather can be changed, for example the customer can choose a chrome leather because it will allow to have a wide color panel, but the leather won’t be eco sustainable anymore with this method.

4. Marketing Plan

The first study that the team have to do for the project is the marketing study. This study will allow the team to underline the main trends, the targets of the furniture market and their needs.

4.1. Segmentation

The team wants to sell its product directly to the consumer, to the B2C market. It is important to define where and to who the product is going to be sold.

4.1.1. Geographic

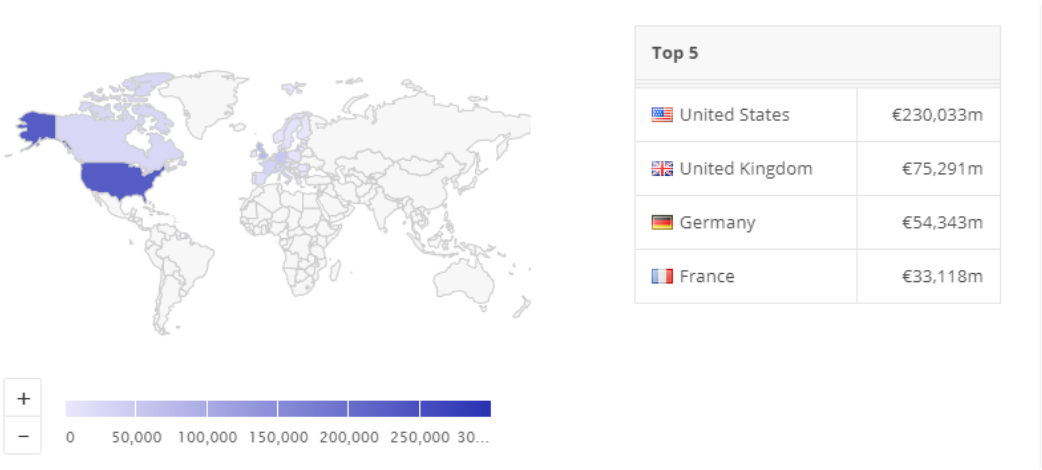


Figure 4.1: *Market volume per country in million euros*[6]

The figure 4.1 shows that most revenue is generated in the United States. The European countries represent also an important revenue regarding the market volume. According to this study, the team will be able to sell the furniture in Europe. In fact, the furniture will be developed in Romania so it would be easier to sell it in the European Union (same laws, opening of the borders). In the future, it would be possible to sell the furniture in the United States, but it would take time because it is difficult to export from Europe to the US.

4.1.2. Demographic

The targets of the furniture market is wide. Everybody needs to buy furniture for them as soon as they get an accommodation.

Gender: all
Age: 20-70
Family situation: all
Interest: have a nice and functional accommodation
Income: average or high

4.2. The Furniture Market

First, it is important to study the furniture market to know if it is a growing market, a stagnant market or a declining market.

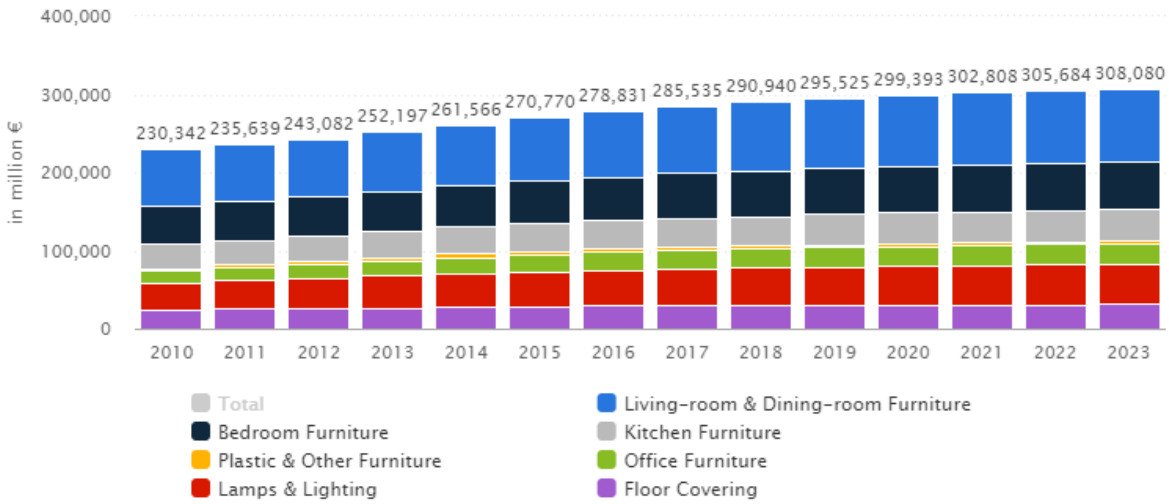


Chart 4.2: *Revenue in the Furniture Market from 2010 to 2023 in million euros*[6]

Revenue in the Furniture market amounts to €295,525m in 2019. The market is expected to grow annually by 1.0%. Living room and dining room furniture have the most important revenue regarding to the figure 4.2. Therefore, the growing of the furniture market is a good opportunity for the project. Office furniture (in green in the figure) and living-room furniture (in blue in the figure) represent the market of the multifunctional furniture.

According to the Market Research[7], the 5 top trends in the furniture market are :

1. The rise of telecommuting is driving the demand for home office furniture
2. Multi-functional, versatile furniture is gaining popularity
3. Online is the fastest-growing channel in developing markets
4. The demand for luxury furniture is increasing
5. More furniture vendors are choosing to go green

The team can underline 4 trends that are useful for the project. First, multi-functional furniture is becoming popular which means that customers will buy it more and more. Second, the team is going to use leather for the furniture, it is an expensive and luxurious material. In parallel, one of the trends is the increase of the demand for luxury furniture.

Thus, the team will be able to sell the new furniture in the market. Furthermore, in the context of environmental concerns, it is essential to create an eco-sustainable furniture. The team will have to take this trend into consideration and choose eco-sustainable materials. Finally, the demand of home office furniture is increasing which is an advantage in the selling of the product.

4.3. Macro and micro environment : SWOT Analysis

SWOT analysis is a strategic analysis tool. It combines the study of the strengths and weaknesses of a product with the opportunities and threats of its environment, to help define a development strategy. An internal analysis (micro environment) and external analysis (macro environment) has to be realized to provide input for the SWOT. The purpose of the analysis is to take into account in the strategy, both the internal factors (strengths and weaknesses) and external (opportunities and threats).

4.3.1. Macro environment

The macro-environment encompasses all the variables (cultural, demographic, economic, sociological, technological, politico-legal, etc.) that influence the market's actors. As illustrated in figure 4.3, the PESTEL analysis can underline all the variables.

Figure 4.3: *PESTEL analysis*[8]

The PESTEL analysis has to be applied on the furniture market for the project to highlight the influence of all the variables. The table 4.1 shows the PESTEL analysis for the project.

Variables	Contents	Consequences
Politics	Romanian and European politics is stable	Easier to create a new product and company
Economy	The furniture market is growing	Good for the sale of the furniture
Social	Urbanization: more and more people live in cities, in small apartments	Good for the development of multi-functional furniture
	Animal Lovers : a part of the population is against killing animals, so against using leather	Bad for the sale of the furniture
Technology	Development of new materials and technology	Allow to have a huge variety of furniture
Environment	Pressure of NGO to make eco sustainable furniture	Must choose eco-sustainable materials
	Deforestation	Must be careful with the kind of wood chosen
Legal	European directives about : Timber from sustainably managed forests Limited use of organic solvents Limited emissions of volatile organic compounds	Must be aware of the directives for the wood, and solvent used

Table 4.1: *PESTEL analysis for the project*

4.3.2. Micro environment

The micro environment includes all the actors on which the company depends (competitors, suppliers, distributors, customers). To study the micro environment, the Porter's Five Forces can be used (see figure 4.4).

Figure 4.4: *Porter's Five Forces analysis*[9]

The table 4.2 shows the Porter's Five Forces analysis applied on our project.

Rivalry in the industry	There are many competitors in the furniture industry. There are multinational companies that make a lot of profit like Ikea. However, most of the companies are making similar furniture. The multi-functional and eco-sustainable furniture can make the difference, that answer the new needs of the customers and set the project apart from the competitor.	Low
Power of suppliers	There are many suppliers of wood and steel. So it is easy for the team to switch to another suppliers and to fix the prices. However, the suppliers have to propose eco-sustainable materials that may increase the power of suppliers and the price of the materials. Furthermore, the leather is difficult to make and it takes time especially if the leather has to be eco-sustainable. Thus, it can affect the team' profits because they have to pay expensive materials.	Medium
Power of customers	There are lots of companies where customers can buy furniture. However, multi-functional and eco-sustainable furniture are rare and answer the new trends of the furniture market. Therefore, the customer is limited and cannot go to another store to buy the same product.	Low
Threats of new entrants	The furniture market is always evolving. Competitors can easily make the same kind of furniture because there are no important barriers. First, it does not cost a lot of money for a company to switch to multi-functional furniture. Second, there are no laws or government regulation about it. Finally, there is no new technology used. As a result, the threat of new entrants is high.	High

Threats of substitutes goods	Multi-functional and eco-sustainable furniture are rare and very specific. As a consequence, the threat of substitutes is low.	Low

Table 4.2: *Porter's Five Forces analysis for the project*

It is also important to know the weaknesses and strengths of the team. The McKinsey's 7s model can be used to define them (see figure 4.5).

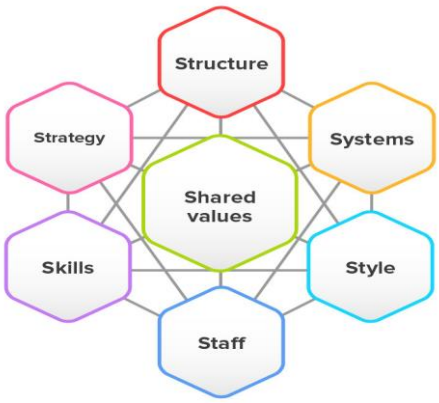


Figure 4.5: *McKinsey's 7s model*[10]

The McKinsey's 7s model has been applied on the team as illustrated in the table 4.3.

Structure	The team is composed of 4 students who come from different universities and have different degrees. Because of that, the team didn't have a hierarchy. However, Mariana can be nominated as the mentor because she is Romanian and she is studying at University POLITEHNICA of Bucharest. All the decisions are made during the meeting where everybody is able to give his/her opinion.
Systems	The meeting with the company is on Wednesday every week. During this meeting the team and supervisors can discuss about the progress of the project and establish what the team have to do for the next week. To prepare this meeting with the company, the team organized a meeting usually on Monday. In fact, the courses are on Tuesday, which allow the team to talk about the project with their teachers before going to the company on Wednesday.
Style	Each member of the team has worked on a part of the project without any hierarchy. However, each member could ask for help from the others and some part has been done with 2 or 3 members.
Staff	The team is composed of 4 members, who are students in different countries: Ana (Spain), François (France), Mariana (Romania) and Marie (France). This multiculturalism is an asset to run this project. Nevertheless, it can also be difficult to understand each other.
Skill	As the team come from different countries, each member has a different field of study. Marie is studying Packaging engineering, François' major is materials engineering while Mariana and Ana are studying Industrial Design. It is also a huge advantage.
Strategy	The team strategy is to use every skill from each student to carry out a complete and successful project.

Shared values	As a hard working team, each member shared the same values: working together, with the company and the teachers to create efficient furniture and get a good grade.

Table 4.3: *McKinsey's 7s model for the project*

4.3.3. The SWOT

Thanks to the internal and external analysis, the SWOT analysis can be created. The strengths and weaknesses come from internal factors (micro environment) while the opportunities and threats come from external factors (macro environment). The strengths and opportunities will be helpful for the project while the weaknesses and threats will be harmful (see figure 4.6).

Figure 4.6: *The SWOT Analysis*[11]

As illustrated on Chart 4.4 and 4.5 the SWOT has been created for the project and for the team.

STRENGTHS	WEAKNESSES
-multifunctional -save place -easy to clean -uses ecological material -fireproof/waterproof	-leather is expensive -difficult technology of production -limited time
OPPORTUNITIES	THREATS
-market is growing -demand of luxury furniture is increasing -demand of home office furniture is increasing -people are looking for eco-sustainable furniture -people are looking for multifunctional furniture	-big competition -animal lovers are against using leather

Table 4.4: *SWOT Analysis for the project*

STRENGTHS	WEAKNESSES
-multicultural team -different skills and diploma -helpful teachers -company strongly involved in the project	-problem of communication due to language barriers -limited in time and budget -still student
OPPORTUNITIES	THREATS
-working in a multicultural team -acquiring additional knowledge from each other -earning experience and expertise	-cultural differences

Table 4.5: *SWOT Analysis for the team*

4.4. The brand and the product

4.4.1. Logo and branding

The aim was to create a brand that distinguishes, in the eyes of the possible customers, this multifunctional furniture from other products available on the market.

The name of the brand must be suggestive and attractive. The first step was to brainstorm different ideas, such as:

- Create your home
- Exclusive leather furniture
- Urban furniture
- Home living furniture
- Mood Home
- Movable
- 2thetop

Next, it was the choice of the most appropriate one, which the team decided that is ''Movable''. It was chosen because it means "able to move" so it reflects one important characteristic of a convertible furniture. It is also short and easy to remember.

The following step was creating a logo. In this point, a lot of sketches have been made (see figure 4.7). For the chosen one, the font, the design and the colors were decided. In figures 4.8, 4.9 and 4.10 are presented the options created in Illustrator in order to see which one suits better .

Figure 4.7: *the shape of the logo*

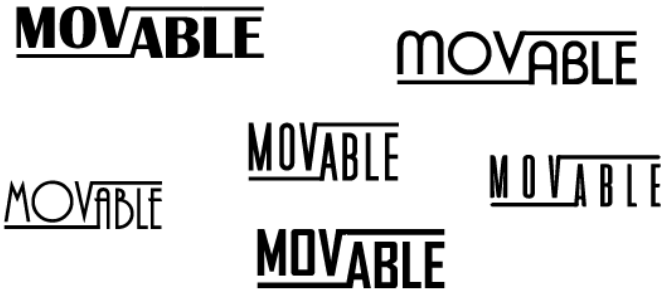


Figure 4.8: *Possible typography for the logo*

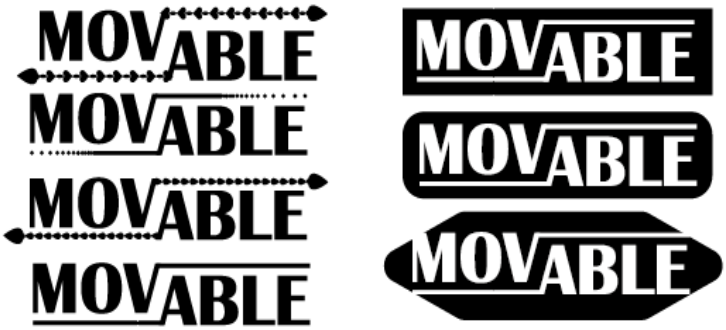


Figure 4.9: *Possible designs for the logo*

Figure 4.10: *Possible colors for the logo*

In figure 4.11 is illustrated the final logo. The design and the colors are suggestive for the products, for their main material and functionality.

Figure 4.11: *The final logo*

4.4.2. The marketing mix: Product, Price, Promotion, Place

The furniture is going to be named **Tainaat**. First, the team was thinking about Taunat because “tau” comes from the word “taula” that means table in valencian (the mother tongue of Ana) and “nat” comes from the word “nature”. After that, the team looked for similarities in other languages and discovered the word “tainaat” which means deployed or unfold in Hindi. It fits for the product because it emphasizes the way it will be used (see figure 4.12).

***Figure 4.12**: Product: tainaat*

The marketing mix also called the 4Ps is divided in 4 categories: Product, Price, Place and Promotion, as shown in figure 4.7. It refers to the marketing decision that will be taken for a product to ensure its place on the market. For that, the team has to develop the strengths and avoid the weaknesses, take the opportunities and be award of the threats (see figure 4.13).

***Figure 4.13:** The marketing mix[12]*

The table 4.6 shows the marketing mix applied for the furniture. the SWOT has been used to create it (see table 4.3).

