

# Ergonomic Reconfigurable Home-Desk | Report

## FRE Home-Desk



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## Acknowledgement

## Glossary

Abbreviation	Description
2D	Two-dimensional
3D	Three-dimensional
EOL	End-of-life
EPA	Environmental Protection Agency
EPS	European Project Semester
EU	European Union
ISEP	Instituto Superior de Engenharia do Porto
LCA	Life Cycle Analysis
MFC	Melamine Faced Chipboard
USB	Universal Serial Bus
WFH	Work From Home

# 1. Introduction

Over the course of the 2021 spring semester, multiple students from different countries and backgrounds will participate in a program which is called the European Project Semester (EPS). The goal of this semester is to work together to develop a product. In the following chapter, we will introduce our team members and our project.

## 1.1 Presentation

Our team is called team FRee, which stands for **f**urniture that is **re**configurable and **e**rgonomic and so refers to the subject that we have chosen. Team FRee is part of the European Project Semester (EPS) at Instituto Superior de Engenharia do Porto (ISEP). During the 2021 spring semester, this team will work together to develop a product which is a flexible home desk. The team consists of five students with different backgrounds, who each have their own set of characteristics, habits and skills. In Table 1, which is shown below, you can find information about the team members. During this spring semester, we would each like to combine our individual knowledge and skills to reach our goal to the best of our abilities. Our team is presented down below, in figure 2. Marcel sadly couldn't be here for the photo because of the COVID-19 pandemic.

Figure 2: Team Members



Table 1: Team Members

Name	Country	Field of Study
George-Gabriel Nicoara	Romania	Industrial Design Engineering
Anastasia Vandoorne-Feys	Belgium	Product Development
Marcel Michał Karpiak	Poland	Mechanical Engineering and Applied Computer Science
Ioana-Silvia Carasel	Romania	Industrial Design Engineering
Nikola Kocheski	Macedonia	Computer Science and Engineering

## 1.2 Motivation

Our team members are each highly motivated to participate in the EPS program. We think it would be very interesting to collaborate with students from other countries with different academic backgrounds! Learning to work together in a diverse team is incredibly important to us. In today's work environment, this is increasingly becoming the norm. We also thought it would be instructive to work in a different way than we're used to and to be able to focus on a single project for a longer period of time. Not to mention, we're eager to develop new skills; both language skills and skills that can be useful within our field of study. Finally, we hope to have some fun along the way!

## 1.3 Problem

### Introduction

With our adjustable desk, we want to tackle two global issues; the shift to a working-from-home model and the decrease in the average living area. In light of the COVID-19 pandemic, businesses drastically shifted to a working-from-home model. This shift has become a policy priority for governments to reduce the number of infections. Many people, all over the world, had to convert their home into a workplace in no time. This drastic adjustment wasn't easy on everyone, including for those who live quite small.

### Reduced Living Area

A United Nations report stated that in 2018, 55% of the world's population lived in urban areas. They expect this number to increase to 68% by 2050 [1]. "In most metropolises in the world, people's average living area is getting smaller and smaller. More and more young people tend to move to large cities for more opportunities and more active life style. However, this phenomenon decreases the average living area gradually" [2]. According to a research by LABC Warranty, 'the living rooms of newly built homes in Britain are nearly a third smaller than equivalent homes built in the 1970s [3].' With more and more people living smaller, the adjustable furniture trend is increasing.

### Working-from-home

"Before the pandemic, discussions on the future of work-life were unclear and often questioned. COVID-19 forced a decision upon people, and with the world having to adapt quickly, many businesses opted to try WFH. The WFH practices have been employed widely, as can be seen in the

U.S., where studies show in May 2020, 35.2% of the workforce worked from home, an increase from 8.2% in February” [4]. Hundreds of millions of people have lived through lockdowns and periods of quarantine. More than a year after the World Health Organization declared Covid-19 a pandemic, a lot of people are still working remotely. At first, the shift to working-from-home was abrupt for many. In the meantime, this working-from-home model has been normalised because of the pandemic. The whole 9-to-5 model has been turned upside down and the lines between home and office are becoming more and more blurry, illustrated in Figure 3.



Figure 3: Long-term remote work has completely reshaped the 9-to-5 and blurred the lines between home and office [5]

There are certain risks associated with working from home, specifically on the long term. These consequences, primarily related to health, should be considered by both employers and employees. “According to the Get Britain Standing organisation, a sedentary lifestyle is one of the four top causes of preventable death. From cardiovascular health and metabolism issues to mental health, back and neck pain, muscle degeneration and osteoporosis, a wide range of conditions can be caused or exacerbated by excessive amounts of time spent sitting down [6].” Constant sitting is a real problem when working from home. As mentioned before, the boundaries between work and life get more and more blurred. Some employees work way longer hours because the starting and stopping time is more unclear. They can start their work day long before the time they would normally enter the office and also finish later in order to finish their work. Going out for a coffee or lunch is getting replaced with taking ten steps to the kitchen. This all results in more sitting and less steps throughout the day.

We need to rethink the working environment for sedentary workers - and that's where standing desks come in. Remote workers should have a desk that enables them to sit or stand as they prefer. “Research and medical trials suggest that standing desks directly help to boost work performance and reduce the risks inherent in a sedentary lifestyle. In research published by the British Medical Journal (BMJ) in 2018, NHS staff who swapped their standard desks for sit-stand workstations reduced their sitting time by around 80 minutes per day after a year [7]. ”

Our way of working will probably never be the same, but how it will differ is still unclear. “A Future Forum research of 4,700 knowledge workers found the majority never want to go back to the old way of working. Only 12% want to return to full-time office work, and 72% want a hybrid remote-office model moving forward [8]”. A sitting to standing desk can be a solution for remote workers who are concerned about the consequences of reduced moving and increased sitting.

## 1.4 Objectives

The main objective of this project is to develop an adjustable home desk that enables the user to decide which position allows him/her best to focus. When not in use, the desk should be transformable into a bench so the user can rest or use it for different purposes. After analysing similar products on the market, we will design our own prototype. During this process, we must keep in mind the ethical and sustainable issues regarding our product. In the end, our product must meet the predetermined requirements and undergo the necessary tests.

## 1.5 Requirements

We've made up a list of requirements for our desk, that is shown in Table 2. At the beginning of the project we received a predetermined budget of 100 euros, which must be taken into account.

Table 2: Requirements

1	Easily and electrically adjustable
2	Ensures an ergonomic posture
3	Ensures a comfortable position
4	Easy maintenance
5	Room for storage
6	Charging ports
7	Inclination angle
8	Built in desk lamp
9	Three possible heights

## 1.6 Envisaged Tests

*Describe here the functional and performance tests envisaged.*

## 1.7 Report Structure

The report consists of eight chapters. Their names and contents are listed below, in Table 3.

Table 3: Chapters

1	Introduction	A presentation of our team and our project. More precisely the problem we want to tackle, what we want to accomplish and how we plan to do this.
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2	State of the Art	Presented here is our research. We looked into different kinds of transformable furniture and made a comparative table with existing desks. We also delved deeper into ergonomic furniture to support our design. Finally, we investigated the shift to working from home and its consequences.
3	Project Management	A report on our management process using SCRUM and Agile Project Management.
4	Marketing Plan	An analysis of the market and our target group followed by strategies to launch our product in that specific market.
5	Eco-efficiency Measures for Sustainability	An analysis of the impact our product has on the environment; focusing on the social, economic and environmental aspects.
6	Ethical and Deontological Concerns	An analysis of all ethical issues relating to our product and possible solutions.
7	Project Development	Specifications related to the product such as the different components, the product architecture, ... Sketches and prototypes will also be shown here.
8	Conclusions	Summary of the report and possible future development.

## 2. State of the Art

### 2.1 Introduction

The overall theme of our project is ergonomic reconfigurable furniture. Now, what does this actually mean? Our team thought about the meaning of reconfigurable and came up with some terms; modular, multifunctional, transformable, adjustable, ... According to the Cambridge Dictionary, to reconfigure means ‘to change the structure or arrangement of something’. ‘Modular’ is described as ‘consisting of separate parts that, when combined, form a complete whole’. The remaining terms speak for themselves and I think it’s safe to say that they are all more alike than they are different. In the state of the art, we will discuss these terms and some solutions related to them. By reading and analyzing different papers and projects, we hope to gain a better insight into the existing design solutions.

### 2.2 Transformable Furniture



Transformable furniture is designed based on the concept that the furniture's design must involve at least two forms of appearance and function [9]. By having multiple functions, the furniture forms a solution for people with too little space. Transformable space-saving furniture is often innovative, has much opportunity for future development and a huge potential market in metropolises [10]. In this section, we're looking into some of the existing transformable furniture designs. We started looking into transformable furniture in general and then, when the scope of our product was defined, we focused mainly on adjustable desks.

## FURNITURE IN GENERAL

### **Transformable bed**

The most common example of this type of save-spacing furniture, may be a transformable bed. There are a lot of forms of transformable sleeping spaces because beds take up a lot of space and don't have a lot of use during the day. Space saving beds can be divided into two categories, regular beds and bunk beds. The bed can be transformed into a different type of furniture (e.g.; a table, a couch, a desk, etc. ...) and hereby helps owners to utilize their furniture efficiently. The most important function of this design is that it increases the available space of the room which makes is very helpful for people who live in small apartments. There are different ways to transform a bed; some beds are extendable and can be pulled out of some kind of storage space, others have the possibility to be mounted against the wall. Transformable beds can be quite expensive [11].

### **Transformable tables**

Many tiny houses use transformable tables. These tables that can serve as a bar, desk, small coffee table, etc. ... but have the possibility to expand into a large dining table. Sometimes the tables can be folded down from the wall, saving even more space. Some people build storage shelves on the wall against which the table is mounted, these are hidden when the table is folded and revealed when the table is in use.

### **Az desk and seat**

The Az desk and seat by Guillaume Bouvet is designed with the life cycle of the user in mind, the furniture is supposed to grow with children. The vertical blackboard with a magnetic surface can be converted into an ergonomic work surface and be adapted to the user's size from young children to adults. The desk is made using birchwood ply panels providing a good stability and a solid aspect to the unit. This type of wood, from eco-managed forests in northern Europe, is known for its robustness; its texture, grain and natural colour stimulate the development of the child's senses. This project has been designed based on ecologically sustainable development principles [12].

### **N+L Convertible Series**

FEIT designed a cradle for newborn babies that can transform into a drawing table and then a desk, as the child develops and grows. The Green Product Award writes that "The N+L convertible Series, consists of a cradle NINA, plus a table LUCA with a maxi drawing top and desk whose height can be adjusted thanks to its feet. A special feature are the natural materials used, like the solid wood for the frame, or the organic lambswool for the cradle sides and coconut fibre for the mattress filling. The average cradle has a lifespan of about 9 months, this piece of reconfigurable furniture provides a second use and therefore also a longer life of the product [13].