Product	The furniture will be multifunctional in order to answer the customer's needs of saving space. Leather will be used because the team works with the national Research and Development Institute for Textiles and Leather. The leather will be eco-sustainable because it is one of the new trends for furniture. The other materials will also be eco-sustainable.
Price	The leather is an expensive material. The team is also going to use other materials such as walnut wood which is also very expensive. So the price of the furniture will be around 900 euros. Indeed the price of all the material is around 750, we add 150 euro of manufacturing and profit. The team also wants to create a more affordable furniture for students. In this case, the walnut wood will be replaced by a cheaper one and the furniture will cost approximately 260 euro.
Place	The furniture will be sell in luxurious furniture stores. However, the affordable one is going to be sold in collaboration with famous stores like Ikea. The brand will also have its own website where customers will be able to buy the furniture directly in Europe.
Promotion	The promotion of the furniture will be through the website and social networks. The collaboration with luxurious stores and affordable one will be also helpful for the promotion of the product. A catalog is also going to be created to show all the possibilities to the customer. Finally, an event will be organized to promote the product (see part 4.5.promotion of the product).
Target market	The main target is people with high income that can afford luxurious furniture for their home. They are working in cities so they live in apartments and they are looking for multifunctional furniture to save space. They are aware of environmental issues, so they appreciate eco-sustainable furniture. To extend the sales, another target can be taken in consideration: students between 18 and 24 years old. This part of the population lives most of the time in apartment and need to save space. They need a desk to work on it but also an auxiliary table to receive guests. They do not have any income or low so they looking for affordable furniture.

Table 4.6: *the marketing mix for the furniture*

4.5. Promotion of Tainaat

Creating a new brand and a new product is a challenge and it has to be known by the customers and the targets. Hence, the promotion of the product is very important, especially when it is new and unknown. Creating an event to promote the product is a good way to improve its popularity.

4.5.1. Description

The event will be hosted during the Romanian design week in Bucharest. It is a 10 day festival staged every year in May that promote design as a pad for cultural, social and economic growth. During this week, events and showcases are made for the promotion of the Romanian design and especially industrial design, interior design and furniture (see figure 4.14). Their aim is to make design accessible to a broad-based public. So it will allow the brand to promote the multifunctional furniture.

Figure 4.14: *Romanian design week*[13]

4.5.2. Marketing

The 4P (promotion, product, price, place) can also be used to organize an event. It will help to achieve the team's goals.

- Promotion : it is very important to promote it in order to convince the customers to come at the event. Nowadays, social networks are the most efficient way to advertise an event. Indeed, it is very simple, quick and cheap to post an event on Facebook, Instagram, Twitter or Youtube. This way of promotion will bring customers between 18 and 24 years old, which is one of our target group. For the ones that don't have any social media, posters and flyers will be printed and placed in every university of Bucharest. However, the second target who are looking for luxurious furniture has to be aware about the event too. The team is going to publish advertising in the Romanian furniture magazine "Mobila" (see figure 4.15).

Figure 4.15: *example of "Mobila" magazine*[14]

- Product : During the event the brand will be able to show the multifunctional furniture, and a catalog (see figure 4.16) in order to present all the possibilities and to satisfy the needs of both targets.

Figure 4.16: *Catalog*

- Price: The price of the luxurious furniture will be 900 euros. To make a comparison, a wood table come from Cioata costs 947,34 euros as illustrated in figure 4.17. Cioata is a brand that makes furniture with wood from Transylvania.

The affordable furniture will cost 260 euro. This price is an advantage because the student target is looking for the smallest price. In comparison, an auxiliary table, a desk and 5 chairs would cost 289 euro in Ikea (see table 4.7).

Figure 4.17 : *Table Wagner IDR*[15]

Product	Picture	Cost	Quantity	Total
Auxiliary table	 [16]	69 euros	1	**289 euros**
Desk	 [17]	75 euros	1	
Chair	 [18]	29 euros	5	

Table 4.7: *Price of Ikea furniture*

- Place: the event will be hosted by the Romanian design week as it has been said before, so it will take place in Bucharest at University's Square in BCR building. It is a good location because it is in the center of the city, that means students and workers can easily came by.

4.5.3. Human resources

For this event, all the team will be required to show the product to the customers and talk about the brand and the project. In addition, a security man is necessary just in case there were any problem, and a photographer will be needed in order to make this event unforgettable. Because the team is making a collaboration with the Romanian Design week, they will not need to hire the photographer and security man by themselves, they will be provided by the organizer of the Romanian Design week.

4.5.4. Planning

The schedule of the event is presented in table 4.8.

Hour	Activity
1:30 PM	Stand preparation
2:00 PM	The beginning of the event in order to promote the new product of the brand
2:15 PM	Presentation of the team, the brand and the product
3:00 PM	Discussion with customers and sell the product
5.00 PM	End of the event. Stand storage

Table 4.8: *The schedule of the promotion event*

4.5.5. Financial details

The organizers of the Romanian Design week offer package that includes the stand, the security man and the photographer for 3 hours for 600 euro (cost estimate). The cost of 1000 A7 flyers is around 20 euros, and the cost of 50 A2 posters is around 39 euros according to the company Instantprint. The advertising in the magazine "Mobila" will cost 500 euros (cost estimate). Table 4.9 and Chart 4.2 illustrate the costs of the event.

costs	
Stand Package	600 €
Flyers	20 €
Posters	39 €
Ad in Mobila	500 €
Total	**1 159 €**

Table 4.9: *Costs of the event in euros*

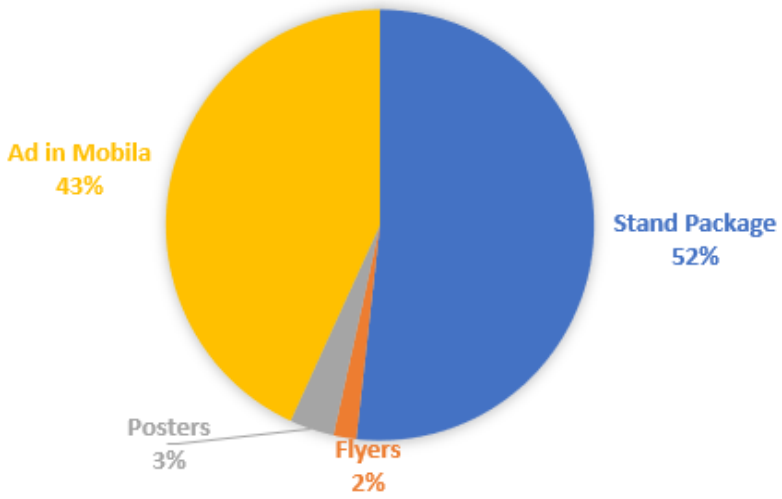


Chart 4.1: *distribution of costs in percentages*

The goal of this event is to make the brand and the product Tainaat known. The event is going to be free, but every potential customer can come and may buy the product. The profit will come from the sale of the furniture. The income for the luxurious Tainaat is 100 euros, whereas the income for the affordable one is 50 euros. According to the chart 4.3, at least 11 customers have to buy the luxurious furniture in order to not lose money during this event. In the case of affordable furniture, it is 24 customers that have to buy the product (see chart 4.2). In average, that means that at least 18 Tainaat (half affordable and half luxurious) must be sell during the event to ensure profits. The sales take place during 2 hours according to the planning, so in average one Furniture has to be sell every 7 minutes. It might be difficult to achieve those goals. However, it is important to underline that the objective of this event it is not making profit but making the brand and the product known by the customers. In other words, even if the team does not make a profit, at least they would have make potential customers.

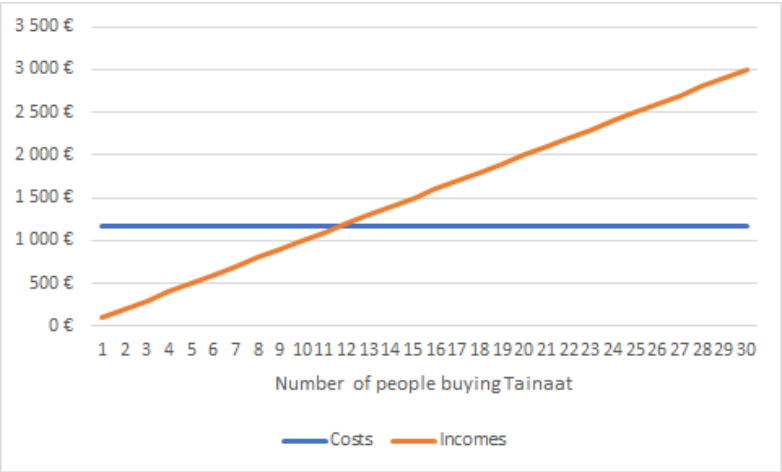


Chart 4.2: *costs and income in euros according to the number of people buying luxurious furniture*

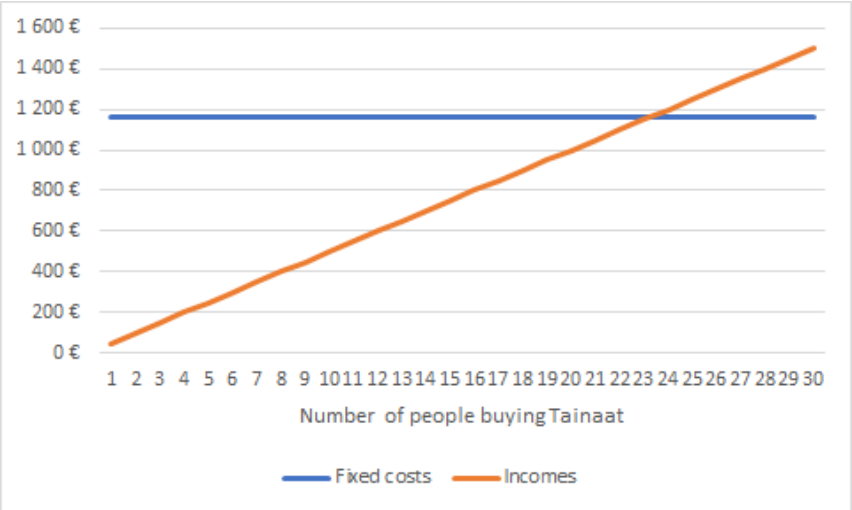


Chart 4.3: *costs and income in euros according to the number of people buying affordable furniture*

5. Project Development

5.1. Introduction

This section of the report details the steps followed in the development of Tainaat. It started with research and bonding between the team members and it continued with brainstorming, sketches, finding pro and contra arguments, 3D modeling in CATIA and SolidWorks, foam board modeling, 3D printing, and, in the end, a catalog for this type of furniture.

5.2. Furniture ideas

Different ideas were brainstormed to design the furniture in order to meet all the above mentioned requirements. The first solution found consist of an auxiliary table that converts into a desk. Inside there is enough space to storage 4 cubic chairs. This idea is illustrated in figure 5.1.

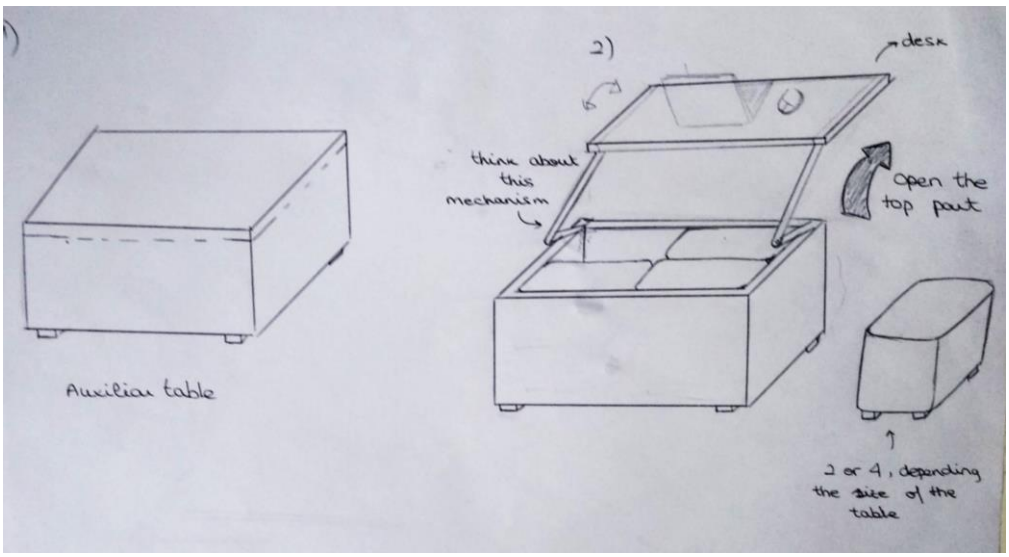
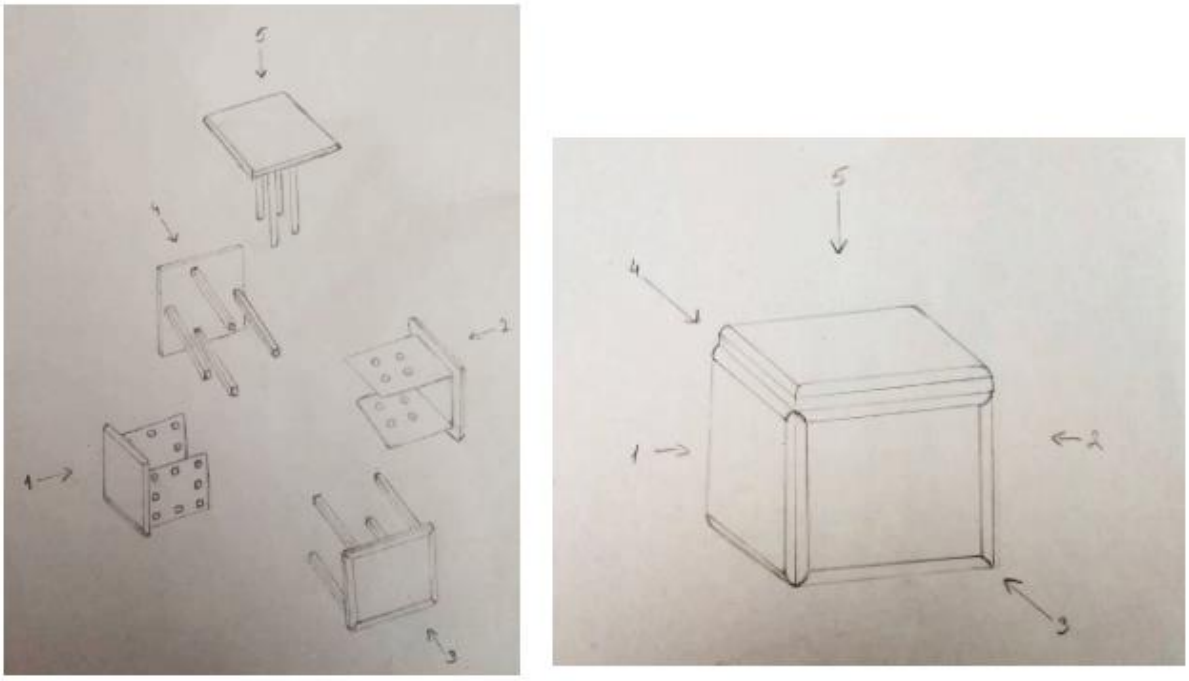


Figure 5.1: *Sketch of the first idea of the desk and chairs*

This solution had been improved by changing the design of the chairs so as 5 pieces to fit in the space occupied by one cubic chair. Thus, the dimensions of the table were reduced. The top part was also modified. Instead of a fix wood component, it has 2, a fix one and a mobile one covered in leather on one side.

Hence, a lot of conceptual sketches were done, as illustrated in Figures 5.2 and 5.3.



a. b.

Figure 5.2: *Sketches of the chairs in the assembling position (a) and in a space saving position (b)*

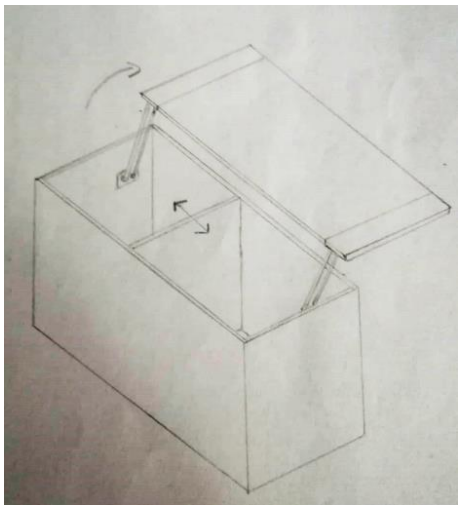


Figure 5.3: *Sketch of the desk*

Once the sketches realized, the 3D modelling was started. They were done in CATIA and SolidWorks.

5.2.1 The table

In figure 5.4 is presented the auxiliary table, a nice and compact piece of furniture that fits perfectly in the living room. The top part has a fix component and a mobile one which is provided with a rotating mechanism that allows the owner to use both sides. The difference between them is that one is made of wood (see in Figure 5.4) and the second one is covered in leather (see Figure 5.5).