### **IKEA HACKA**

Designer Philip Süssmann wants to respond to the fact that more and more people want to modify

products to make them their own. The design is a frame system, made out of standard sized wooden beams and metal joints, which function as the main structure for kitchen appliances such as cabinets, surfaces and fittings. Due to the systems flexibility and possibility of hacking, it allows for custom sizes and third party objects, making it possible to cater for different needs in any environment [14]. The kitchen is really something you can make your own, what makes it more flexible and personal to the user.

## DESKS

### **PROPR OFFICE**

PROPR OFFICE IS a new name in the furniture space that delivers sit-to-stand adjustable desks in an array of sizes for whatever space constraint you may have. This adjustable height desk is powered by "smooth, nearly silent" electric lifters. The desk features a durable and commercial quality laminate top that is easy to clean and disinfect. The two steel legs at the base are powered by dual motor lifters that operate under 50 decibels. There are two versions available; Prch Adjustable Height Desk 48" wide x 24" deep and 42" wide x 24" deep. They both weigh approximately 130 lbs [15].

### **Jaswig StandUp Nomad**

Using standing desks is a great way to incorporate a bit more activity into ones workaday life, which is much needed during this pandemic. "The Jaswig StandUp Nomad is a wooden standing desk that is adjustable, made locally with eco-friendly materials, and, most importantly, a pretty piece of furniture [16]." The desk is 100% manufactured in the United States, using eco-friendly materials namely, sustainably-grown, Forest Stewardship Council-certified birch plywood. The Jaswig StandUp Nomad can be assembled tool-free in under 15 minutes. The desk is easy to move around due to its compact design, which makes it a very flexible home desk. On top of that, an ergonomic footrest provides comfort and assists with weight distribution. There's even room for storage beneath the tabletop. There are nine different height settings, that can be adjusted manually; starting from 93cm minimum up to 122cm maximum. The tabletop is available in a regular and a wide size. The desk also has a kids version available starting from 250 € a desk, the wide version can go up to 420 € [17].

### **Modular desk**

This desk concept from French design student Francois Dransart consist of built-in interchangeable modules for organising specific desktop items. With this design Dransart wants to address the problem of office clutter. "It features a slim oak top with rectangular slots that hold completely flush-fitted storage boxes - for paper, pens, wires, plug outlets, and other items - plus a headphone stand, an LED lamp and an induction charging plate [18]."

On top of of the white plastic storage boxes, there are small brown leather tabs for lifting them out of the desk. On the front of the desk there's a grey felt tab for comfort, and on the back there's one for holding wires. The slender frame is intended to be made from bent steel, coated white to match the boxes. [19]

### **Unplugged**

Unplugged is a thesis project of Swedish student Eddi Törnberg. The idea behind this energy producing workspace came from the belief that society as a whole lacks "the will, interest and energy to struggle to achieve a sustainable society." Törnberg tried derive energy from things we already do. "Unplugged is an office that facilitates producing the energy needed to run all of our office electronics through doing everyday activities." In this design, he incorporated three techniques to produce energy: piezoelectricity from the carpet, the chair utilizing the Seebeck effect, and the flower through



photosynthesis [20].

### **SIT-STAND DESK**

This sit-stand desk from MATEO GOODS aspires to make the working environment both inspiring as functional. This adjustable height desk with 2 felt-lined drawers and integrated wire management comes with 3 power modules with USB charging ports. The desk is made out of resilient materials, including solid Baltic Birch with a focus on eliminating waste and ensuring durability. With the help of electronic height adjustment, the desk rises and falls through a simple push button. The desks have a built-in wire management system that hides unsightly wires and accounts for just how many devices we have in our lives. It contains a whole suite of accessories and is therefore fully customizable to suit your every need. The design includes secondary surfaces that help hide clutter and allow you to enjoy your office spaces [21].

### **BEKANT DESK IKEA**

“This robust desk is guaranteed to withstand years of coffee drinking and hard work. By alternating sitting and standing, your body stays in motion so that you feel better and perform better. The height of the work surface is electrically adjustable from 65-125 cm, giving you an ergonomic working position. With the cord net under the tabletop, you can easily keep your desk neat and tidy. A melamine tabletop is wear-resistant, stain-resistant and easy to keep clean. The depth of the desktop provides ample workspace and a comfortable distance from the display. By using saw residues and wrecking wood in the chipboard of this product, IKEA uses the whole tree and not just the trunk. This desk has been tested for office use and meets the requirements for durability and stability according to standards: EN 527-2 and ANSI/BIFMA X5.5 [22].

### **YAASA DESK**

The YAASA Desk Basic is designed to be adjusted to the perfect height in a fast, intuitive and effortless way. The height can be adjusted from 71 to 120 cm. The hand switch is located beneath the tabletop, and can be mounted in different positions according to your preferences (e.g. if you are left-handed). The desk guarantees seamless transitions with optimum drive dynamics through integrated high-performance motors. At just 32 kg, the YAASA Desk Basic is a lightweight champion on the market for height-adjustable desks. There are no compromises on stability or quality, while simplicity makes assembly quick and easy. On top of that, the desk is robust and easy to assemble [23].

### **VIVO**

VIVO has a wide range of electrical height adjustable desks. The DESK-KIT-2E1B is one of their bestsellers, which we chose to analyse. The desk uses built in cable management for a clean and organized appearance [24]. It contains a timer that reminds you to stand up throughout the day. Using three memory presets, you can easily remember your ideal height. The desk can hold 77kg and the height can be adjusted between 75 and 126cm. These last two numbers can differ according to the specific desk you buy from VIVO.

### **Allcam Desk**

Just like VIVO, Allcam has quite a range of sit-to-stand desks. We analysed the Allcam Desk EDF21SS, one of their ergonomic height adjustable sit-stand desks. The height can be adjusted between 73.5 and 123.5cm, with a simple 2-button remote. The desk is innovating because the motor and controller are merged into one module, which results in a more reliable product at a reduced cost [25]. The construction is made out of heavy steel and can bear a load of 60kg. The desktop is made out of MFC and has a compact size of 120×80 cm. The whole desk is flatpacked and according to Allcam, you




should be able to finish the assembly in 10mins.






### PrimeCables®

We analysed the PrimeCables® Sit-Stand Dual-Motor Height Adjustable ADR Desk. The company calls this desk “a minimalistic option and the best standup desk if you want something without frills or high costs, perfect for offices, schools, homes and most working environments” (PrimeCables®). The desk contains 3 programmable height memory presets. It has an adjustable width range from 110 to 180cm. The height is adjustable between 62 and 125cm. The desk can carry a load up to 124kg. They claim that the range fits almost everyone but after reading some reviews, this doesn’t seem to be right. Some people claim that the shortest position is still way too high. On top of that, multiple reviews state that the desk is quite wobbly.

Table 4 summarizes all the commercial desks, and their features, mentioned above.

Table 4: Commercial desks

Name	Image	Price (€)	Features	Sustainability	Market	Ethics
Propr Office		420-585	(electrical) adjustable height desk, electric lifters, durable and commercial quality laminate top (easy to clean and disinfect)	/	/	/
Jaswig StandUp Nomad		250-420	Tool-free assembly in under 15 min, easy to move around, ergonomic footrest, storage room, different height settings (manually adjustable)	100% manufactured in the United States, using eco-friendly materials namely, sustainably-grown, Forest Stewardship Council-certified birch plywood	/	See sustainability
MATEO GOODS SIT-STAND Desk		1165	(electrical) adjustable height desk, integrated wire management, 3 power modules with USB charging ports	Resilient materials + Focus on eliminating waste and durability	“For creative thinkers and problem solvers that want to live a more inspired life through exceptional furnishings, designed and curated by artists, for artists.”	Handcrafted

Name	Image	Price (€)	Features	Sustainability	Market	Ethics
BEKANT Desk		449	(electrical) adjustable height desk, Cable management net (keep desk tidy), Deep table top, Tabletop is wear-resistant, stain-resistant and easy to keep clean	By using saw residues and wrecking wood in the chipboard of this product, IKEA uses the whole tree and not just the trunk.	/	/
YAASA Desk		498	(electrical) adjustable height desk, Hand switch beneath tabletop, Lightweight	/	/	Production is performed by partners in Europe.
VIVO Desk		333	(electrical) adjustable height desk, built in cable management, memory presets, timer to stand up	/	/	This product can expose you to chemicals including Diisononyl phthalate (DINP) which is known to the State of California to cause cancer and Di(2-ethylhexyl)phthalate (DEHP), Lead which are known to the State of California to cause cancer and birth defects or other reproductive harm.
Allcam Desk		230	(electrical) adjustable height desk, 2 button remote, assembly in 10mins	Whole desk is flatpacked.	/	/
PrimeCables Desk		270	(electrical) adjustable height desk, memory presets, adjustable width, can bear a high load (124kg), not very stable	/	/	Bad customer service

## 2.3 Ergonomic Furniture

Ergonomic, as Cambridge Dictionary defines the term, “is relating to the design of furniture or

equipment which makes it comfortable and effective for people who use it". Another two definitions are given by Merriam-Webster Dictionary: " 1: an applied science concerned with designing and arranging things people use so that the people and things interact most efficiently and safely; 2: the design characteristics of an object resulting especially from the application of the science of ergonomics".

As scientific literature mentions, ergonomics is a scientific discipline that studies the relationships between humans and other system components. It is also a field of study that uses theory, concepts, data, and methods to improve human well-being and overall system efficiency by design. The term ergonomics is derived from the Greek words "ergon" (work) and "nomos" (laws). It's basically the "work rules" or "work science." Good ergonomic design reduces incompatibilities between human and their working space, resulting in the perfect working environment.

Ergonomic furniture has the ability to adapt to the individual requirements of the user to ensure good posture. This type of furniture is specifically designed to function in harmony with the shape and natural curvature of the human body so as to ensure maximum comfort and overall wellness of the user. Ergonomic furniture is recommended in areas like the home office and offices where one tends to spend a lot of time sitting in one place [26].

### **Ergonomic school chair with adjustable parts**

An ergonomic chair with adjustable parts was designed to achieve a good match between the anthropometric characteristics of students and the furniture they use. Anthropometry is defined as measuring dimensions of the body, including body size, shape, strength, capacity, and volume for designing aims. A large number of studies, worldwide, have shown a mismatch between students' anthropometric characteristics and dimensions of classroom furniture. Studies have shown that inappropriate design of chairs and their disproportion with body dimensions in the long-term not only influences physical growth, poor postures, and musculoskeletal disorders, yet also decreases student's learning interest, even during the most stimulating and interesting lessons, and indirectly affects educational efficiency and focus [27].

The chair designed and developed in this study was ergonomic and helped to reduce musculoskeletal disorders in students. Some ergonomic characteristics of this chair included adjustability of footrest, backrest, armrests, and desk and these factors led to the use of this chair by many students with different body sizes. The edges of the seat had a curvature that prevented pressure to different parts of the body and created comfort for users. Other advantages of this chair that distinguished it from other educational chairs include adjustable footrest so that legs can be fully fitted, adjustable height of the desk and left armrest, desk rotation in two axes of X and Y, adjustability of the angle between the backrest and seat in four degrees, the large surface of the desk, grooves on the backrest to place bags, a groove on the desk to place pens and pencils [28].

### **Classroom furniture with proper anthropometric measures for primary school**

The aim of this study was to compare the dimensions of students to the dimensions of school furniture in primary school to see if this form of furniture is well-designed and encourages good sitting posture at school by taking the children's dimensions into account. The data reveal a discrepancy between the physical measurements of the students and the classroom furniture they normally use. The seats are too high and too deep, and the desks are also too high. This situation has a negative impact on children's sitting posture, especially while reading and writing. The study proposes adjustable furniture as a solution, due to the fact that a range of furniture sizes from which students can pick the correct one at the start of the school year is unlikely to be financially feasible [29].

## Dynamic office chairs and their impact upon muscle activation, physical activity and posture

Studies in the literature show that repeated and static sitting postures at visual display unit workplaces cause physical inactivity and are risk factors for the musculoskeletal system. The aim of the present study was to evaluate the effects of four specific dynamic chairs on spine, postures angles and physical activity intensity, compared to those of a conventional standard office chair. All chairs were fitted with sensors that measured chair parameters (backrest inclination, forward and sideward seat pan inclination) and were tested by 10 subjects performing a number of office tasks, as well as in the field by another 12 subjects doing their daily office work. There were almost no noticeable variations in muscle activation, postures angles, and physical activity during the execution of traditional office tasks when comparing the four different dynamic office chairs with a typical one. The study's findings highlight the importance of considering multiple aspects of workplace design, such as tasks variability and other elements in the working space, other than the chair, in order to reduce physical inactivity at visual display unit workplaces and musculoskeletal disorders [30].

## Design and analysis of an ergonomic-automated adjustable drafting table

The majority of young adults nowadays have a daily job that requires them to sit at a table or at a desk. As a result, they experience pressure, back and neck pain, because the table's dimensions are incompatible with their body dimensions. Based on the anthropometric data of a random sample of students, the goal of this study was to design an ergonomic-automated adjustable drafting table. The product was tested among the target group and, as a result, students prefer the proposed design to the current fixed one since it has an adjustable height, width, and desktop inclination with an automatic mechanism. The proposed desk aims to assist in the prevalence of musculoskeletal disorders, as well as provide users with safety, comfort and adaptability [31].






## The ups and downs of sit-stand desks

This study is a complex review that examines the effects of sit-stand desks on six domains: behaviour (e.g. time spent sitting and standing), physiological, work performance, psychological, discomfort, and posture. It concludes that while sit-stand desks may change the user's behaviour, they only have a minor impact on health outcomes. It has also been identified that sit-stand desks are most effective for reducing discomfort and least effective for increasing productivity. Despite this, further research is required to investigate long-term effects and assess clinically appropriate dosage and workstation configuration [32].

## 2.4 Mechanism for lifting and inclination of the desk



An adjustable desk has to be adjusted in an ergonomic way, so that the user is as comfortable and efficient when working from home. Table 5 illustrates the comparison between lifting mechanisms used in desks on the market.

Table 5: Lifting mechanisms


Product	Pros and Cons	Price (€)	Picture
Crank mechanism [33]	+ Durable + Wide lifting range (manual or electrical) + Comes with a handle/button - Expensive - Heavy	83 for manual 170 for electronic	
Lift-up table mechanism [34]	+ Quick to lift up - Less durable -Expensive	167	
Automatic Sliding Mechanism [35]	+ Automated mechanism + Can be done handmade + Space saving - Complex structure - Expensive -Does not lift heavy weights	Unavailable	
Folding mechanism [36]	+ Quick, easy to lift + Cheap + Space saving - Lifting range limited (short range) - Not durable - Small lifting strength	8	
Scissor lifting mechanism [37]	+ Durable + Can lift heavy weights + Space saving - Slow lifting process	Unavailable	

As for the inclination of the table top, there are some mechanisms that can Table 6 illustrates the comparison between the inclination mechanisms used in desks on the market.

Table 6: Inclination mechanisms

Picture	Pros and Cons
 [38]	+Space saving + Easy to use - Fixed values of inclination range - Easy to break
 [39]	+ Space saving + Easy structured + No fixed values of inclination range - Small range of inclination -



Picture	Pros and Cons
 <p data-bbox="151 369 207 403">[40]</p>	<p data-bbox="459 253 1442 320">+ More stable + No fixed values of inclination range - Complex structure - Easy to break - Higher price</p>

## 2.5 Working From Home

The pandemic situation changed the way of work all around the globe. Following sanitary restrictions, companies started to move towards remote work. At first for most of the society it was an obstacle, as many wasn't so efficient when it comes to operating with computers and so on. But as the time went by, people started to get used to it. Many companies started thinking that some of the tasks can not necessarily be done stationary. This article shows why working from home will be a thing in a near future and possibly will stay with us for a long time.

### **COVID-19 forced workers and firms to experiment with working from home, helping overcome inertia.**

The pandemic situation forced some companies and workers to experiment with remote work, a technology they previously had access to but not tried out due to inertia. Prior to COVID-19 they operated on on business premises, with the payoffs of this strategy coming from a known distribution. At the same time firms had access to a second technology — working from home — which they could try out at some fixed cost. Once COVID-19 arrived it forces firms to all pay the cost of trying out working from home. This is also a learning opportunity. The survey showed that more than 60% of workers confirmed that the remote work turned out better as they expected it to be.

### **Workers and firms have made investments enabling working from home that will remain after the pandemic**

The sudden shift to working remotely seen in 2020 spurred workers and firms to invest in physical and human capital to help them work from home effectively. Millions of people learned to use teleconferencing software and many others faced incentives to purchase desks, chairs, microphones, etc., to help them work from home more effectively. These investments will remain after the pandemic and will thus lower the marginal cost of working from home after the pandemic. Thus, they will enable the persistence of working from home.

### **Stigma associated with working from home has diminished during COVID**

As said before, working from home at first had a pretty negative reputation. In particular, the view is that employees “shirk” instead of work on days when they are not in the office. In the survey, a major question was asked - how have perceptions about working from home changed among people you know? Responses to this question indicate that two-thirds of Americans report perceptions of working from home have improved among people they know. Only a small number — 6.1 percent—say perceptions have worsened. Furthermore it shows that employee preferences and employer plans for post-pandemic working from home are both higher among respondents who report more widespread improvements in perceptions of working from home.

## Innovation to improve working from home

Technological advances and investments enabling working from home will help workers and firms to shift to working from home and provide incentives for others to create and further implement new technologies and conduct further investments. Implementation of these innovations leads to more working from home and more investment in the networks that support it, such as physical communication networks and common knowledge of popular collaboration platforms like Zoom and Microsoft Teams. Greater working from home in turn creates demand for new technologies and further investments [41].

## Effects on working from home in pandemic times

From the beginning of the 2020 the world had to face one of the biggest challenges of the century – the COVID-19 pandemic. According to a study made by the Department of Health and Human Development of University of Pittsburgh, working on a regular basis at home on your personal desk – when pandemic restrictions requires everyone to stay as much as possible at home – can negatively influence your lifestyle, as shown in the list below.

- Sedentary behavior increased with 1.3h in a non-working day;
- Sleep quality decreased – wake time delayed up to 40 minutes;
- Mood disturbances;
- Decreased concentration on work-related tasks;
- Stress.

These results had more impact on those who have changed their work environment into remote work. As a conclusion to this article, employees need to understand what working from home means for their lifestyle and also employers have to support desk-workers during pandemic restrictions, otherwise the performance of their work will decrease over time [42].

## 2.6 Summary

Several experts have stated that sitting behind your desk all day is bad for your health. This pandemic has brought more and more people to move less and less. Research shows that working from home can decrease sleep quality and concentration, cause mood disturbances and stress and increases the sedentary behaviour. We want to redefine the work environment at home, because it seems like this working-from-home model isn't going anywhere.

We're designing a sit-to-stand desk, that enables the user to define which position allows him best to focus. The desk starts of as a bench, providing a sense of comfort. It can be transformed into a sitting desk, and eventually a standing desk. Our aim is to keep the design simple but functional and ergonomic. We want to make the work environment comfortable and flexible. When staying at home most of the day, it's important to create a sense of comfort. At the same time, it's important to have a clean working space; after all, your office is also your home.

After thoroughly looking into different existing desks on the market, papers on ergonomics and the working-from home models, we've come up with a list of features that we should integrate into our own design. It speaks for itself that ergonomics is one of them. Considering desks nowadays, and especially home-desks, ergonomics are required rather than desired. In terms of the sitting-to-standing desk, the height should range from 50cm, the bench height, to 125cm to provide an ergonomic working position to all. Most of the desk are electrically adjustable, this makes it easier for

the user. In the YAASA desk [43] the hand switch is located beneath the tabletop, and can be mounted in different positions according to your preferences (e.g. if you are left-handed). This is a possibility we could consider. An integrated wire management is something we'd like to integrate to keep the working area organised. For the same reason, storage space should also be included. A lot of the desks mentioned above don't have any room for storage. A feature we want the desk to have is power modules with USB charging ports to charge all the users devices.

Organization is extremely important to bring this project to a successful conclusion. In the next chapter, we will go into more detail on how we handle this.

## 3. Project Management

### 3.1 Scope

The scope of the project is determined by the scope of the product. To describe the project scope, it is important to first understand the product scope.

According to the PMBOK Guide, 6th edition:

- *"The project scope is the work performed to deliver a product, service, or result with the specified features and functions";*
- *"The product scope is the features and functions that characterize a product, service or result"* [44].

Summarizing the notions, we can refer to the project scope as the work needed to deliver the product (the *"how"*), and for the product scope as the total number of features and functional requirements of the product (the *"what"*).

The project's WBS (or Work Breakdown Structure), describes both the product and project scope.

**Product scope:** This project will consist of creating an innovative, reconfigurable desk that transforms into a bench. The project will be completed by June 2021. For providing ergonomics, there will be a system integrated into the product, that will facilitate the movability of the desk's tabletop, transforming it into a bench, sitting desk, and standing desk. Furthermore, the tabletop will be inclinable and will have an integrated lamp. The product will also include an integrated battery with specific ports, having its own autonomy without a source of electricity nearby.

#### **Deliverables:**

- Research and State of the Art analysis
- Design and ideation: System Diagrams & Structural Drafts, System Schematics & Structural Drawings, Cardboard model
- Prototype
- Functional tests
- Final Report, Presentation, Video, Paper, Poster, and Manual

**Project scope:** The work to be done in order to build the product: planning, project management,

risk management, material procurement, engineering the necessary system for the implementation of the features.

### 3.2 Time

Based on the work plan with deadlines and deliverables, we created the Gantt Chart as presented below, according to the product backlog.

The Gantt Chart represents the user stories, and each user story is part of an epic (for which we assigned a specific color).

#### EPICS LEGEND:

- E1: Weekly classes - *in green*
- E2: Final report - *in orange*
- E3: Solution design - *in pink*
- E4: Prototype - *in blue*
- E5: Website - *in red*

The project plan, including the Gantt Chart, is created based on the urgency of deliverables, the Interim Report representing a key milestone. For a comprehensible representation, the Gantt Chart doesn't contain all the subtask that divide from each user story. The Weekly classes and Final report are the recurrent activities, and the team allocates time for them during every stage.