Figure 5.4: *Auxiliary table*

The table converts into a desk thanks to a standard mechanism and allows the access to the storage place. It has a dividing wall (see Figure 5.5) which moves according to the customer's necessities. The main dimensions are presented in figure 5.6 .

Figure 5.5: *The desk*

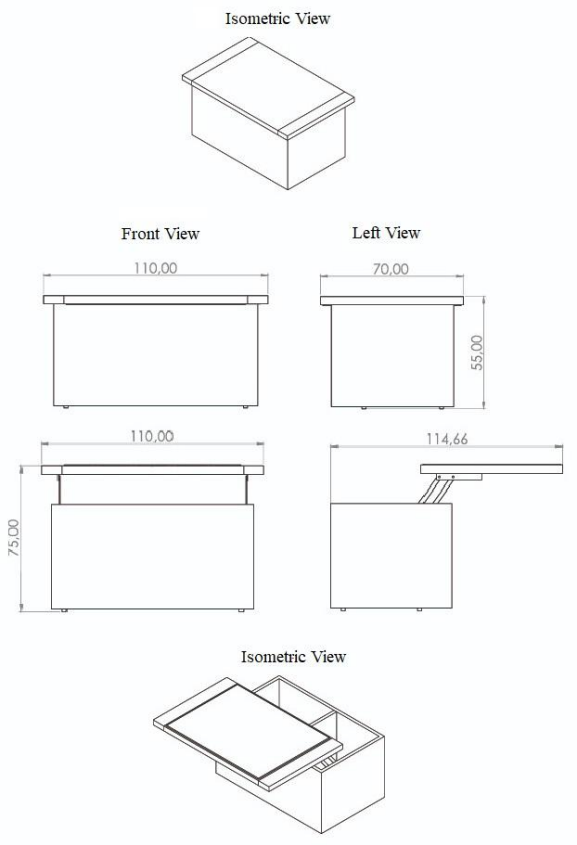


Figure 5.6: *Dimensions of the table*

5.2.2 The chairs

The chairs are designed to fit one into another in order to save space as shown in Figure 5.7. In this position, they can be used as a single cubic chair and they are easy to store inside the table.

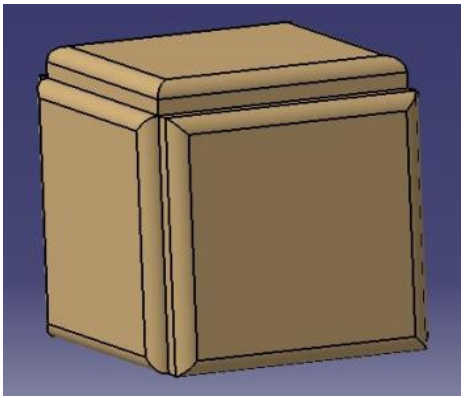


Figure 5.7: *Chairs in a space saving position*

5.2.2.1. First attempt

The first design of the chairs is illustrated in Figure 5.8. All of them have different legs on functionality purpose but this detail makes the concept even more attractive. The legs of the chairs number 3 and number 4 have a square shape and will go through the legs of the chair number 1 when they are in the saving position. The fifth chair have cylindrical legs that fit through the ones of the second chair. This attempt includes a support for the chair number 5, positioned as presented in Figure 5.9.

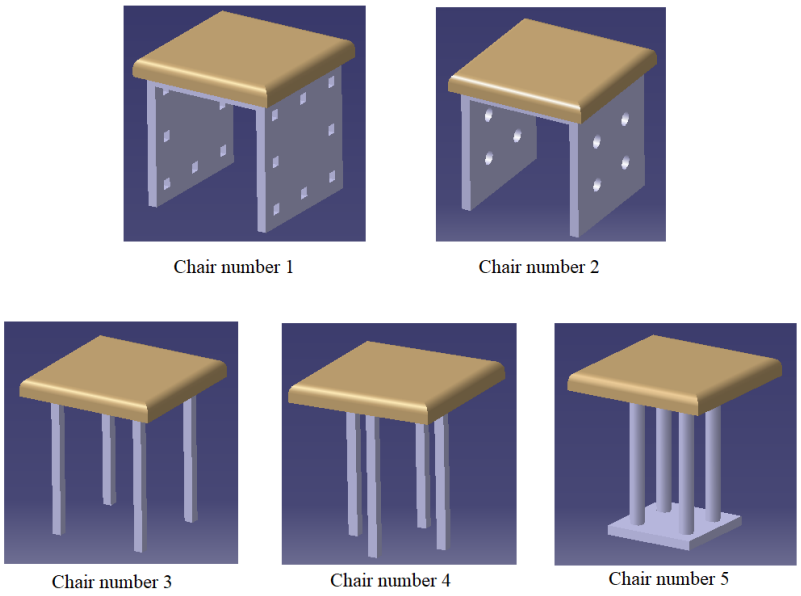


Figure 5.8: *Chairs*

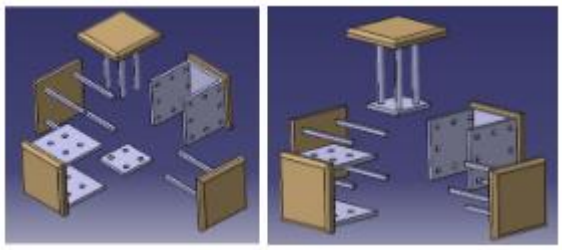


Figure 5.9: *Chairs. Assembling position*

5.2.2.2. Final design

In order to reduce the number of assembling pieces and to increase the stability of the chairs, the legs were made bigger (see Figure 5.10). More precisely, chairs number 3 and 4 will have the legs big enough so the fifth ones will get through them, as illustrated in Figure 5.11. The first chair kept its design, only that the dimensions of the holes enlarged proportionally. On the legs of the second chair, the shape and the dimensions of the holes were modified according to the changes occurred for the fifth one. The main final dimensions are visible in Figure 5.12.

Figure 5.10: *Chairs*

Figure 5.11: *Chairs. Assembling position*

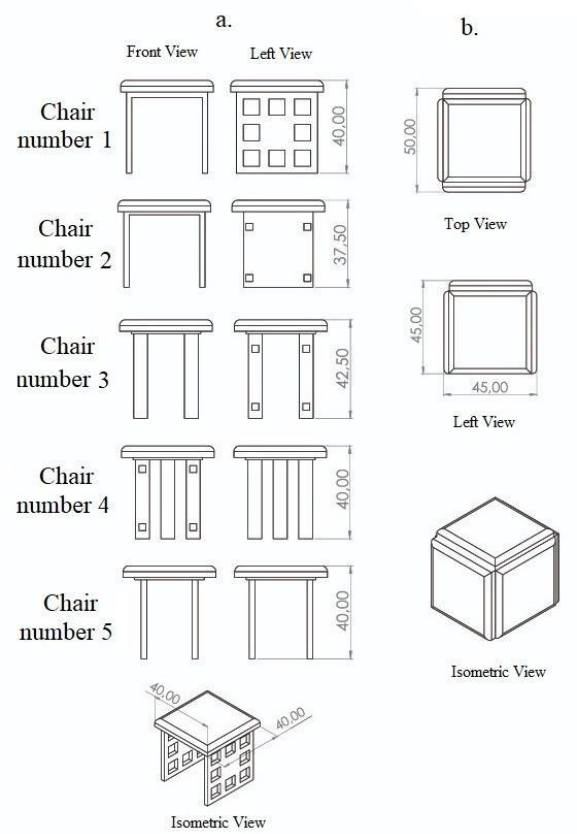


Figure 5.12: *Dimensions of the chairs. Orthographic and isometric projections: individually (a) and in a space saving position(b)*

5.3. Components

5.3.1. Table

The table is composed of the following components:

a) A wood structure divided into:
   -Top
   - fix component (figure 5.13)

Figure 5.13: *Fix component of the top part of the table*

- mobile component, illustrated in figure 5.14

Figure 5.14: *Movable component of the table top part*

-Dividing wall (see figure 5.15)

Figure 5.15: *Dividing wall of the table storage space*

-Sides
-Bottom
-Legs

The sides, bottom and legs are glued and assembled together as presented in figure 5.16.

Figure 5.16: *Assembly of sides, bottom and legs of the table*

b) A standard mechanism for furniture (Figure 5.17) that converts the table into a desk

It is built in Hot-rolled steel. This type of steel requires less heat treatment and, therefore, it is less expensive.

The mechanism can support a maximum load of 45 kg. Needless to say that this feature is sufficient for this furniture in desk position because the load cannot run 45 kg for office supplies.[19]

However, there are limits with this mechanism because, for example, it cannot support the weight of a person.

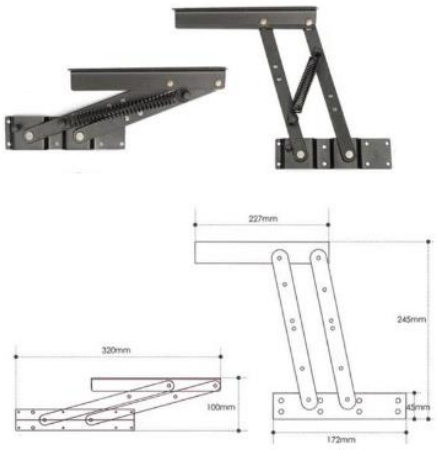


Figure 5.17: *Standard mechanism for furniture* [19]

c) A steel bar (Figure 5.18)

It is inserted in the middle of the table's top part. The bar allows the rotation of the mobile wood component in order for the owner to be able to use the leather part or the wood one.

Figure 5.18: *A steel bar (Ø1.3X100cm)*

d) 4 latches (Figure 5.19)

They are inserted in the fix part of the table's top. Their purpose is to stop the rotation (see figure 5.20) and thus the desk can be functional.

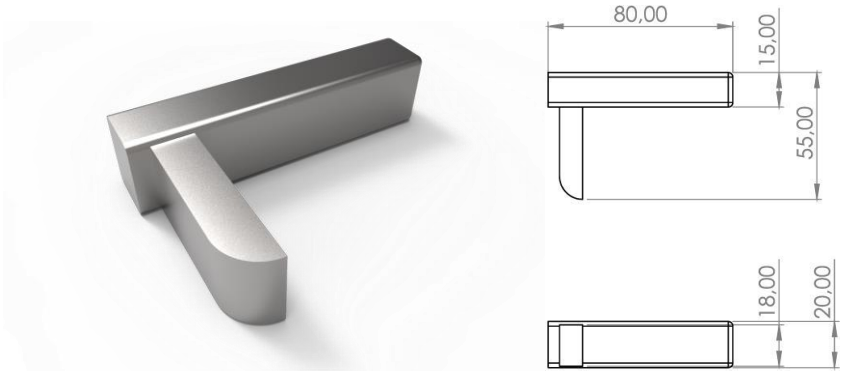


Figure 5.19: *Fixing mechanism (mm)*

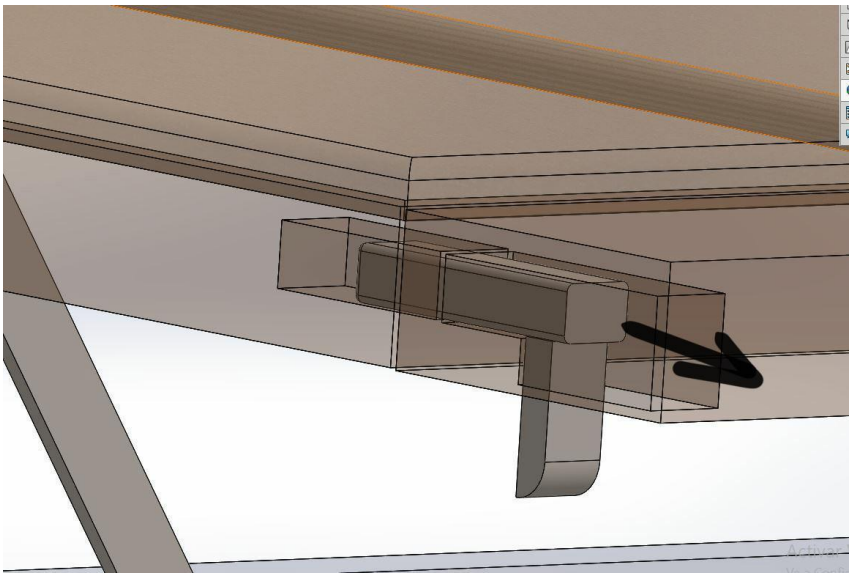


Figure 5.20: *How to use the Fixing mechanism*

5.3.2. Chairs

The chairs are composed of the following components:

a) The top (Figure 5.21)

Figure 5.21: *Top part of each chair*

The top part is made by gluing foam on a wood panel of 40 X 40 X 2.5 cm and covering it with leather.

b) The legs (Figure 5.22)

Figure 5.22: *Legs of the chairs. Wood structure*

c) Four M6 x 20mm Nickel Plated Connecting Screws for each chair. The nut will be inserted in the top part. The piece is illustrated in Figure 5.23, along with its technical drawing.

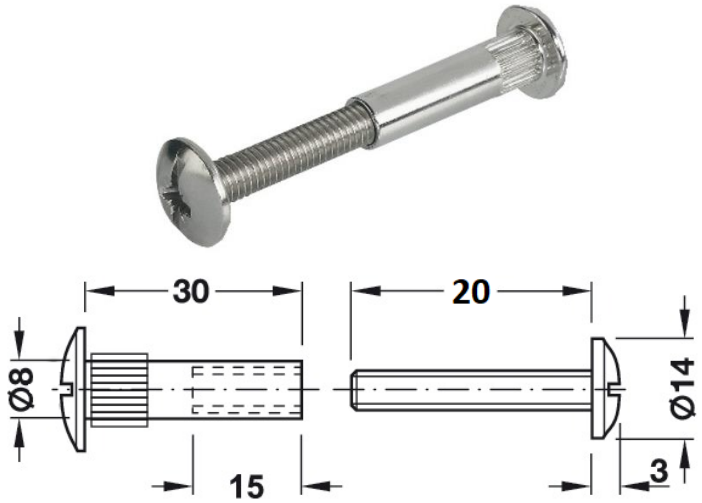


***Figure 5.23**: Nickel Plated Connecting Screw*[20]

d) A metal structure for chair number 5 (Figure 5.24)

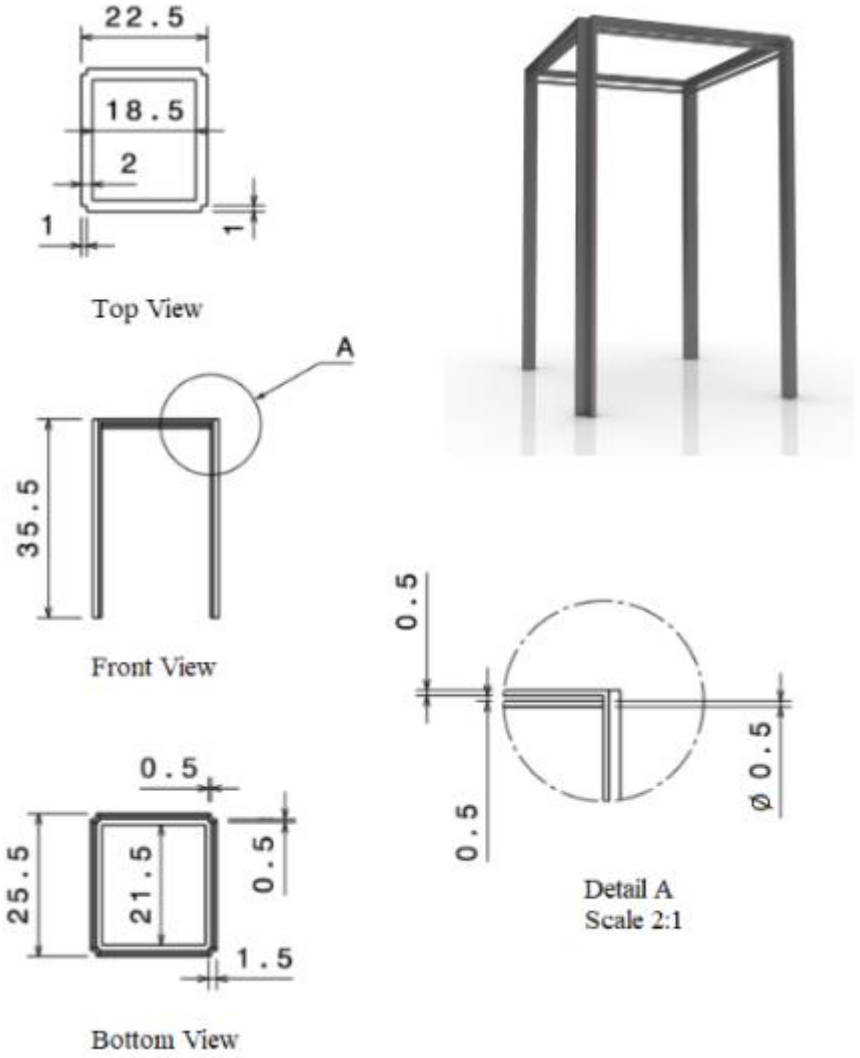


***Figure 5.24:** Metal structure of chair number five*

5.4. Materials

Four types of materials were used in the designing of the furniture: wood, leather, foam and steel.

5.4.1. Wood

Wood is an organic material, found in the roots of trees.

5.4.1.1.Structure of Wood

As illustrated in figure 5.25, the tree is divided into 3 parts (from center to outside): pith or medulla, wood and bark. Pith is small and located in the center. The wood part is differentiated into heartwood and sapwood. Heartwood is darker and contains only dead tissue, whereas sapwood contains both living and dead tissue. Sapwood conducts sap from the roots to the leaves. Annual rings correspond to each season of growth and are located in the wood part. Between wood and bark there is the cambium (can not be seen with naked eyes).[21]

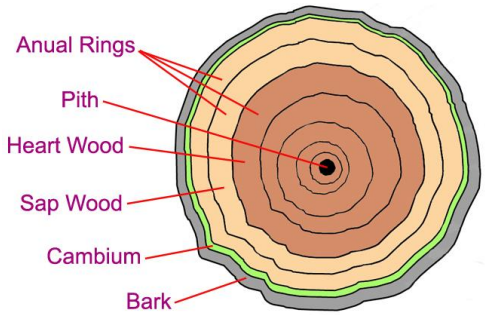


Figure 5.25: *Cross section of a tree*[22]

5.4.1.2. Hardwood and Softwood

Wood can be divided into two different kinds: Hardwood and Softwood. Hardwoods come from deciduous trees whereas softwoods come from coniferous trees. The table 5.1 shows the differences between both types.

Deciduous trees	Coniferous trees
 [23]	 [24]
Hardwood	Softwood
Angiosperm (seeds in fruits or pods)	Gymnosperm (naked seeds)
Ash, walnut, maple	Pine, spruce, cedar

Table 5.1*: differences between the origin of hardwood and softwood*

5.4.1.3. Chemical composition

The major components of Wood are cellulose, lignin and hemicellulose. Cellulose is the most important component (around 50%), it is a polymer constituted by chains of monomer glucose (see figure 5.26). Lignin is a complex polymer, it is a three-dimensional phenylpropanol polymer, it binds individual cells together. Its percentage in wood varies between both types of wood: between 23% and 33% in softwood and 16% and 25% in hardwood. Hemicellulose is a polymer composed of different kinds of pentose and hexose sugar monomers.

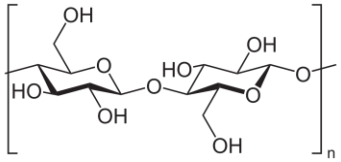


Figure 5.26: *molecule of cellulose* [25]

5.4.1.4. Advantages

The reason wood was chosen is that this type of furniture has some specific advantages, such as:

- Sustainability

Wood is the only renewable building material around—trees that are harvested for their wood can be replenished by new growth. What is more, the carbon footprint that results from the production and processing of wood products is drastically lower than that for other building materials. And with up to 50 per cent of the dry weight of wood being carbon, they also have the capacity to store carbon, something that is crucial in the fight against climate change.

Another way wood is a sustainable option is that it gives you the opportunity to 'buy local' from specialized artisans in your community. This gives you the chance not only to support the local timber industry, but also the local economy.

- Strength and durability

Wood is, of course, a long-lasting and robust material and is the perfect choice for anyone looking for longevity from their furniture. Whether you opt for hardwood (Australian oak, blackwood or jarrah, for example) or softwood (hoop pine, celery top pine or pinus radiata), there is an innate stability and reliability to a well-made wooden chair or desk.

This durability ensures that wooden furniture offers excellent value for money. A solidly made and well-looked-after furniture can maintain its value over the years.

Durability also ensures easy maintenance. Waxing, polishing and oiling only needs to be carried out occasionally, and therefore it proves an undemanding process.

- Look and feel

As mentioned, wood can add a certain dignity and charm to any room, be it lighter-colored wood or rich darker hues.

Wooden furniture can also go a long way to create a sense of the natural world indoors. If you live in a high-density apartment block in a city, you may wish to foster a sense of nature in your living space.

Wood is the perfect way to achieve this, through both its wide-ranging color spectrum, and the fascinating patterns of grains and fibers. Wood can also immediately bring warmth to otherwise sterile surroundings.

- Variety

The vast range of colors and tones of wood means that plenty of variety is available for style and look. And this is not to mention the subtle but noticeable differences between the grains and textures of different species and cuts.

There is little uniformity when it comes to wooden furniture, and certainly scope to get creative design-wise to ensure a one-of-a-kind piece.

- Versatility

Unlike many other materials, wood looks good in pretty much any setting. Wooden furniture can be a part of any design scheme, be it modern or rustic, and different species will blend together tastefully within one room or house.

And of course, its versatility extends to the outdoors. When treated with oils to withstand exposure to the elements, furniture made of timbers, such as jarrah and treated pine, can look wonderful in the garden or on a veranda.[26]

5.4.1.5. Walnut wood

Walnut wood (see Figure 5.27) was used for the present project. It is a straight-grained hardwood that ranges from chocolate brown (deep inside the tree) to yellow (on the outer side). Heartwood can range from a lighter pale brown to a dark chocolate brown with darker brown streaks.

Walnut is a very strong and stable wood that can take intricate carving. Typically easy to work provided the grain is straight and regular. It has good dimensional stability and shock resistance.[27]

Also, this wood species is not listed in the CITES Appendices or on the IUCN Red List of Threatened Species, which makes it suitable as sustainable material.

Figure 5.27: *Walnut wood*[28]

5.4.2. Leather

The project was realized in collaboration with the National Research and Development Institute for Leather and Textile in Bucharest thus one of the requirements was to integrate leather into the furniture. This condition was achieved by choosing to use vegetable leather on the top of the chairs and on one side of the table's. To justify the decision, a description of the leather and the options it offers will be presented next.

5.4.2.1. Structure of the skin

The skin is composed of three different parts, as illustrated in Figure 5.28.

- The epidermis, which is the external part of the skin
- The dermis, which is used to make the leather.
- Auxiliary structures, like furs, skin glands or the arrector muscle[29]

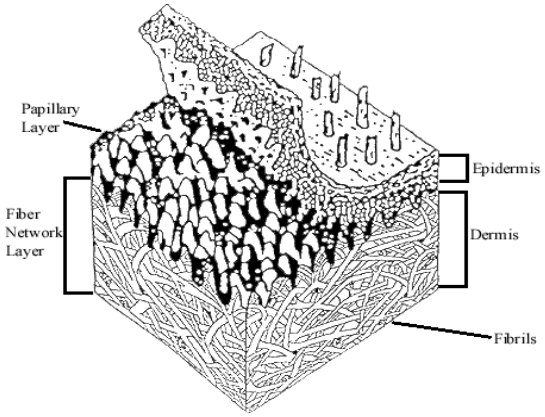


Figure 5.28: *Components of the skin[30]*

Collagen is a structural protein that is represented as fibers. This protein confers the biological tissues a mechanical resistance to stretching. Collagen is the most abundant protein in the animal kingdom. It is recovered for use in industry especially for the manufacture of gelatin or cosmetic products.

Thanks to the properties of the collagen, leather has good resistance to stretching but also to traction due to intertwined collagen fibers, as can be seen in Figure 5.29.

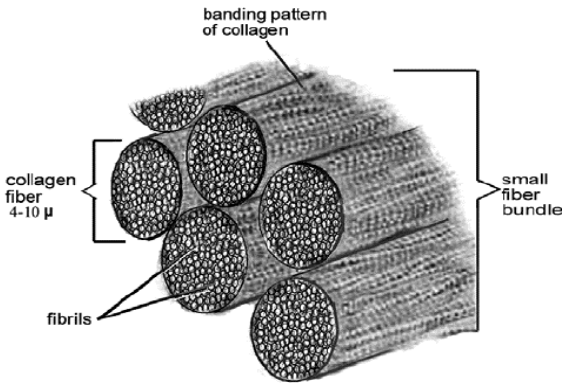


Figure 5.29: *Collagen fibers [31]*

The greater the fiber interleaving, the more resistance there is. The interlacing of collagen fibers varies depending on the location on the skin. [29]

5.4.2.2. Manufacture of leather. Chrome tanning VS Vegetable tanning

Leather can be made from any type of hide. On the market can be found some from kangaroos, lizards, crocodiles, snakes, ostriches etc. However, the "classic" hide such as the one from sheep, goats, beef and pigs are the most used because the industry has them at constant disposal.

Tanning is an important process in turning skins into leather, making them more durable and more flexible. During this operation, the skins pass successively in tanks filled with water and

tannins (plants or chrome) to turn them into leather. Mainly, two processes are being used: vegetable tanning and tanning with chromium.

Chrome tanning has been a revolution in the leather industry. Indeed, this type saves considerable time compared to the vegetable one because it can be obtained in 24 hours. Chrome tanning is more common in the footwear industry because it gives the leather better heat resistance.

However, chrome tanning has drawbacks. It is dangerous for the health of the tanners because the compounds formed are carcinogenic. It is also dangerous for the environment because is difficult to extract the excess of toxic chromate effluents. [32]

Vegetable tanning was the most used process until the appearance of chrome tanning. It consists of repeatedly soaking skins in natural tanning solutions and is a slow and complex process. It usually takes a minimum of 30 to 60 days to finish and requires the skill, patience, care and supervision of skilled craftsmen. Most plants contain tannins, especially in the bark but also in leaves, roots or even fruits. Those with a high concentration are useful for tanning hides. Many different plants and trees have been in use for leather tanning over thousands of years such as oak, chestnut, acacia or wattle, mangrove bark or birch. This type of process takes longer and use a lot of water but it is more respectful for the health of the tanners and it has minimal negative environmental impact.[33]

5.4.3 Foam

It is worth mentioning that high-resilience foam was also considered to be used in the project.

5.4.3.1. Composition

High-resilience foam is a polyurethane foam. Polyurethane is a polymer composed of organic units joined by carbamate urethane links. Polyurethane polymers are traditionally and most commonly formed by reacting a di- or tri poly-isocyanate with a polyol [34]. The urethane groups -NH-(C=O)-O- link the molecular units as illustrated in Figure 5.30.

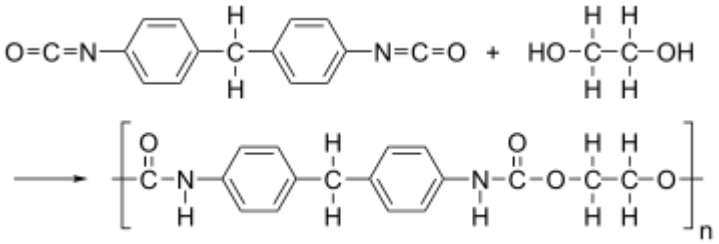


Figure 5.30: *Polyurethane synthesis [35]*

5.4.3.2. Properties

HR-foam has special comfort properties and advanced flexibility. As opposed to standard foam, the structure of HR-foam is heterogeneous, the cells are of different sizes and differently react to the applied load. When the load is low only the small cells react, hence it matches the reaction of soft foam. As the load rises, the bigger cells with higher resistance begin to work. This gives the marvelous comfort feeling and provides the correct anatomical body support. [36]

The specifications for this type of foam are presented in Table 5.2.

Weight	3.0 lb. per cubic ft.
Quality	excellent
Longevity	approx. 12 years
Density lbs/cu. ft.	minimum 2.50
Support Factor	2.5
Tensile Strength, lbs/sq. in.	12.0 PSI min.
Tear Strength, lbs/linear in.	1.50 PLI min.
Elongation, %	15% min.
Resilience, %	50% min.
Compression set, 90%, 22 hrs., 158° F	less than 10%

Table 5.2: *Specifications for high-resilience foam[37]*

5.4.4. Steel

5.4.4.1. Composition

Steel is an alloy, it is a modified form of iron with a small amount of carbon and some other elements. Iron is the major component of steel. Like others metals, its structure is polycrystalline, that means the atoms are well ordered. Iron can be found in 2 kinds of crystalline forms: in body-centered cubic (BCC) or in face-centered cubic (FCC). Both are a unit cube with iron atoms at its corners, but BCC has another iron atom in the center of each cube whereas FCC has additional iron atoms at the center of each face of the cube (see figure 5.31). Those crystalline forms let space for foreign atoms.[38]

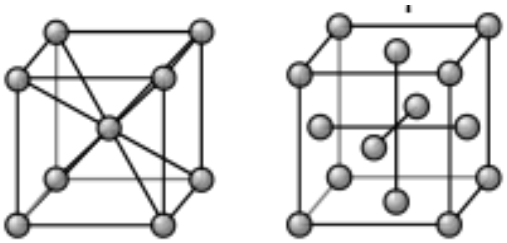


Figure 5.31: *crystalline forms of iron, BCC and FCC[39]*

Iron in its pure state is soft, so other elements are added to create alloy and improve its physical and mechanical properties. Small amounts of carbon is added to iron to create steel.[38]

5.4.4.2. Hot rolled steel: Dual Phase 600

The components of the furniture made of steel are: the mechanism that converts the table into a desk, the steel bar and the latches and the metal structure of the chair number 5. They are bought from different providers and they are made of hot rolled steel, more precisely, of Dual Phase 600. In tables 5.3 and 5.4 are the mechanical properties and the components of this material.

''Hot rolling is a mill process which involves rolling the steel at a high temperature (typically at a temperature over 1700° F), which is above the steel's recrystallization temperature. When steel is above the recrystallization temperature, it can be shaped and formed easily. Hot rolled steel is typically cheaper than cold rolled steel due to the fact that it is often manufactured without any delays in the process, and therefore the reheating of the steel is not required, as it is with cold rolled.'' [40]

''Dual Phase steels offer an outstanding combination of strength and drawability as a result of their microstructure, in which a hard martensitic or bainitic phase is dispersed in a soft ferritic matrix. These steels have high strain hardenability. This gives them good strain redistribution capacity and thus drawability as well as finished part mechanical properties, including yield strength, that are far superior to those of the initial blank. High finished part mechanical strength lends these steels excellent fatigue strength and good energy absorption capacity, making them suitable for use in structural parts and reinforcements. The strain hardening capacity of these steels combined with a strong bake hardening effect gives them excellent potential for reducing the weight of structural parts.''[41]

Tensile Strength, Ultimate	580 - 670 MPa
Tensile Strength, Yield	330 - 460 MPa
Elongation at Break	>= 22 %

Table 5.3: *Mechanical Properties*[41]

Carbon, C	<= 0.090 %
Iron, Fe	>= 98.66 %
Manganese, Mn	<= 1.0 %
Silicon, Si	<= 0.25 %

Table 5.4: *Component Elements*[41]

5.5. The manufacturing process

The wood and the leather are processed simultaneously. After both of these raw materials have gone through all the required processes, they are assembled together with the steel components.

5.5.1. Preparation of leather

There are different processes that must be followed to convert hide into leather.

The first process is the softening. The raw hide is transformed into leather, ready to be tanned. This process eliminates the epidermis, hair and greasy tissues and cleans the hide to improve the penetration of tanning agents.

Next is the tanning process when the hide is transformed into leather thanks to tannings. These are substances of different nature that makes it more durable and less susceptible to decomposition.

The last step is the finishing process where leather goes through different stages such as re-tanning, the spin that eliminates water, winding of the leather that makes the hide dry and stiff. Moreover, the clutch equalizes the thickness of the hides and pecking of the hides help to prepare hides for the next operation.

The next operations are of different types, according to the customer's needs and expectations. Hence, the following operations are carried out: dyeing, graining which allows leather to be decorated with an artificial grain, smoothing or satin leather for brightness. [42]

The leather used in this project was prepared as following.