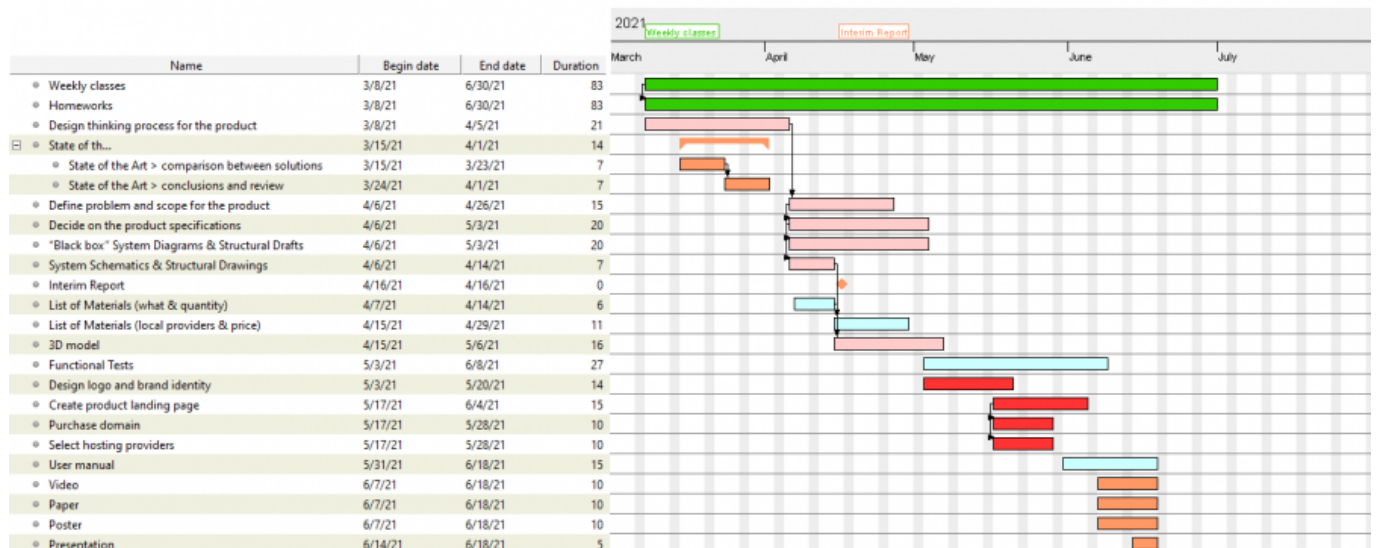


Figure 4: Project Gantt Chart

### 3.3 Cost

There are different forms of costs in project management:

- direct costs, like fixed labor, materials, and equipment;
- indirect costs, like utilities [45].

During the next phase of our project, we will focus on the implementation process and we will have a more wide overview in order to forecast the costs. This section will be presented in more detail for the next report presentation.

### 3.4 Quality

1. Product quality
  1. Functionality
    - The mechanism for desk reconfiguration
    - Lamp power
    - Battery life
  2. Materials quality and reusability
2. Stakeholder expectations - the review and approval from teachers
3. Teamwork

### 3.5 People

Successful projects are generally the product of rigorous planning, as well as the expertise and cooperation of the project's team members. Without each of their key team members, projects can't move forward.

**The project team members** are the individuals who primarily work on one or more stages of the project. In our project, the team members' roles can vary depending on the different stages of the project.

Overall responsibilities of team members:

- Contribute to overall project objectives;
- Complete individual deliverables;
- Provide expertise;
- Work with users to determine and meet business needs;
- Document the process [\[46\]](#).

Figure 5: Team Members' Responsibilities



**The advisory committee** consists of the teachers that evaluate project deliverables and coach the team. Throughout the project, they secure resources for our team, approve the project's proposed changes, budget, or schedule.

In project management, the **Responsibility Assignment Matrix (RAM)**, also known as **RACI matrix**, lists all of the roles among the team and their active participation in a project. A RACI matrix guarantees that all partners are aware of who is in charge of performing tasks or receiving input on deliverables.

The RAM Matrix for our project is presented below:

Table 7: RACI Matrix

Activity Description	Gabriel	Silvia	Anastasia	Nikola	Marcel	Supervisors
Brainstorming and Task Allocation	R	R	R	R	R	C/I
Project Backlog	R	A	R	R	R	C/I
Global Sprint Plan	R	R	R	R	R	C/I
Gantt Chart	C/I	A/R	C/I	C/I	C/I	C/I
State of the Art	R	A	A	R	R	C/I
Technical Research	R	R	R	R	R	C/I
Black Box Diagrams	A/R	C/I	C/I	A/R	C/I	C/I
System Diagrams & Structural Drawings	R	C/I	A	R	C/I	C/I
Marketing Analysis	A/R	R	C/I	C/I	C/I	C/I
Eco-efficiency Measures for Sustainability	C/I	C/I	A/R	C/I	C/I	C/I
Ethical and Deontological Concerns	C/I	C/I	C/I	C/I	A/R	C/I
Project Development	R	R	R	R	R	C/I
Project Management Analysis	C/I	A/R	C/I	C/I	C/I	C/I
List of Materials	C/I	C/I	C/I	A/R	C/I	C/I
Brand design: Logo, Flyer, Leaflet	R	R	R	R	R	C/I
Website	C/I	R	C/I	A	C/I	C/I
3D Model	R	R	R	R	R	C/I



Activity Description	Gabriel	Silvia	Anastasia	Nikola	Marcel	Supervisors
Prototype	R	R	R	R	R	C/I
Paper	R	R	R	R	R	C/I
Poster	R	R	R	R	R	C/I
Video	R	R	R	R	R	C/I
User Manual	R	R	R	R	R	C/I
Final Presentation	R	R	R	R	R	C/I

### Table legend:

- **R: responsible** (the person who works on the specific task)
- **A: accountable** (the coordinator of the activity, the one who approves task and takes responsibility for the final outcome)
- **C: consulted** (the persons who opinion about the task, the expert whose opinion is relevant on the specific subject - mostly the teachers)
- **I: informed** (the person who will be kept up-to-date regarding the outcome of the task)

## 3.6 Communications

In project management, communication is essential. There are a lot of examples from projects that have struggled as a result of miscommunication and communication discrepancies. An effective communication process would facilitate communication between team members, as well as with the supervisors, and other project stakeholders.

### Communication Methods:

- Meetings (online and in-person);
- Team's Private Chat (WhatsApp group for instant messaging);
- Email (mostly with teachers and supervisors);
- Collaboration apps (Microsoft Teams, Microsoft Tasks, Microsoft Notebook, Google Drive, Zoom).

Table 8: Communication Plan

Communication	Method	Frequency	Goal	Audience
Team building meetings	Online conference call	One week, at the start of the program	Get to know each other. Define the way of work.	Team
Kick-off meeting	Online conference call	Once, at the start of the project	Introduce the project. Confirm objectives, goals, and deliverables needed.	Team
Team standup	Meeting	Daily	Discuss what each team member did yesterday, what will do today and any blockers.	Team
Sprint planning & review	Online or in-person meeting (with video conference link for the remote colleagues)	Every Monday	Review the previous sprint and plan the next one. Discuss potential issues or delays.	Team

Communication	Method	Frequency	Goal	Audience
Team’s weekly meeting	Online or in-person meeting (with video conference link for the remote colleagues)	Every Wednesday	Discuss project/tasks status. Work collaboratively for different tasks. Prepare the agenda for the meeting with the supervisors.	Team
Task progress updates	Microsoft Tasks Notebook, WhatsApp	Daily	Share daily progress made on project tasks.	Team
Project status report	Meeting, Email	At milestones	Present project deliverables, gather feedback and discuss next steps.	Team, Supervisors
Supervisor meeting	Online conference call	Weekly	Discuss issues that appeared during the week. Gather feedback about the recently accomplished tasks.	Team, Supervisors

### 3.7 Risk

#### 3.7.1 Product risks:

*The possibility that the system might fail to satisfy expectations of stakeholders.*

**RISK: functionality**

CAUSE: lack of development skills, issues with the suppliers

EFFECT: unsatisfied customers, partially functional product

RISK EVALUATION:

- Impact: **high**
- Likelihood: **2**

MITIGATION: prioritize prototype release, outsource development skills

**RISK: performance efficiency and usability**

CAUSE: improper mechanism, improper design

EFFECT: unsatisfied customers, low number of sales

RISK EVALUATION:

- Impact: **high**
- Likelihood: **3**

MITIGATION: detailed research about mechanisms that can be useful, with pros and cons, cardboard model to have a view of the product

**RISK: tight schedules**

CAUSE: poor planning and time estimation

EFFECT: people work in a rush and commit more mistakes

RISK EVALUATION:

- Impact: **high**
- Likelihood: **3**

MITIGATION: understanding the specifications, good planning, and time management

**3.7.2 Project risks:***An uncertain event that can affect the project's progress.*

---

**RISK: team disagreement or lack of communication**

CAUSE: misunderstanding, team's members' different perspectives, remote working

EFFECT: delays, lack of decision, quality of deliverables

RISK EVALUATION:

- Impact: **medium**
- Likelihood: **1**

MITIGATION: open discussions, assistance from the communication teacher

---

**RISK: time management**

CAUSE: bad estimations and unclear Gantt

EFFECT: delays and inconsistent sprints

RISK EVALUATION:

- Impact: **medium**
- Likelihood: **3**

MITIGATION: update planning based on weekly reviews, break task according to the Fibonacci sequence

---

**RISK: team's skillset issues**

CAUSE: poor related experience

EFFECT: quality and on-time delivery issues

RISK EVALUATION:

- Impact: **medium**
- Likelihood: **2**

MITIGATION: ask teachers for guidance and support, estimate the extra time needed to acquire the knowledge

---

RISK: **development process**

CAUSE: lack of skill set, the scrum master not setting up the right processes

EFFECT: could impact the quality of deliverables

RISK EVALUATION:

- Impact: **high**
- Likelihood: **2**

MITIGATION: align project requirements with the team members expertise, plan sprint backlog taking into account the team's efficiency

---

**External causes:**

RISK: **supplier issues**

CAUSE: external causes - transportation delay or products not in stock

EFFECT: delay in project development

RISK EVALUATION:

- Impact: **medium**
- Likelihood: **2**

MITIGATION: reorganize work in order to save time, make a backup list with other suppliers

---

RISK: **cost, too expensive materials**

CAUSE: external causes - market prices

EFFECT: delay in project development

RISK EVALUATION:

- Impact: **medium**
- Likelihood: **2**

MITIGATION: build the product at a lower scale level

Figure 6: Risk Assessment Table

**Risk Assessment Table**

		Severity of Harm (Impact)		
		Low (L)	Medium (M)	High (H)
Likelihood	High (H)	3	4	5
	Medium (M)	2	3	4
	Low (L)	1	2	3

### 3.8 Procurement

Effective project procurement ensures that the project is completed successfully. **Project Procurement Management** is divided into four stages:

- **Plan procurement** is a reporting mechanism for determining what to buy and from what suppliers;
- **Conduct procurement** is a process in which you reach an agreement with vendors by reviewing their bids;
- **Control procurement** refers to the managing phase of the procurement process. According to the deals, the producer controls the seller and the supplier controls the buyer;
- The final step is the **close procurements** phase, which helps to complete the project [47].

During the next phase of our project, we will focus on the procurement process and we will document it for the next report presentation.

### 3.9 Stakeholders Management

Identifying stakeholders is an ongoing process that takes place during the project life cycle. It is critical for the project's success to identify stakeholders, consider their level of impact on the project, and meet their demands, wishes, and expectations [48].

Our project's stakeholders can be classified into two types:

- **Internal:** Project Team, Supervisors
- **External:** Customers & Users, Competitors, University, Suppliers

In the image below we represented the power and interest of each stakeholder:

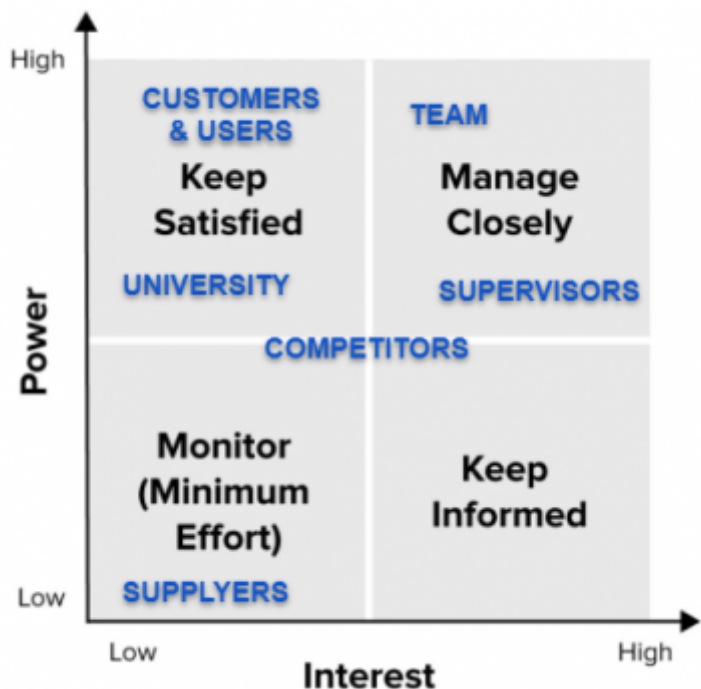


Figure 7: Stakeholders

Table 9: Degrees of stakeholders dialogue and engagement

Inform	Consult	Involve	Collaborate	Empower
Keep them informed and assist them in understanding our product, but not take into consideration their views.	Keep them informed, listed to their views and feedback, but we decide after an internal analysis.	Consider their needs, concerns. We will make sure that their view reflects in the analysis and the solution developed.	Seek their suggestions and advice on solutions. Take their views into account in the final decision to the maximum extent possible.	The final decision-making.
Suppliers	University, Competitors	Customers & Users	Supervisors	Team

### 3.10 Sprint Outcomes

Below we present the real-time outcome for our sprints. We started to implement this methodology of working right after the course about Agile Scrum and because of this reason, the outcomes from the first 3 weeks can't be presented in real-time.

- **Sprint 4**



Sprint Start: 2021/03/22  
 Sprint End: 2021/03/28  
 Work Capacity: 5 days \* 5 \* 7h = 175h  
 Available capacity: 175h - classes = 175h - 5 \* classes(17h) = 90h  
 Sprint backlog total should be to available capacity (90h) - buffer = 85h  
 Real velocity = 6 d (estimation of completed tasks)

PBI	Assignee	Planned Effort	Completed	Not Completed	Notes
E1.U1. Weekly classes	A,S,G,M,N	2.5 d	X		
E1.U2. Homework	MA	0.5 d	X		
E3.U2. Define problem and scope for the product	A,S,G,M,N	0.5 d	X		
E3.U4. "Black box" System Diagrams & Structural Drafts	N	0.5 d		X	Created a general black box and now we have to do it according to our subject.
E2(Final Report).U1. State of the Art > Conclusions and review the final State of the Art Report	A,S,G,M,N	1d		X	Did not manage to finalize because we wanted to do more research.
E2(Final Report).U1. State of the Art > Make a comparison between state-of-the-art solutions (low, medium, high impact)	A,S,G,M,N	1 d		X	We started it but did not manage to finalize it.

*\*1d > 7 hours \* 5 = 35 hours of work/ team*

Sprint 4 Velocity: 3.5 d (sum of all completed tasks)

• **Sprint 5**

Sprint Start: 2021/03/29  
 Sprint End: 2021/01/11  
 Work Capacity: 7 days \* 5 \* 7h = 245h  
 Available capacity: 245h - classes = 245h - 5 \* classes(22h) = 145 h  
 Sprint backlog total should be to available capacity (145h) - buffer = 135h  
 Real velocity = 10 d (estimation of completed tasks)

PBI	Assignee	Planned Effort	Completed	Not Completed	Notes
E1.U1. Weekly classes	A,S,G,M,N	2.5 d	X		
E1.U2. Homework Homework 1 Homework 2 Homework 3 Homework 4	A S M N	2 d	X		
E3.U3. Decide on the product specifications	A,G,N	0.5 d	X		
E3.U5. System Schematics & Structural Drawings	A,S,G,M,N	0.5 d	X		
E3.U4. "Black box" System Diagrams & Structural Drafts (Draft 2.0)	G,N	0.5 d		X	Haven't decided upon product specifications in time to finish the "Black box" System Diagrams.
E2(Final Report).U1. State of the Art > Conclusions and review the final State of the Art Report	A,S,G,M,N	1 d		X	The workload is lower compared to the previous sprint when we accomplished half of the task. Did not manage to finalize because we prioritized other tasks.
E2(Final Report).U1. State of the Art > Make a comparison between state-of-the-art solutions (low, medium, high impact)	A,S,G,M,N	1 d		X	Did not manage to finalize because we prioritized others tasks.
E2.U2. Interim Report - draft 1.0	A,S,G,M,N	2 d		X	Managed to accomplish just 20% of the task. Because of tasks that must be redone (like the black box diagram) and the postponed decisions from previous weeks, our sprint backlog is overloaded.

\*1d > 7 hours \* 5 = 35 hours of work/ team

Sprint 4 Velocity: 5.5 d (sum of all completed tasks)

• **Sprint 6**

Sprint Start: 2021/04/12  
 Sprint End: 2021/04/18  
 Work Capacity: 5 days \* 5 \* 7h = 175h  
 Available capacity: 175h - classes = 175h - 5 \* classes(12h) = 115 h  
 Sprint backlog total should be to available capacity (145h) - buffer = 110 h  
 Real velocity = 9 d (estimation of completed tasks)

PBI	Assignee	Planned Effort	Completed	Not Completed	Notes
E1.U1. Weekly classes	A,S,G,M,N	1.5 d	X		
E3.U5. Cardboard model	A,S,G,N	0.5 d	X		
E3.U4. "Black box" System Diagrams & Structural Drafts (Draft 2.0)	G,N	0.5 d	X		
E2(Final Report).U1. State of the Art > Conclusions and review the final State of the Art Report	A,S,G,M,N	1 d	X		
E2(Final Report).U1. State of the Art > Make a comparison between state-of-the-art solutions (low, medium, high impact)	A,S,G,M,N	1 d	X		
E2.U2. Interim Report - draft 2.0	A,S,G,M,N	2 d	X		
E2.U2. Interim Report - final version for upload	A,S,G,M,N	2 d	X		
E4.U1. List of Materials (what & quantity)	M,N	0.5 d		X	Did not manage to finalize because we prioritized the report.

\*1d > 7 hours \* 5 = 35 hours of work/ team

Sprint 4 Velocity: 8.5 d (sum of all completed tasks)

In the next graphic, we represented our team’s velocity. During sprint 4 and sprint 5 we managed to accomplish shortly above 50% of the tasks from the sprint backlog. Because of the tasks that must be redone and the postponed decisions from previous weeks, our sprint backlog from sprints 4, 5, and 6 was overloaded. During the last sprint, we increased our velocity due to the fact that we inherited the work from the 2 previous sprints. It is important to mention that the interim report was the milestone that drove the team to do an extra mile of work.

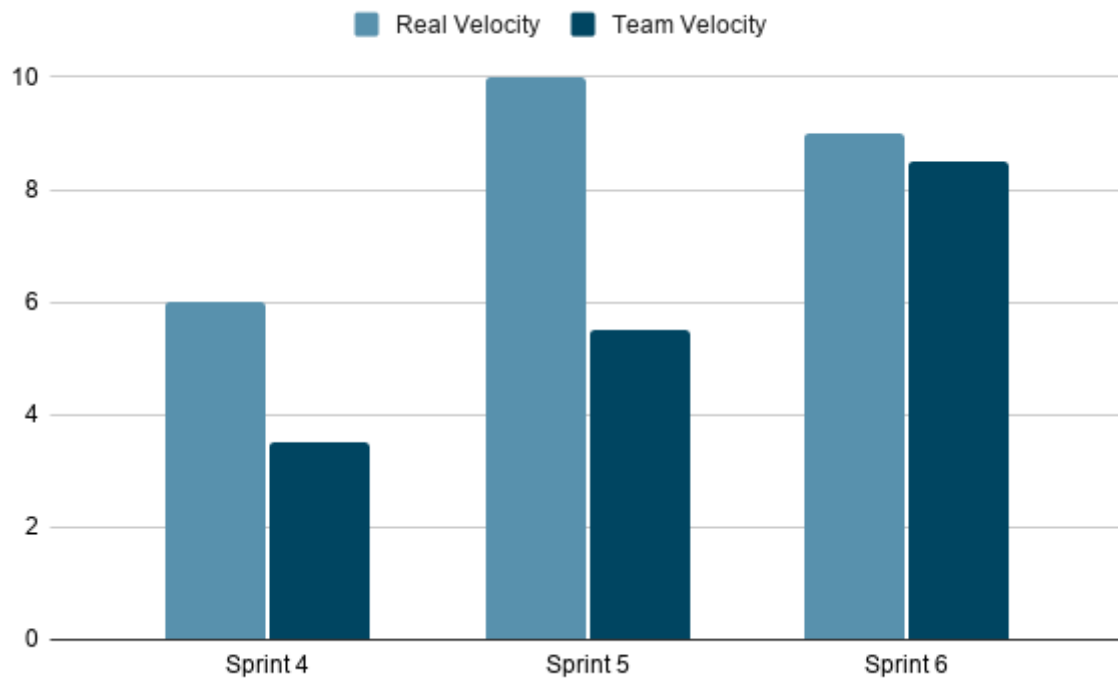


Figure 11: Team's Velocity

### 3.11 Sprint Evaluations

Our team analyzed the progress that had been performed at the end of each week (which represents a sprint), and for those tasks that had not been completed, they were delayed until the next week, and so forth until reaching completion. We used Microsoft Planner and Microsoft OneNote to plan and document our sprints.