The first process was realized in the softening workshop and in the ash box. It implied the next steps:

- Raw material: goat hide, preserved by salting
- Soaking I: 600% water (temperature: 20°C)
- Valero barrel:
  - 4 hours of shaking
  -600% water (temperature: 20°C)
  -leak
- Soaking II:
  -600% water (temperature: 20°C)
  -4% salt
  -0.2% detergent
  -3-4 hours of stirring
  -Left over night
- Flesh and fat removing

Ash box:

-400% water (temperature: 25°C)
-4% $Ca(OH)_2$
-3% Na_2S (concentration 60%)
-0.3% detergent
-left 2 days
-Stirring for 6 hours
-static overnight
-30 minutes of stirring at the beginning
-10 minutes of shaking 4 times a day
-leak

- Control: organoleptic control of hair loss, degree of swelling, fibrous tissue, temperature
- Treatment after the ash box:
  -400% water (temperature: 25°C)
  -2% $Ca(OH)_2$
  -2 days
- drain

- Washing:
  -water (temperature: 20°C)
  -30 minutes
- Manual tweaking
- Smoothing
- weighing
- Washing
  -water (temperature: 30°C)
  -30 minutes
- Decalcification:
  -150% water (temperature: 35-38°C)
  -4-5% ammonium sulfate
  -40 minutes of stirring
- Control: section 100%
- Washing:
  -water (temperature: 40°C)
  -30 minutes
- Saponification:
  -150% water (temperature: 38°C)
  -0.3% Sama Oropon OR GRAN
  -Control after 40 minutes
- Organoleptic control at 30 minutes and then every 15 minutes
- Degreasing:
  - 100% water (temperature: 35°C)
  -1.3% detergent,
  -10 minutes, stirring
  -adding 200% water (temperature: 35°C)
  -10 minutes of stirring
- Washing:
  - water (temperature: 35°C)
  -15 minutes of stirring
- Pickling:
  -100% water (temperature: 25°C)
  -6-10% salt
  -15 minutes of stirring
  -0.6% CH_2O_2 (concentration 85%) in two portions
  -30 minutes of stirring
  -0.6% H_2SO_4 in two portions
  -30 minutes of stirring
  -left over night
  -shaking for 30 minutes
- pH control and pH adjustment at 3.5-4

The next process is in the Tanning Workshop (ICPI) and implies the following steps:

- tanning:

-300% fleet (temperature: 30°C)
-10% plant extract (mimosa)
-3x30 min. + 3 hours of stirring (3 hours with shaking 5 minutes every hour)
-fleet exhaust control and plant tanning penetration
-add 3% plant extract (mimosa)
-3 hours of stirring
-0.2% $NaHCO_3$
-3 hours with shaking 5 minutes every hour;
-pH adjustment at pH 4.2

- Drain
- Rest 48 hours
- Squeeze
- Equalization

The last process is in the Wet Finishing Workshop (ICPI) and implies the following steps:

- Washing: 15 minutes with water at 35°C
- Neutralization:
  -200% water (temperature: 35°C)
  -0.5% $C_2H_2O_4$
  -1.2% $CHNaO_2$
  -10 + 30 minutes of stirring
  -PH control
- Control section
- Drained, rinsed
- Re-tanning:
  -3% plant extract (mimosa)
  -60 minutes of stirring
- Lubrication:
  -+ 50% water (temperature 40-45°C)
  -5% Taurol IGV
  -5% Taurol GS
  -50 minutes of stirring
- Fixation
  -+ 0.3% formic acid
  -10 minutes of stirring
- Control: pH 4.3, Tc = 77 ° C
- Drain
- Washing
- Rest 48h
- Free drying
- Conditioning

When the preparation of the leather is complete, it is cut in the required dimensions.

5.5.2. Preparation of wood components

The wood comes in timbers, cut to predetermined lengths and sold in cubic meters. Some of them will be cut to shorter lengths, glued with water-resistant glue and clamped together with furniture clamps to ensure a tight bond in order to obtain sturdy wood panels, from which the parts of the furniture will be cut. The timbers must stay in a carefully temperature and humidity-controlled room or the wood may swell (too much humidity) or shrink (very dry) and the piece will have cracks when finished. Temperatures must stay in the range of 50-85°F (10-29°C).

A computer-guided band saw cuts the necessary shapes for the legs, the top part of the chairs and also the sides, bottom and top of the table. A profiler finalizes the shape and sands the wood surfaces on all sides.

The next step is to create the joints. A computer guided machine drills slots called mortises. These mortises will receive pins called tenons, protruding from adjoining parts. The tenons are made by an automated machine with a rotary knife.

A coat of protective finish will be sprayed. This will make the wood waterproof and fireproof.

For the assembly, the joints are glued, aligned together and put in a press to force the tenons in their place (see Figure 5.31).

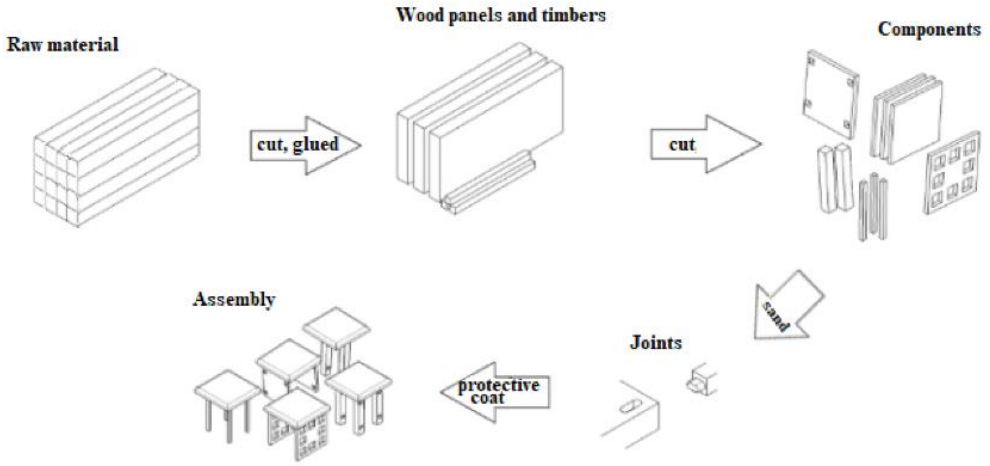


Figure 5.32: *Manufacturing process*

5.5.3. Assembly

The top part of the chairs will be attached with screws. The top part is made by gluing foam on a wood panel and covering it with the prepared leather. One side of the mobile component of the desk will be also covered in leather. The pieces of the table are assembled together with the mechanisms and the steel structure.

5.5.4. Tipping moment of the table

It is important to calculate the tilting moment of the table in order to know the available weight at the most sensitive point of it.

With the help of the diagram found in figure 5.33, it is possible to determine this weight:

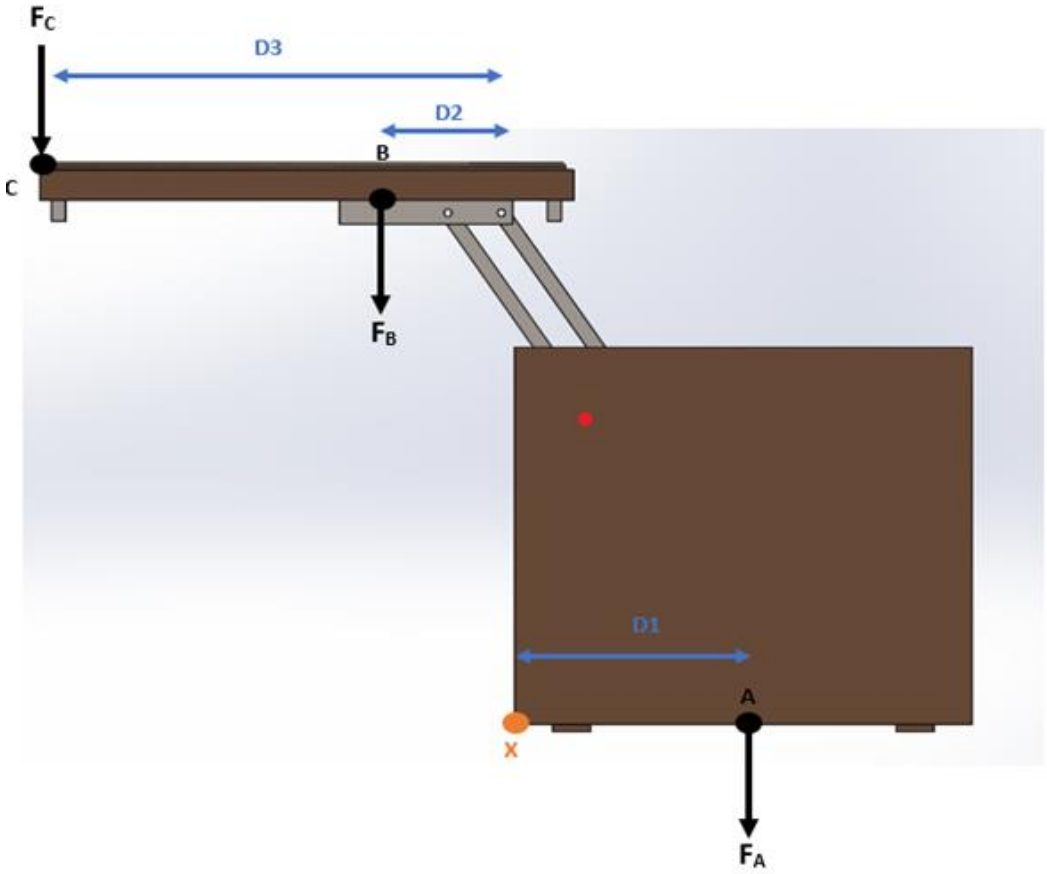


Figure 5.33: *Tipping moment of the table*

Data :

F_A : center of gravity of the storage box at point A

F_B : center of gravity of the top part and the mechanism at point B

F_C : force to be determined : the maximum force before tilting of the table

D1, D2 and D3 are distances in mm

W_A, W_B and W_C are the weights at different points of application

X: point from which the table can toggle

The red point is the center of gravity of all the system in open position, of the desk.

Resolution:

The weight of the table alone is 53 kg so we can calculate the force at point A:

$$F_A = W_A * g = 53 * 10 = 530\ N$$

The weight of the top part and the mechanism is 37 kg so we can calculate the force at point B:

$$F_B = W_B * g = 37 * 10 = 370\ N$$

It is now possible to calculate the moments of points A and B at the point of application X.

First, the calculation of the moment of F_A at point X:

$$M_X(F_A) = F_A * D1 = 530 * 300 * 10^{-3} = 159\ Nm$$

The calculation of the moment of F_A at point X:

$$M_X(F_B) = F_B * D2 = 370 * 270 * 10^{-3} = 100\ Nm$$

Using this calculation, it is possible to see that the table cannot toggle when it is fully open because Mx(Fb) < Mx(Fa).

Now it is important to know the force at point C to know what is the maximum weight that can be applied on this edge.

For the system to remain stable, there must be:

$$M_X(F_C) + M_X(F_B) < M_X(F_A)$$

$$\text{So} : M_X(F_C) = 159 - 100 = 59\ Nm$$

The force at point C can now be deduced :

$$F_C = \frac{M_X(F_C)}{D3} = \frac{59}{590 * 10^{-3}} = 100\ N$$

So the weight can be deducted :

$$W_C = \frac{F_C}{g} = \frac{100}{10} = 10\ kg$$

The maximum weight that can be placed at this point on the table is 10 kg. This result is rather weak compared to the loads that the furniture will have to bear. However, all the furniture is made of pure wood and to increase the weight it's possible to change the materials of the top of the desk to reduce the weight of the top part of the desk. For example, it is possible to use plywood painted in walnut for the top part which will have the effect of reducing the weight this part.

Another solution would be to add weights on the right side of the cabinet to move the center of gravity to the right side of the table part which will move the point A to the right and increase the moment in this point. The force at point C can therefore increase (see Figure 5.33).

However, due to lack of time, the team was unable to perform these tests.

5.5.5. Pattern

As the team has been inspired by traditional Romanian furniture, they wanted to create a pattern inspired from a traditional Romanian one (see Figure 5.32)

Figure 5.34: *Traditional Romanian pattern*[43]

The color of the pattern will be red because most of the traditional Romanian patterns come in red. Also, it is a noble color that matches perfectly with the leather and wood colors. In figures 5.35 and 5.36 are illustrated the patterns created as a reinterpretation of the old one.

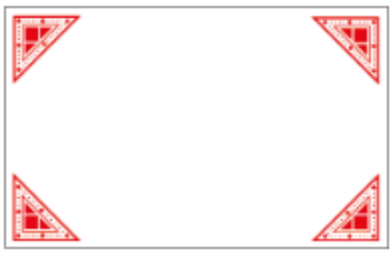


Figure 5.35: *Pattern for the table*

Figure 5.36*: Pattern for the chairs*

5.6. Model

5.6.1. Foam board model

The first model has been made of foam board on a 1:5 scale.

Foam board is a lightweight and easy to cut material used to build architectural models and in picture framing as a backing material. It consists of a board of polystyrene foam covered on both sides with white clay-coated paper.

The foam board has been cut in the necessary dimensions and glued together (see Figure 5.37) with UHU, a special glue for this kind of material. For the mobile component of the table were used 2 toothpicks.

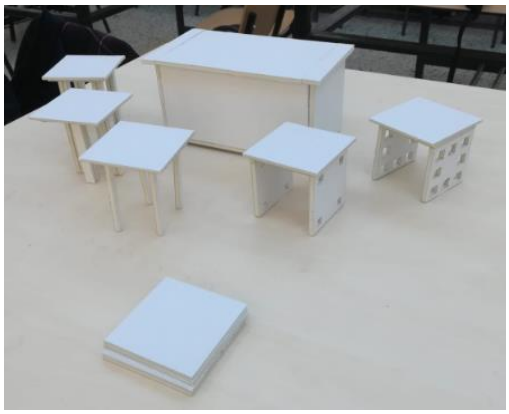


Figure 5.37: *Foam board model on going*

Next, they were painted with a brown spray and wiped with a sponge to create the illusion of a wooden piece. The top of the chairs and one side of the table's mobile part were covered in leather. The final foam board model is illustrated in Figure 5.38.

Figure 5.38: *Final foam board model*

5.6.2. 3D printed model

For a better precision, the second model was 3D printed and this one shows indeed the functionality of the product (see Figure 5.40). The printer used with a filament of PLA.

Polylactic acid or polylactide (PLA) is a thermoplastic aliphatic polyester derived from renewable biomass, typically from fermented plant starch, such as corn, cassava, sugarcane or sugar beet pulp (see figure 5.39). [44] It is one of the most popular bioplastics, used for many applications ranging from plastic cups to medical implants, thanks to its properties (see table 5.5). PLA is ideal for 3D prints where aesthetics are important. Due to its lower printing temperature is easier to print with and therefore better suited for parts with fine details[45]

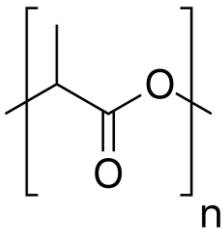


Figure 5.39: *Molecule of Polylactic acid (PLA)[46]*

Tensile Strength	37 MPa
Elongation	6%
Flexural Modulus	4 GPa
Density	1.3 g/cm3
Melting Point	173 ℃
Glass Transition Temperature	60 ℃

Table 5.5: *Properties of PLA*[45]

Figure 5.40: *3D printed model*

5.6.3. Chair prototype

The prototype of chair number 1 was made of walnut veneered chipboard, foam and vegetable leather. It is presented in Figure 5.41.

The wood panel for the top part was cut and sanded by the team manually with a saw and sandpaper. The following step was gluing the foam on one side and covering it with leather at the institute. The legs were cut and assembled in an atelier.

After both of the components were ready, they were glued together.

Figure 5.41: Chair prototype

5.7. Catalog

In order to make the furniture more exclusive, the team decided to offer the customer the possibility of choosing the wood and leather's color. For that, the brand offers a catalog of the product (see APPENDICE B), where it shows different kinds of wood and leather. In the catalog there is also a page where the main dimensions of the furniture are shown. And another one with the patterns.

The dynamics of this catalog would consist of the consumer, first of all, choose the combination of wood and leather between the different options that are shown. Then he/she will choose the pattern (it could be with pattern or without it).

The structure of the catalogue will be the following one:

1. Cover
2. Introduction about Tainaat
3. Samples (Pinewood and White Leather)
4. Appearance (Pinewood and White Leather)
5. Samples (Olive Wood and Black Leather)
6. Appearance (Olive Wood and Black Leather)
7. Samples (Walnut Wood and Natural Leather)
8. Appearance (Walnut Wood and Natural Leather)
9. Samples (Ash Wood and Brown Leather - Low Cost version)
10. Appearance (Ash Wood and Brown Leather - Low Cost version)
11. Patterns
12. Data Sheet
13. Back cover

Figure 5.42: *Catalog*

6. Conclusions

The goal of the project was to create multifunctional furniture made of eco-sustainable materials and it was achieved by designing a space saving set composed of a table and five chairs that can became a desk with one chair. From the creation of the brand to the realization of models and a prototype, the team has worked to complete the project. Tainaat, as the furniture has been coined, is made of wood, leather, steel and foam. It is fireproof and waterproof as requested and it has an attractive Romanian pattern design. Thanks to the marketing research, two types of one luxurious and one affordable furniture have been created in order to be available for both, lower and upper social classes.