As a summary for the Retrospective Meetings, the positive aspects that we identified so far are the fact that we defined our product and now we have a clear goal, the journey of learning how to work as a team and the in-person meetings which went really productive. The negative aspect of our work is related to a lack of decision-making that involves delays and demotivation. Further on, we will focus on developing more detailed sketches and models that may help us turn the idea into a 3D concept. The future decisions imply the branding of our product, from the marketing perspective and the selection of materials and suppliers, according to our eco-efficiency approach, the ethical aspects, and the budget available as well.

### 3.12 Summary

In this chapter we provided an overview from the project management perspective, focusing on the way we apply the Agile Scrum into our work. We defined the scope of our project and for our product as well, understanding the link between each other, followed by one of the most important aspects in project management, the timeline, represented by the Gantt chart in this case. With respect to the costs and the procurement processes, these are activities that will be completed in the next part of our project and for this reason, they are not documented in more detail. A key aspect was the communication process and identifying the tools we can use as a team to ensure a positive result. The pandemic situation and the working from home represented a challenge that we had to

overcome. From the perspective of challenges, we also evaluated the risks of our project and took them into consideration in the decision-making process. Nonetheless, we came up with a plan to facilitate the management of our stakeholders, in order to assure good communication to all parties that have an impact on our project. We conclude with an analysis of our sprints and their outcome.

Having a clear view of the project management approach and a structured plan for our project, we are now ready to move forward and define our marketing plan.

## 4. Marketing Plan

### 4.1 Introduction

In the development of a new product, the marketing plan is a key component to get to know the actual market and to make your product visible to the public from a business perspective. In short, it constructs the product to become profitable and valuable on the market. But marketing is not only selling and advertising the product. The purpose of the marketing plan is to analyze and determine the customers' needs and using those so that the product can sell itself out to the public. In general, the term "marketing" is misunderstood by the masses. A product needs to communicate in the best way possible the value that it has, so that the customer is completely satisfied and so a long lasting relationship is created.

The analysis will contain, in order, the following chapters:

- Market Analysis – contains trends, needs, segmentations, values;
- SWOT Analysis – describes how our idea looks in comparison with the actual market;
- Strategic Objectives – illustrates the objectives of the development of the product;
- Branding – explains the key concepts behind a brand: name, logo, slogan, target audience, positioning.

### 4.2 Market Analysis

The market analysis is made to define the main characteristics of the public needs and to help reduce the risk by gathering information about the potential that our product can have and evaluate those informations to help make important decisions about purchases and sales. A market analysis is necessary to better understand where your product stands on the current market.

This analysis will contain the main levels of marketing:

- Micro environment – represented by all internal factors that affect the product in the relation with the customers;
- Macro environment – expressed by all external factors that can influence the micro environment.

### 4.2.1 Micro marketing environment analysis

Micro marketing environment concentrates on the factors that can affect the project inside the company. In Figure 12 those factors are briefly represented.



Figure 12: Micro marketing environment [49]

**Suppliers** - Those from which the team gathers resources needed to produce our desk. A good supplier can be an important part of the business and may contribute to a competitive advantage. Choosing the most appropriate partner and having a strong relationship in the “value-delivery” system marks the key to a good product on the market. As for this moment, the team has not yet decided on the current suppliers for our desk, however we will make efforts to contact local providers of materials in a short period of time.

**Marketing Intermediaries** - The distribution system has a big impact in the selling phase of the product in such a way to be made visible to the public and profitable at the same time. The distributors or retailers provide the invaluable service of getting the product to the customer. This can mark a breaking point in the competition standards as not everyone gets access to the trading market they desire. The team has not yet decided on the distribution channels yet, but we will do so in the following weeks.

**Potential customer market** - Customers are the evidence that the product covers the necessities of masses and demonstrates if the project is valuable or not. In order to compute the best product for the market, the team must locate the customers, analyze their needs and then satisfy them in an efficient and profitable way. Those needs are identified as follows:

1. Use space-efficient furniture & save space;
2. Save money (investing in one product with multiple usabilities);
3. Comfortable working posture;
4. More dynamic and efficient working environment;
5. An incentive to move and reposition during work;
6. Autonomy (integrated battery).

**Competitors** - Those who target an audience with the same products or services and try to pursue

the same sets of customers as ours. The most known desk manufacturers and retailers are mentioned below:

1. IKEA
2. VIVO
3. Allcam
4. Primecables
5. FOXELS

#### 4.2.2 Macro marketing environment analysis

Macro marketing environment shows the external factors which influence the decisions made in a business plan. To have a better interpretation of these analysis, we will be using the PESTLE model, as shown in Figure 13. PESTEL stands for Political, Economical, Social, Technological, Environmental and Legal. This analysis shows the main external factors related to the project and helps the team reduce the risks involved in the development of the product.



Figure 13: PESTLE analysis model [50]

In Figure 14 are shown the most relevant risks for our home-desk. Using the PESTEL model, we can evaluate those risks and keeping them in mind for the future tasks regarding our product.



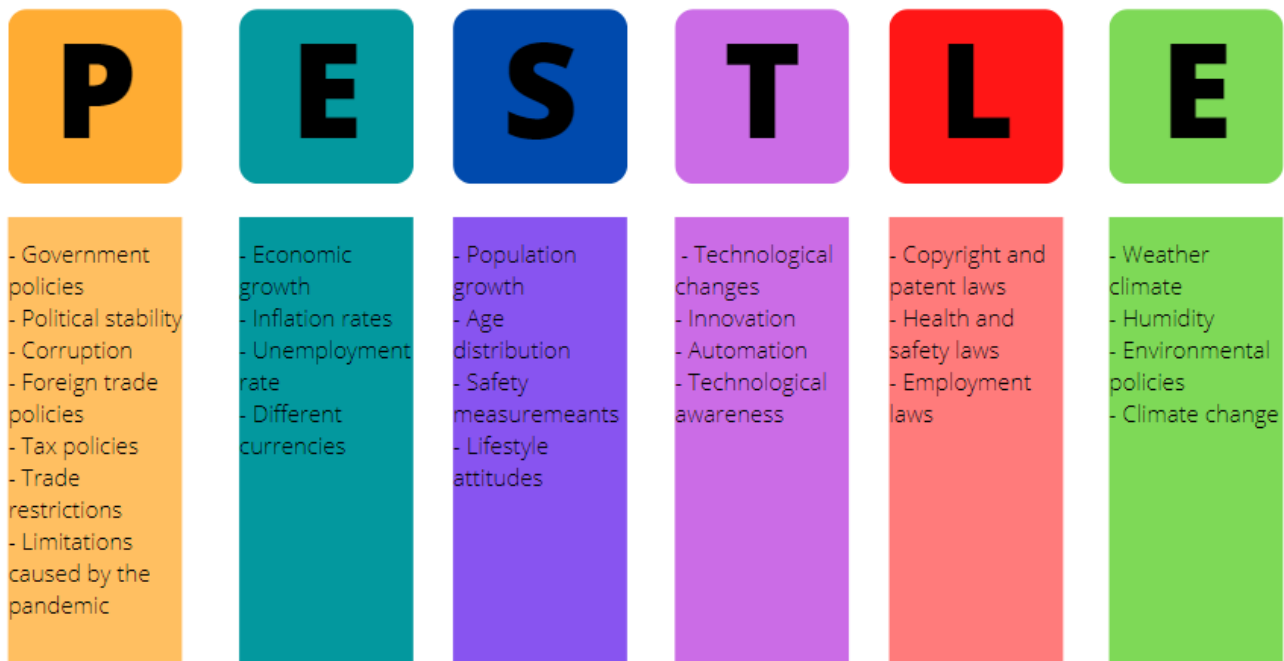


Figure 14: PESTLE analysis

### 4.3 SWOT Analysis

The primary goal of a SWOT analysis is to help the team identify all the favorable or unfavorable factors regarding the project and evaluate those to make the product better. SWOT stands for Strengths, Weaknesses, Opportunities and Threats. This classification is very useful in the beginning of a project to develop strategic plans that will uncover the possible opportunities and threats as well as pointing out the weaknesses the project has. Figure 15 represents the Project SWOT analysis.

## Project SWOT Analysis

<ul style="list-style-type: none"> <li>• desk can be reconfigured into a sitting desk and a bench</li> <li>• it'll make work at home more efficient, adding dynamics into the work</li> <li>• autonomy and innovation, through the incorporated battery</li> </ul>	<ul style="list-style-type: none"> <li>• new market needs due to prolong working from home</li> <li>• customer preferences for online buying</li> <li>• increased public awareness of the importance of working position</li> </ul>
<ul style="list-style-type: none"> <li>• weight &amp; price</li> <li>• limited range of colors, materials, extra features</li> <li>• limited retail experience in the development team</li> </ul>	<ul style="list-style-type: none"> <li>• powerful and resourceful competition on the market</li> <li>• unpredictable user behavior due to the pandemic uncertainty</li> <li>• lack suppliers and distributors of raw materials and components</li> </ul>

Figure 15: Project SWOT analysis

From the SWOT analysis, we can conclude that the current pandemic situation is increasing the

customer's attention into more ergonomic furniture that will help their lifestyle for a long-term period. However, the other competitors on the market have already furnished products with a great visibility to the public and considering that the pandemic is not going to last for a long time, the team needs to find a good strategy that must overlap these threats.

## 4.4 Strategic Objectives

Strategic Objectives are an important part for organizing the way to create an efficient and productive project. To define clear objectives, we will use the SMART method, because it allows us to manage marketing activities correctly and determine which objective is more important. SMART represents Specific, Measurable, Achievable, Realistic and Time-Bound [51].

Figure 16 shows the SMART objectives in a picture view.

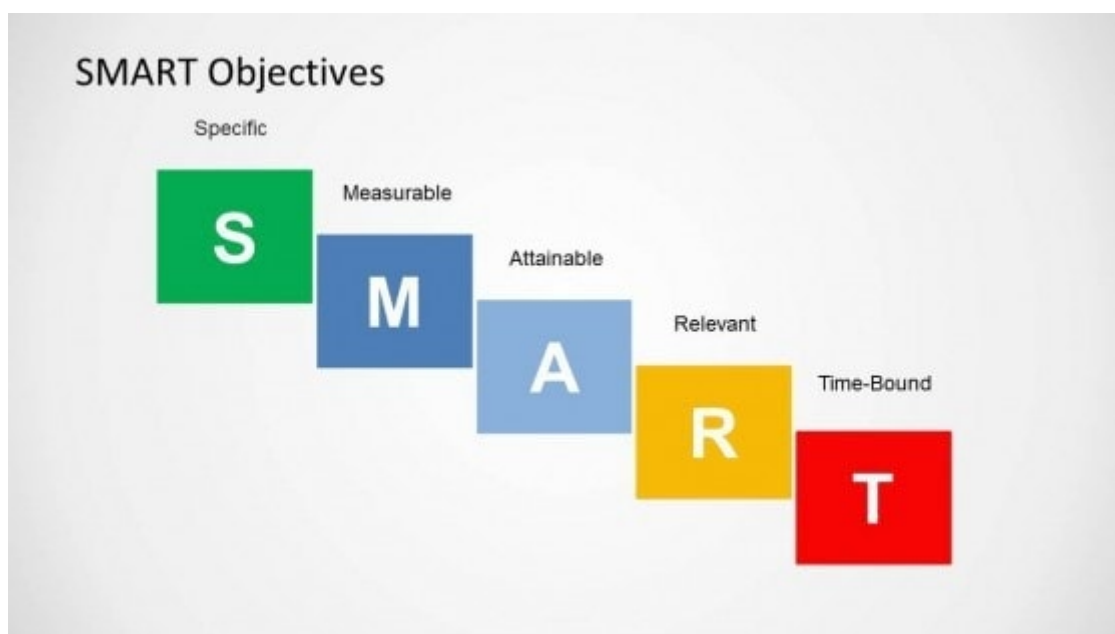


Figure 16: SMART objectives

**“S” - SPECIFIC:** The objectives are clearly defined and every member of the team understands it and why it is important.

**“M” - MEASURABLE:** The goal needs to be defined with key performance indicators to track the progress and display if everything is on track to achieving these goals.

**“A” - ACHIEVABLE:** The objectives need to be within the ability of the team, being aware of the existing limitations and resources.

**“R” - RELEVANT:** Each marketing objective has to contribute to reaching the team's goals.

**“T” - TIME-BOUND:** The goals must have a timeline that indicates when it should be done.

The primary strategic objectives for our product will be the following:

- Create a leaflet and redesign the flyer before the 22th of April 2021.
- Finish selecting the materials and components until May 2021.
- Develop an economically sustainable product by using renewable materials.

- Create a website for the product until June 2021.
- Build 3D Desk prototype before the 15th of June 2021.
- Finish testing phase before June 2021.
- Finish and evaluate the project report before the 15th June of 2021.
- Find sponsors and funding to the business by the end of 2021.
- Popularize and promote the product by media advertising.
- Start selling in European countries at the end of 2022.

## 4.5 Strategy/Targeting/Positioning/Brand

### Strategy/Segmentation

Because strategy has an important role in getting to know the market in which we want to sell the product, we will follow the STP method - Segmentation, Targeting and Positioning as shown in Figure 17.



Figure 17: STP method

The first step into the Segmentation part is to configure the elevator pitch which transcribes our orientation towards targeting the current market as displayed below in Figure 18.

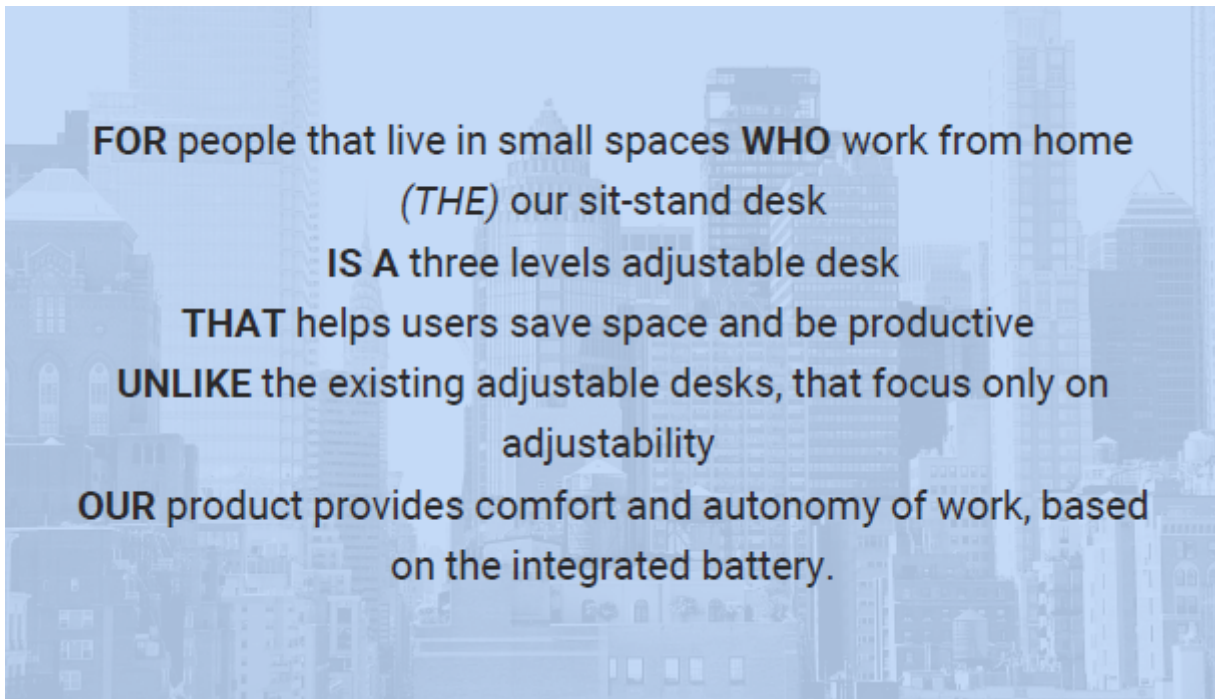
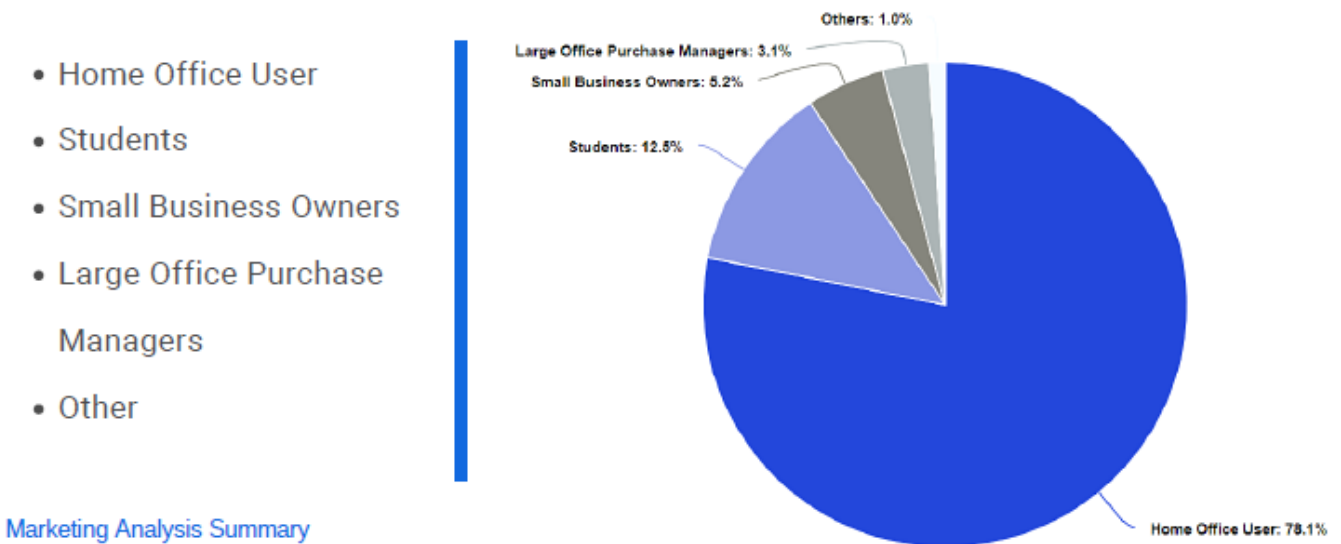


Figure 18: Elevator pitch

On another hand, as our product is designed for a larger audience, we have made a graph to better illustrate the customer’s interests in home desks. This charts (Figure 19 and Figure 20) are part of the demographic segmentation, centered more on the occupation of the customers and the daily usage of a computer at home.

## MARKETING SEGMENTATIONS



Marketing Analysis Summary

Figure 19: Marketing segmentations

# MARKET DEMOGRAPHICS

Market Segments	Computer Usage	Age	Issues	Decision Maker
Home Office User	High	25-45	Space, Comfort	User
Students	High or Medium	18-25	Space, Comfort	User
Small Business Owners	Medium	25-45	Space, Comfort	User
Large Office Purchase Managers	Medium	35-45	Comfort, Innovation	Management
Other	-	-	-	-

Figure 20: Marketing demographics

What we can understand from these images is that our market can be segmented for daily users of a computer at home, employees or employers. Which brings us to Targeting.

## Targeting

Having configured the segmentation, the team can define the target audience, the customers who can be the most interested in our product. The target market can be seen in Figure 21.

## TARGET MARKET

**a home office user  
who lives in a small space**

who seek for:

- **adjustability** . to use the piece of furniture in multiple ways
- **technology and ergonomics** . to provide comfort and productivity




Figure 21: Target market

## Positioning

Product’s Positioning is described by the way the product is defined by the consumers on important

attributes and thus compared with the competing products. We want to configure the products differently from our competitors, and we can achieve that by using sustainable materials that also help the environment, by using new technologies and by having a lower price.

## Brand

According to American Marketing Association (AMA), “a brand is a name, term, design, symbol or any other feature that identifies the seller’s goods as distinct from those of other seller” [52]. We will focus on the Identity of our brand, and that consists of the following:

- Core identity – the brand name – the team has decided to use the brand name FRE, which is an acronym from Furniture, Reconfigurable and Ergonomic. In this way, the brand name refers to the product that we are going to develop.
- Actual identity – the logo. In Figure 22 the brand logo is shown. With this logo we want to strengthen the relationship with the customer and to give him a glimpse about our product.
- Augmented identity – the slogan. We are going to use a simple slogan that it is easy to remember “Sitting or standing, make ideas happen”.

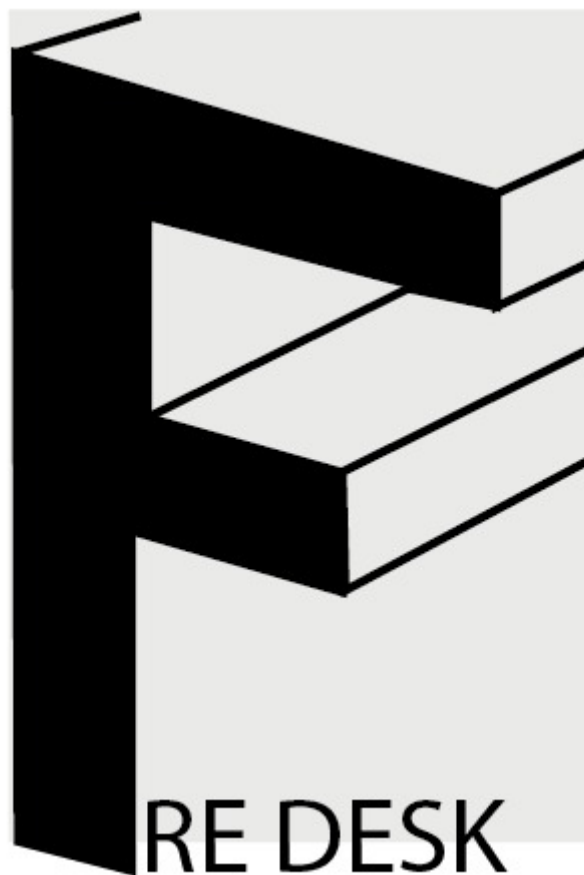


Figure 22: Brand logo

## 4.6 Adapted Marketing-Mix

## 4.7 Budget

## 4.8 Strategy Control

## 4.9 Summary

Provide here the conclusions of this chapter and introduce the next chapter.