The aim of the EPS project was to bring together students of different nationalities in order to cooperate during the spring semester in the development of a specific theme. From this point of view, the team managed to overcome the cultural and language barriers and worked together to successfully finish the project. This required an appropriate organization, well planned and fulfilled tasks, a good management of time and teamwork. This project also allows the team to work with an industrial partner (The National Research and Development Institute for Textiles and Leather), adding more challenge to the project.

In terms of future development, there are some points that need to be improved. First, the amount of weight that can be put on the table has to be increased at least to 50kg in order to support someone working on the desk with a computer and books. Also, if the team would have more time, they would be able to create a real size prototype in order to be aware of the size of the product and its functionality.

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- Lucian Cucu and Delia Prisecaru, for their suggestions about the design of the furniture.

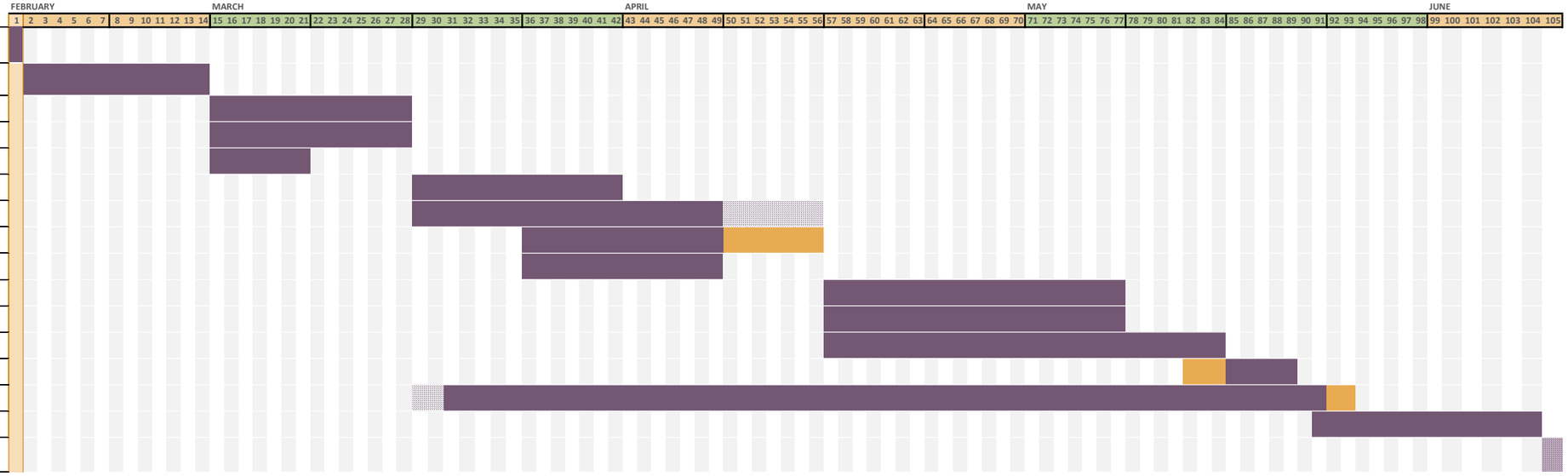
APPENDICE A: Gantt Chart APPENDICE A: Gantt Chart

Gantt chart

Important period : 1

Duration of the plan | Real duration | % achieved | Real (after the plan) | % achieved (after the plan)

ACTIVITIES	BEGINNING OF THE PLAN	DURATION OF THE PLAN	REAL BEGINNING	REAL DURATION	PERCENTAGE ACHIEVED
Theme and forming teams	1	1	1	1	100%
Project idea with the Company	2	13	2	13	100%
Inspiration	15	14	15	14	100%
Marketting	15	14	15	14	100%
Shape	15	7	15	7	100%
Materials	29	14	29	14	100%
Mechanism	29	28	29	21	100%
Patterns	36	14	36	21	100%
First Prototype	36	14	36	14	100%
Article	57	21	57	21	100%
Second Prototype	57	21	57	21	100%
Leaflet	57	28	57	28	100%
Real size chair	85	5	82	8	100%
Report	29	63	31	63	100%
Powerpoint presentation	91	14	91	14	100%
Final Project Defense	105	1	105	1	0%



APPENDICE B: Catalog

MOVABLE

Catalogue

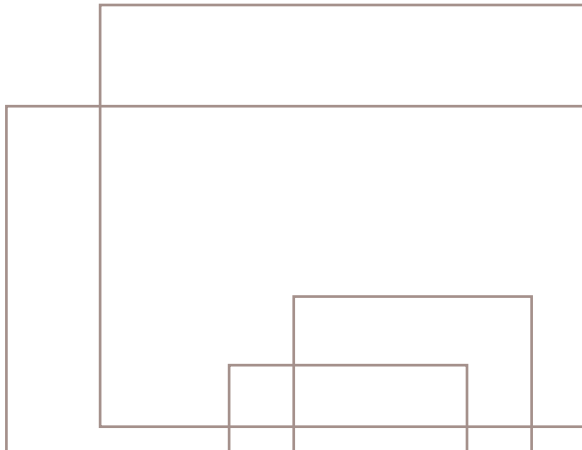
TAINAAT

Tainaat is a multifunctional furniture that will makes your life easier, due to all the possibilities that it offers you.

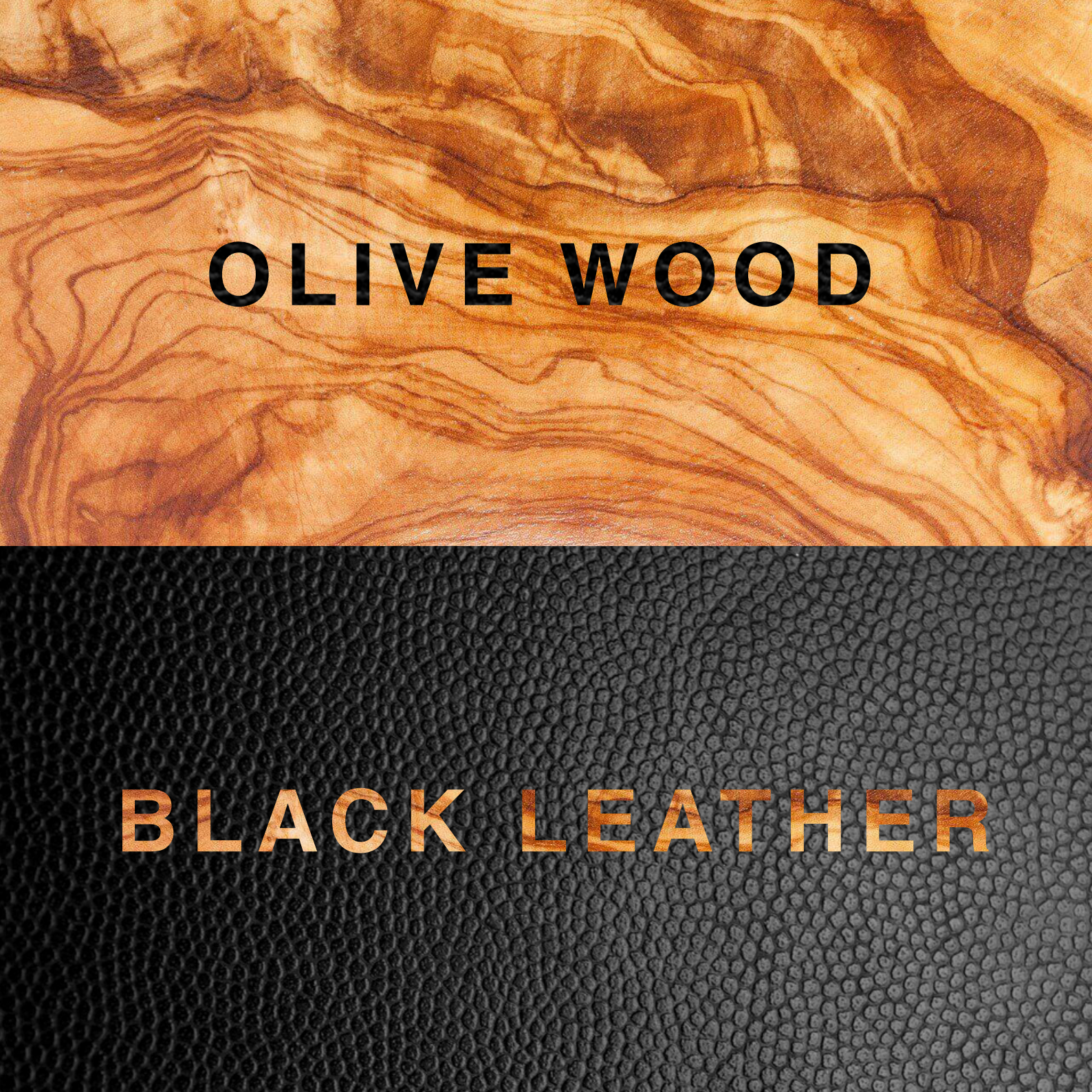
Tainaat gives you all what you need, taking the most profit of your space, always with the exclusivity and elegance characteristic of MOVABLE.

Tainaat offers three different options of solid wood, combined with differerent colors of leather. Also, it has different patters that will make of Tainaat a more exclusive product, if it is possible.

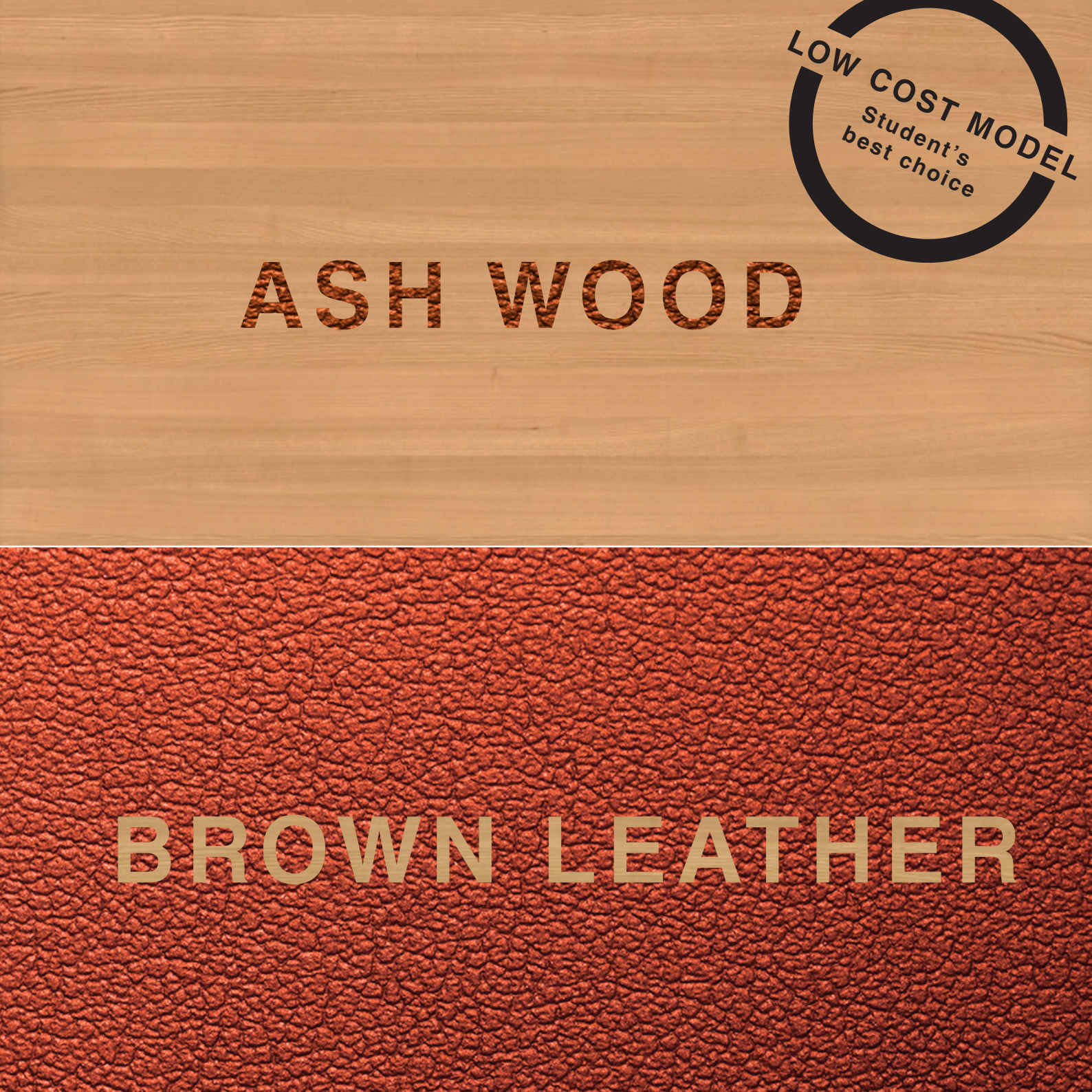
Furthermore, for those who are worried about our planet, Tainaat is an eco-sustainable furniture.




PINEWOOD
WHITE LEATHER

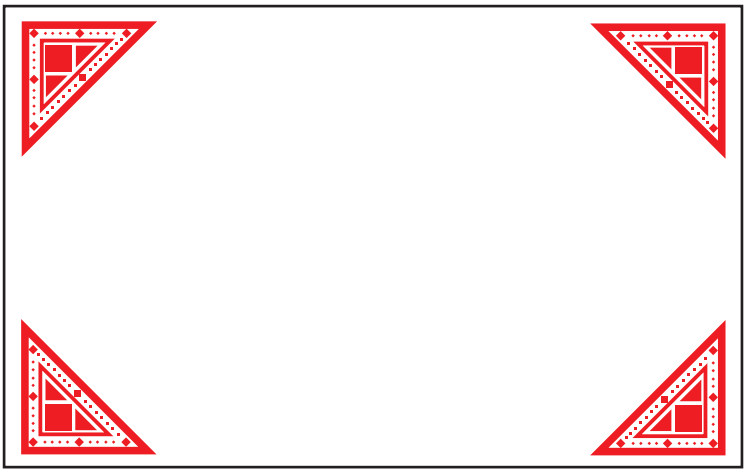

OLIVE WOOD
BLACK LEATHER

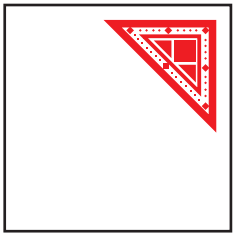

WALNUT WOOD
NATURAL LEATHER


LOW COST MODEL
Student's best choice
ASH WOOD
BROWN LEATHER

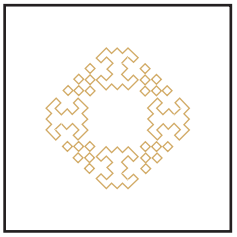
PATTERN

For more exclusivity...





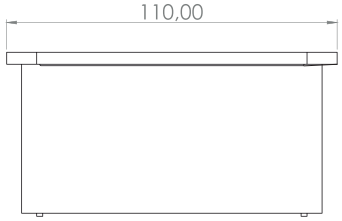
Romaninan style

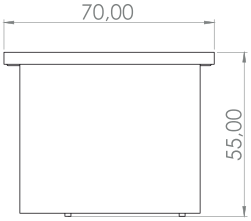


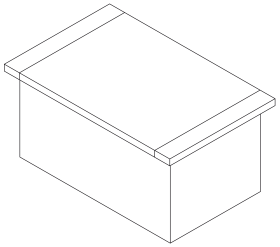
Art Deco stye

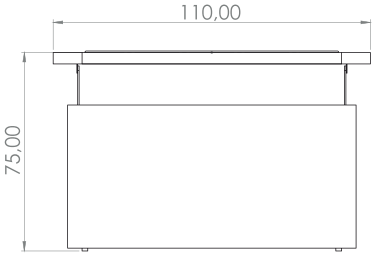
Data Sheet

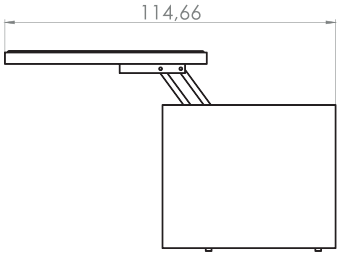
Table

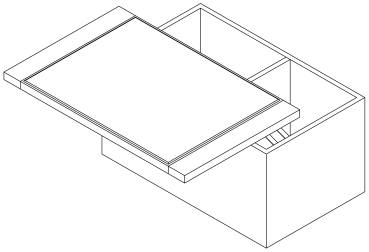




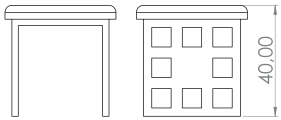


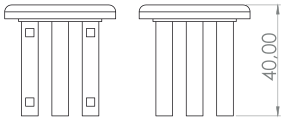


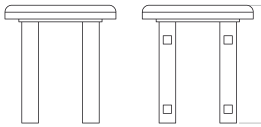


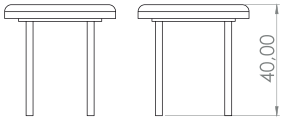


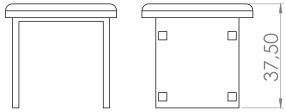
Chairs

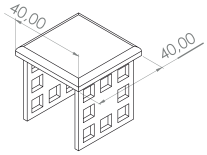


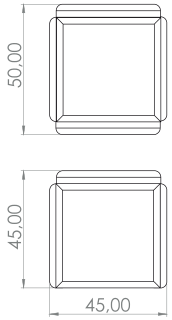


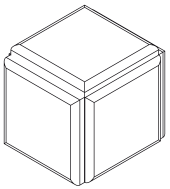






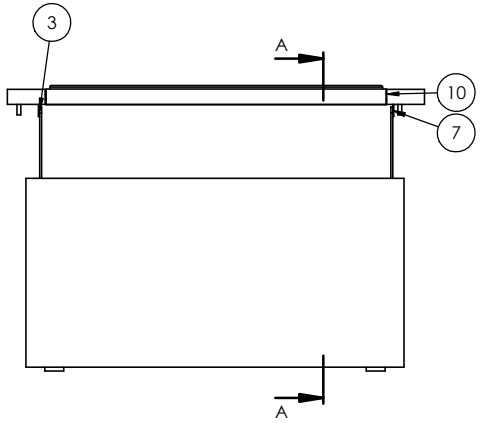


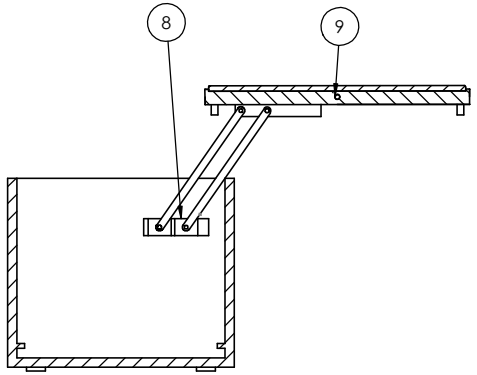




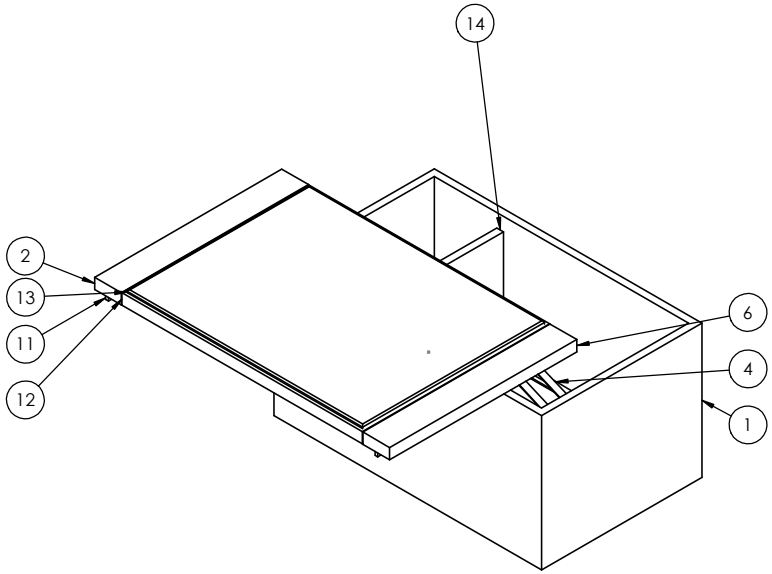

MOVABLE

APPENDICE C: Technical Drawings





SECCIÓN A-A



NUMBER	PIECE	NUMBER OF PIECES
1	Storage box	1
2	Fix part 1	1
3	Fixing mechanism 1	1
4	Guide	4
6	Fix part 2	1
7	Fixing mechanism 2	1
8	Fixing mechanism 3	2
9	Shaft	1
10	Rotative part	1
11	Closing Mechanism	4
13	Leather	1
14	Dividing Wall	1

MATERIAL:

NUMBER OF DRAWING:

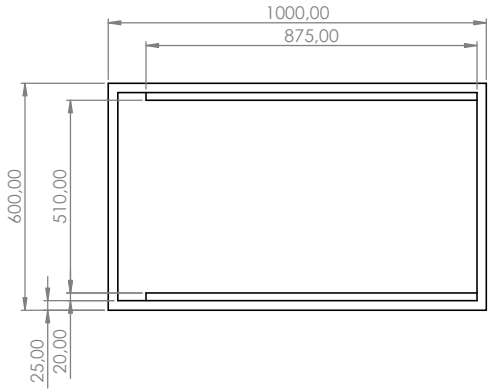
FINAL ASSEMBLY

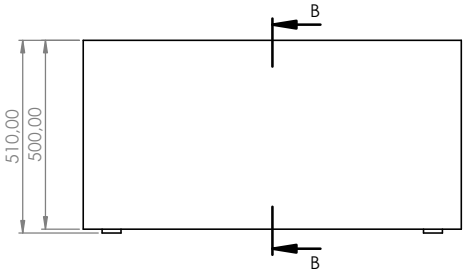
A2

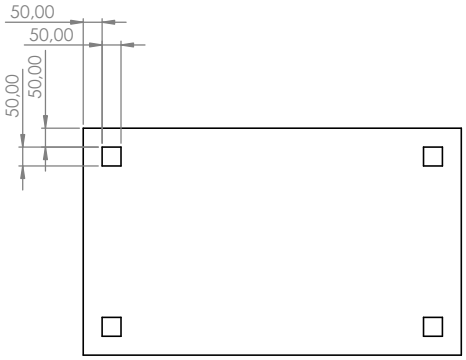
WEIGHT: 94.875 KG

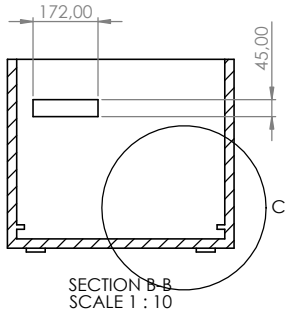
SCALE: 1:10

PAGE 1

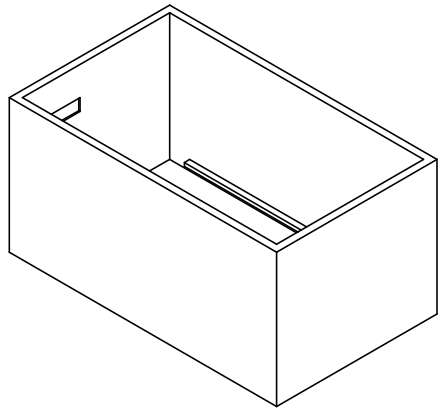


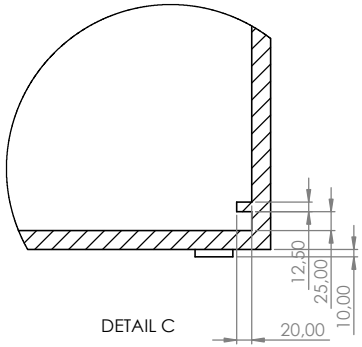






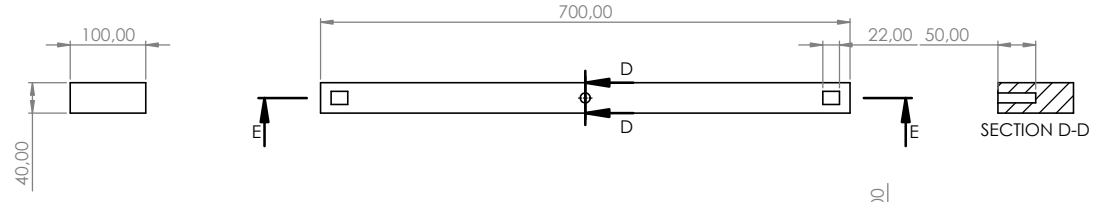
SECTION B-B
SCALE 1 : 10

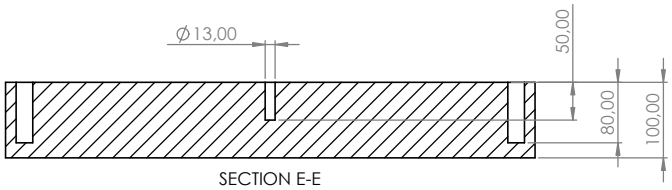


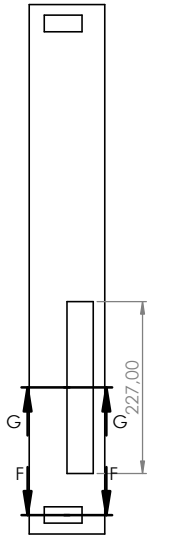


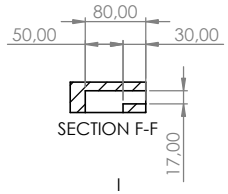
DETAIL C

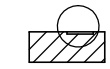
MATERIAL:	NAME OF DRAWING:	
WALNUT WOOD	STORAGE BOX	A2
WEIGHT: 52.272 KG	SCALE: 1:10	PAGE 2

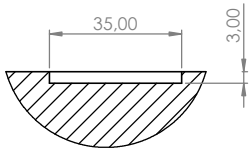


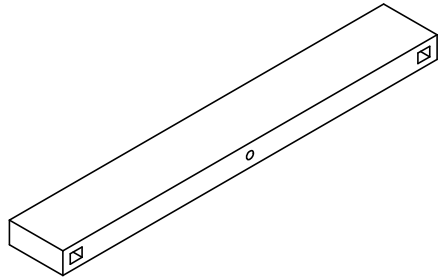




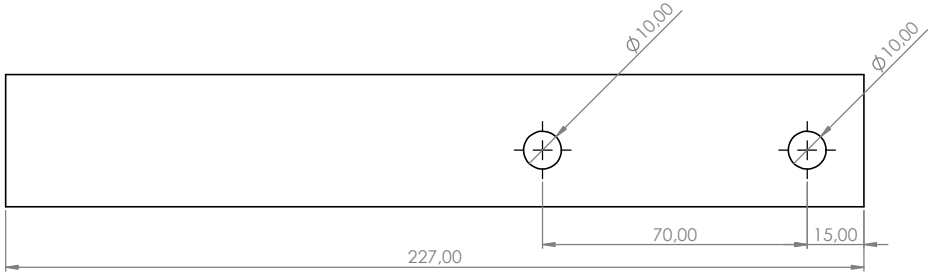


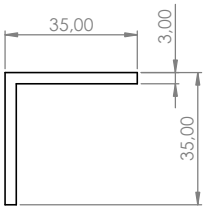


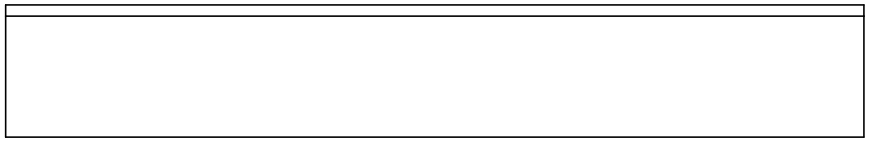


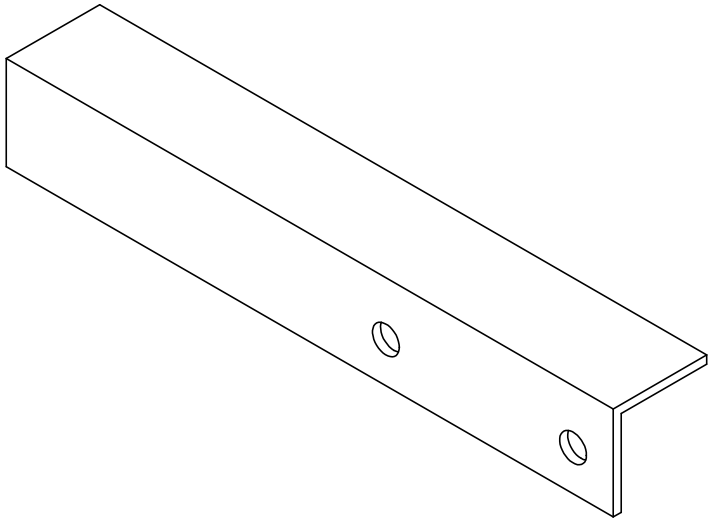


MATERIAL: WALNUT WOOD	NAME OF DRAWING: FIX PART 1	A2
WEIGT: 2,648 KG	SCALE: 1:5	PAGE 3

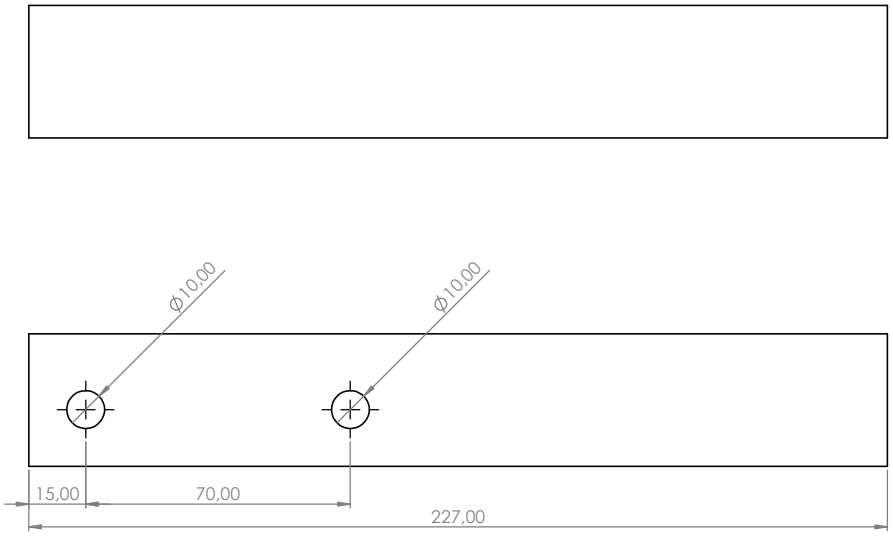


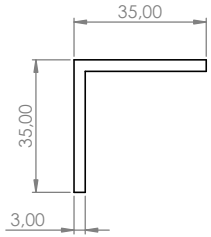




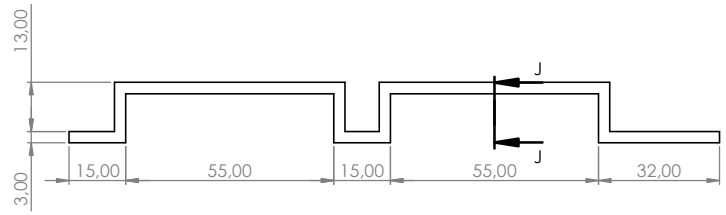


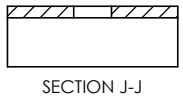
MATERIAL:	NAME OF DRAWING:	
STEEL	FIXING MECHANISM 1	A2
WEIGHT: 45,16 g	SCALE: 1:1	PAGE 3

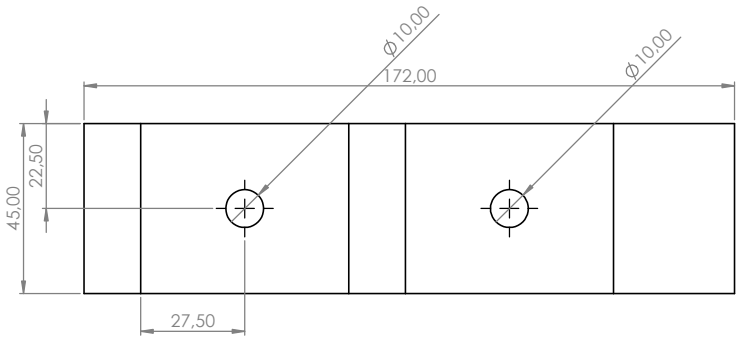


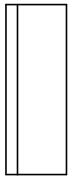


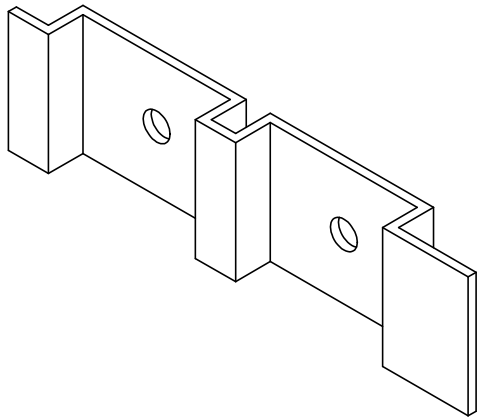
MATERIAL: STEEL	N.º DE DIBUJO FIXING MECHANISM 2	A2
WEIGHT: 45,16 g	ESCALA:1:1	PAGE 4



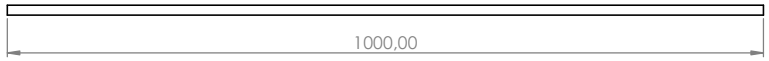


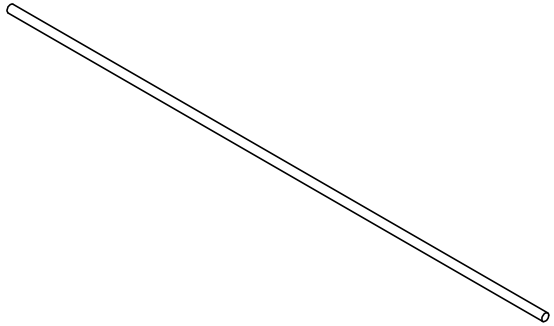




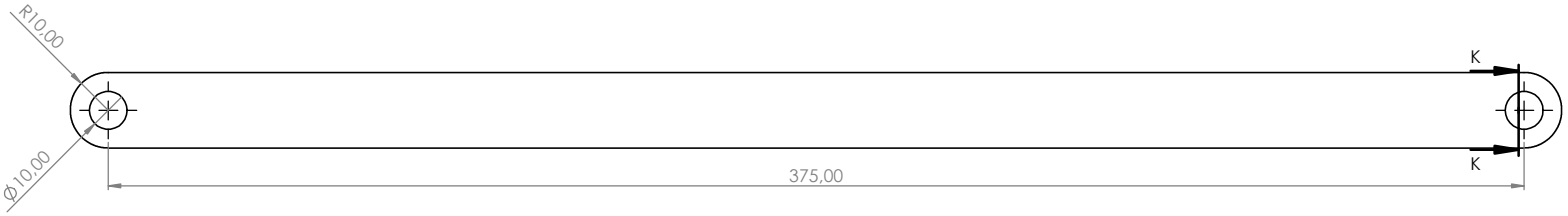


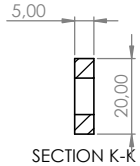
MATERIAL:	NAME OF DRAWING:	
STEEL	FIXING MECHANISM 3	A2
WEIGHT: 29,77 g	SCALE :1:1	PAGE 6



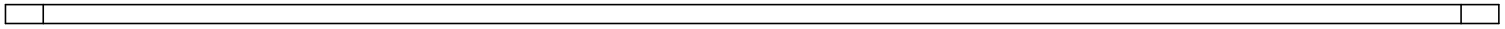


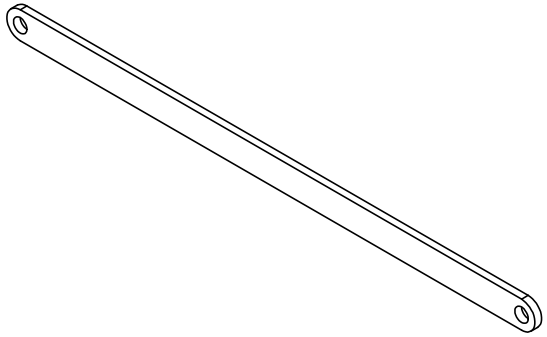
MATERIAL: STEEL	NAME OF DRAWING: SHAFT	A2
WEIGHT: 132,73 g	SCALE:1:5	PAGE 7



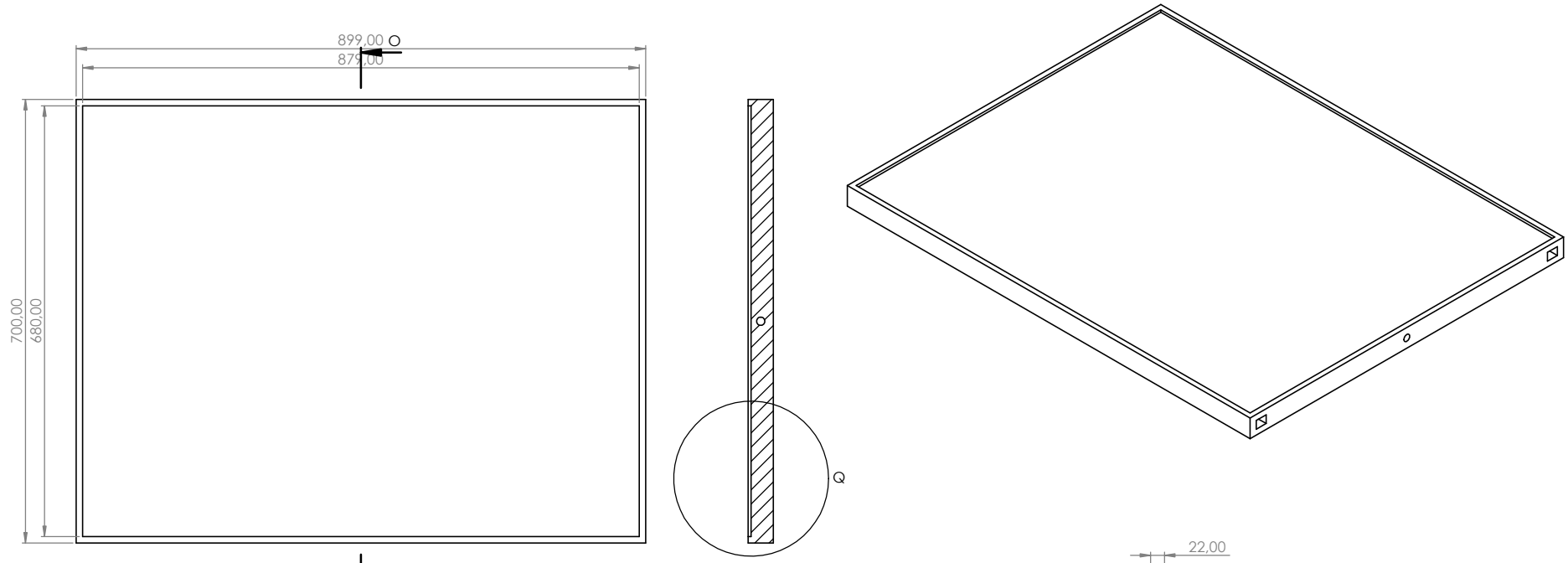


SECTION K-K
SCALE 1 : 1

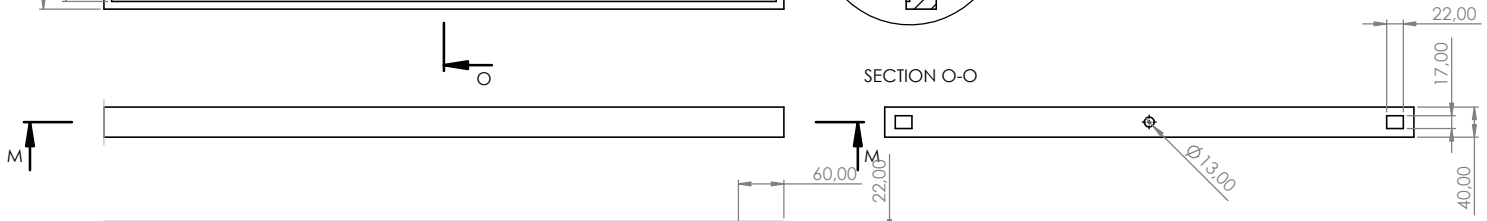


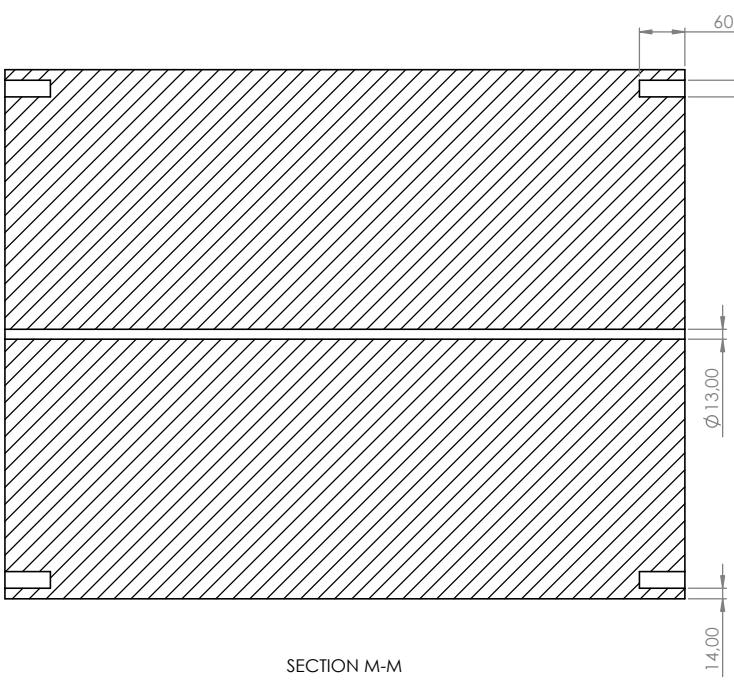


MATERIAL: STEEL	NAME OF DRAWING: GUIDE	A2
WEIGHT: 38,29 g	SCALE: 1:1	PAGE 8

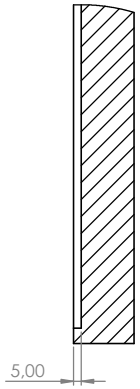


SECTION O-O





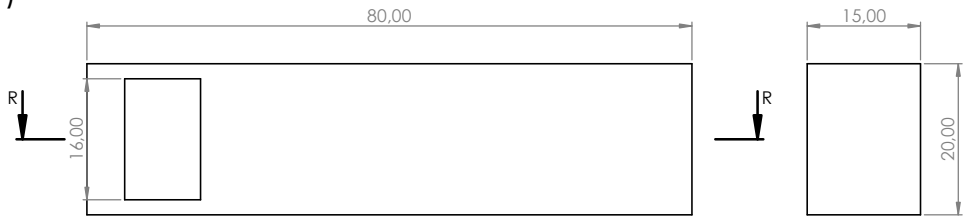
SECTION M-M

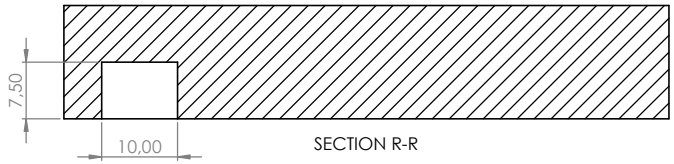


DETAIL Q
SCALE 2 : 5

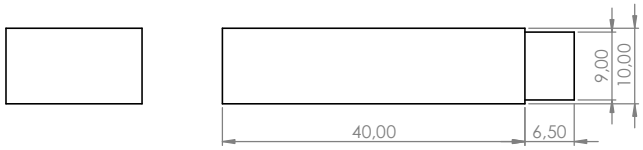
MATERIAL: WALNUT WOOD	NAME OF DRAWING: ROTATIVE PART	A2
WEIGHT: 21,974 Kg	SCALE: 1:5	PAGE 9

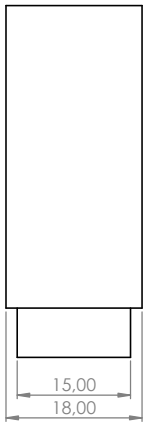
1)

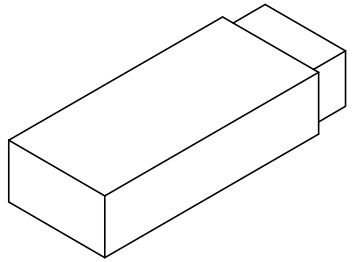


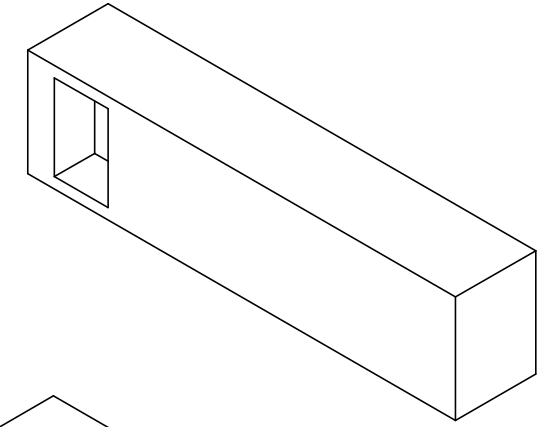


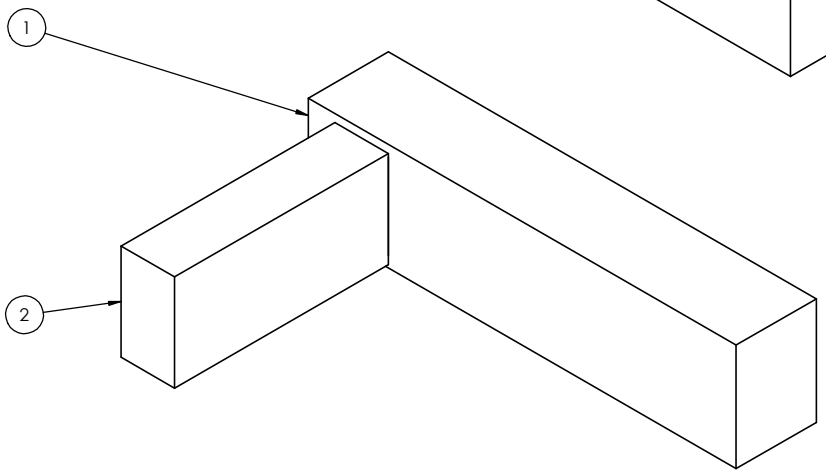
2)



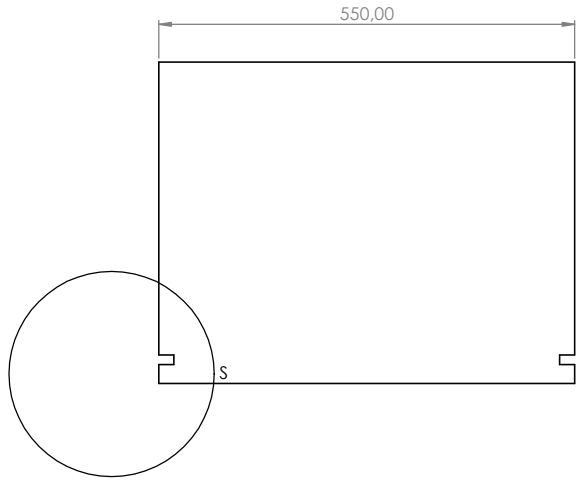


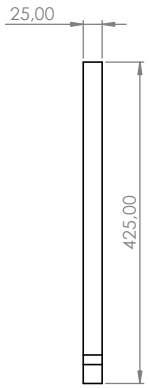


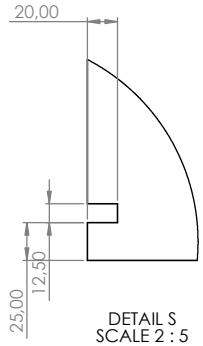




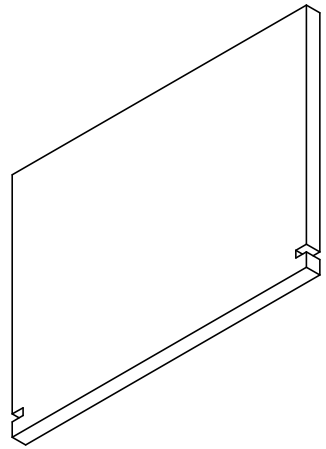
MATERIAL: STEEL	N.º DE DIBUJO: CLOSING MECHANISM	A2
WEIGHT: 30,88 g	SCALE: 2:1	PAGE 10







DETAIL S
SCALE 2 : 5



MATERIAL: WALNUT WOOD	NAME OF DRAWING: DIVIDING WALL	A2
WEIGHT: 5,831 Kg	SCALE: 1:5	PAGE 11