Based on this market/economic analysis, the team decided to create *<specify the type of product>* intended for *<specify the market niche>* because ... Consequently, the team decided to create a product with *<specify the features>*.

# 5. Eco-efficiency Measures for Sustainability

## 5.1 Introduction

### Sustainable development

Our Common Future was published on October 1987 by the United Nations. The report is also known as the Brundtland Report, referring to former Norwegian prime minister Gro Harlem Brundtland. Brundtland was the chair of the World Commission on Environment and Development (WCED). “Our Common Future placed environmental issues firmly on the political agenda; it aimed to discuss the environment and development as one single issue [53].” The report famously defined sustainable development as “Development that meets the needs of the present without compromising the ability of future generations to meet their own needs [54].”

Sustainability is more than just environmentalism; “In addition to natural resources, we also need social and economic resources. Embedded in most definitions of sustainability we also find concerns for social equity and economic development [55].” The concept of sustainability is a holistic approach that covers three pillars; the economic, environmental and social. This approach is shown in Figure 23. The three pillars, sometimes better known as people, planet and people, will each be addressed in this chapter. We don’t want sustainability do be yet another part of the job, it should be a guiding influence for the whole project.



Figure 23: Three Pillars of Sustainability

### Eco-efficiency



Eco-efficiency is a key concept for companies to reach a more sustainable development, considering not only the added value aspect of its activities but also the environmental impacts [56]. Many companies all over the world have adopted this management philosophy. Eco-efficiency is all about doing more with less. The World Business Council for Sustainable Development (WBCSD) first used the term in 1992 in its publication 'Changing Course.' It is based on the concept of creating more goods and services while using fewer resources and creating less waste and pollution [57].

"Eco-efficient companies use less water, material, and energy while recycling more. Companies that embrace this management philosophy also strive to eliminate hazardous emissions or by-products. They aim to reduce their ecological impact. Eco-efficient companies try to reduce human demands on our ecosystem, i.e., they try to reduce the ecological load [58]". To say it simply, it means having an effective business while protecting the environment at the same time. We'll try to apply it to every aspect of business, from producing and purchasing to distribution and marketing.

## 5.2 Environmental

Regarding the environmental pillar, we'll be focusing on easy repair, disassembly and recyclability. Eco-friendly furniture should always be easy to disassemble, this way we avoid it ending up in a landfill. It results in easier repairs, which extends the life of the product and also simplifies the recycling for EOL products. The first feature of eco-efficiency mentioned in the introduction, is reducing the amount of material. We need to find a way to use less material for the desk, while still producing a strong, durable product. We can give here the example of a honeycomb structure, illustrated in Figure 24. This structure provides a product that is solid enough but contains way less material.



Figure 24: Honeycomb Structure in Ikea Furniture

Moving very heavy furniture is often more expensive than buying new furniture, especially furniture from fast chains. It's important to think of ways to keep our furniture lighter, also in terms of flexibility, transport etc. ... The second point is reducing the energy intensity; we should look for ways to produce our products more efficiently. We can do this in multiple ways, think about using more energy efficient techniques, recycling wood waste and sawdust, insulation improvement, replacing old machines, ... We can also be more efficient in terms of shipping; if the desk can be fully disassembled and flat-packed, carriers can fill their trucks to capacity and prevent additional delivery trips and fuel stops. If we want to integrate lights, we should think about ways to make that efficient. LED lights are known to be more efficient and last longer, as shown in Figure 3.



Figure 25: Advantages Led

We should also reduce the dispersion of toxic materials. Solvent-based lacquers contribute to the pollution in your home by emitting volatile organic compounds [59]. Examples of these VOCs off-gassed by furniture are flame retardants and formaldehyde. That's why we choose to treat our furniture with natural substances. Water-based lacquers, for example, are a green alternative to finishing wood furniture [60]. Another point is increased recyclability, this is a very important one. Furniture accounts for a HUGE (and growing) proportion of landfill waste. The desk should be easy to take apart, sort and recycle at the end of its life. The easy disassembling will also result in quicker and easier repairs, which will extend the life of the furniture. The use of renewable resources should be maximized. IKEA, for example, has suppliers that turn wood waste from production into a source for renewable energy. On top of being self-sufficient in renewable energy, they're also able to sell the excess heating [61]. Using recyclable materials, can help us avoid purchasing additional resources. Greater durability is also something we should achieve. We should step away from the fast furniture model, build things to last and not to throw away. Durable furniture can be passed on if you're moving or if it isn't your taste anymore, broken items can't. Even if its fixable, that will still cost some energy. The last thing we want to mention is service intensity. We were thinking about repair points to easily fix up broken components of the desk. Good client service is also of great value. When the user gets left in the dark and doesn't get proper help, in case of broken or missing items for example, he/she will be more tempted to throw the whole desk away then to try and fix it.

### 5.3 Economical

Nowadays, all big brands make pledges to be more sustainable. This often takes a long time to achieve. "Sustainability encourages businesses to frame decisions in terms of environmental, social, and human impact for the long-term, rather than on short-term gains such as next quarter's earnings report [62]. "It is evident that sustainability embedded in business models and products has the potential to enhance economic growth, return on assets, return on equity, internal rate on return and lead to superior stock market performance [63]." On short term however, companies that commit to the sustainable development of resources may have more modest results in the next term. This makes the whole economical pillar a bit difficult sometimes.

"Instead of trying to "force fit" sustainable principles into an existing and often unreceptive

manufacturing system, it may be useful to approach the subject from the opposite direction, and consider how functional objects might be designed and manufactured to be compatible with principles of sustainable development [64]". It's of great value to consider sustainability at the beginning of the design phase. This will result in long-term solutions and minimize the need of resources such as material, energy, water, ... "If a project is well planned and sustainable criteria are included in its early approach, the possibility to reduce negative impacts is greater and the cost of criteria implementation is greatly reduced [65]". This is illustrated in Figure 26.

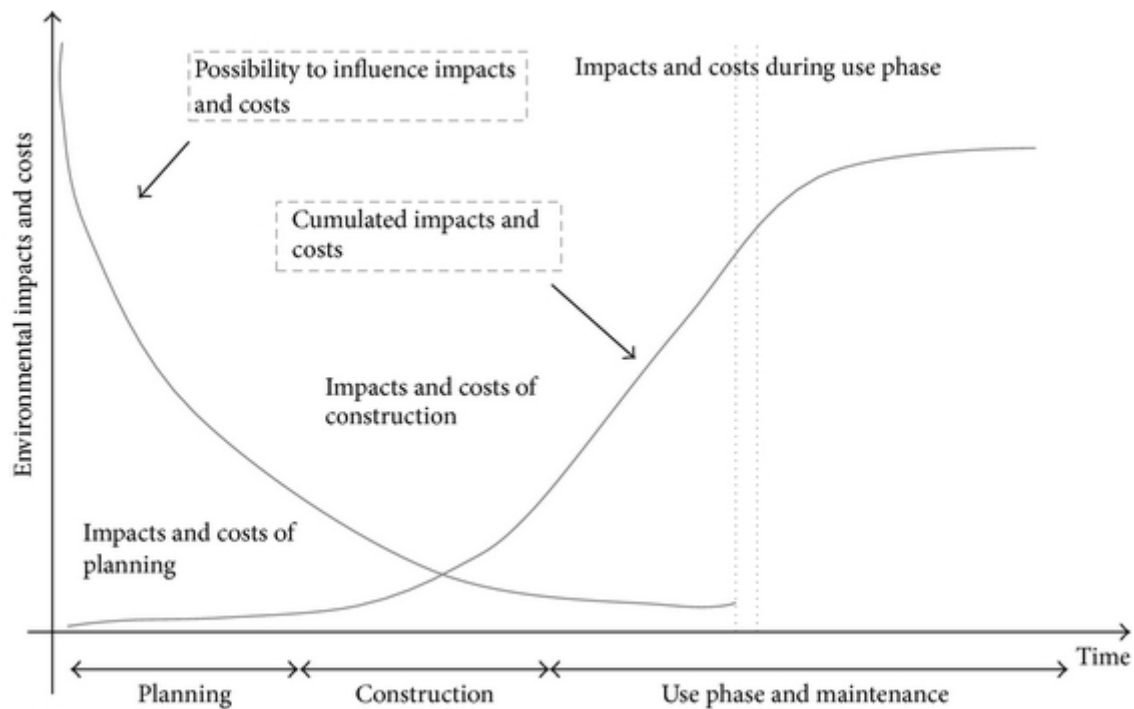


Figure 26: Influence of design decisions on life cycle impacts and costs

## 5.4 Social

"Social sustainability is about identifying and managing business impacts, both positive and negative, on people. The quality of a company's relationships and engagement with its stakeholders is critical. Directly or indirectly, companies affect what happens to employees, workers in the value chain, customers and local communities, and it is important to manage impacts proactively [66]". Social sustainability begins with realising that we impact, or can impact, a lot of people. It's important for us to have the support, and approval, of our employees, stakeholders and the community we work in, both locally and globally. We aim to be an inclusive business that strives for equality. On top of that, being socially responsible is profitable in the long-run. It can unlock new markets, be a source for innovation, attract business partners and employees ... A lack of social sustainability efforts, on the other hand, can set back business and growth. Think about the Bangladesh factory collapse and its terrible consequences, followed by justified outrage.

"While it is the primary duty of governments to protect, respect, fulfil and progressively realize human rights, businesses can, and should, do their part. At a minimum, we expect businesses to undertake due diligence to avoid harming human rights and to address any adverse impacts on human rights that may be related to their activities [67]".

As a company, we can take social action on the level of our employees and on a more global scale.

Concerning employees, it comes down to treating everyone fairly and equally. Good and safe working conditions should always be ensured, just like fair income. Better maternity and paternity benefits, high-quality safety-measures, flexible scheduling, learning opportunities etc. can all help our employees to be more engaged with the company. On a more global scale, we need to be aware of our entire supply chain. Is child labour going into our end product? Are all people across our supply chain being paid fairly? On top of that, there are many other ways we can give back to our community. Think about investing in local projects, scholarships, including and supporting marginalised groups, acknowledging and addressing systems of inequality that we work in, women empowerment initiatives....

## 5.5 Life Cycle Analysis

“Life cycle analysis (LCA) has been defined by the EPA as a way to 'evaluate the environmental effects associated with any given industrial activity from the initial gathering of raw materials from the earth until the point at which all residuals are returned to the earth' or 'cradle-to-grave' [68].” We can use this tool to quantify and qualify the impact of our desk all across its life cycle. As mentioned before, an LCA begins at the cradle stage with the raw materials. It then goes through all of the manufacturing steps and follows the product during his whole lifetime up until the grave stage. This can be defined as the moment of disposal and/or recycling. The study applies to the full life cycle of a product and is illustrated in Fig. 27 [69].

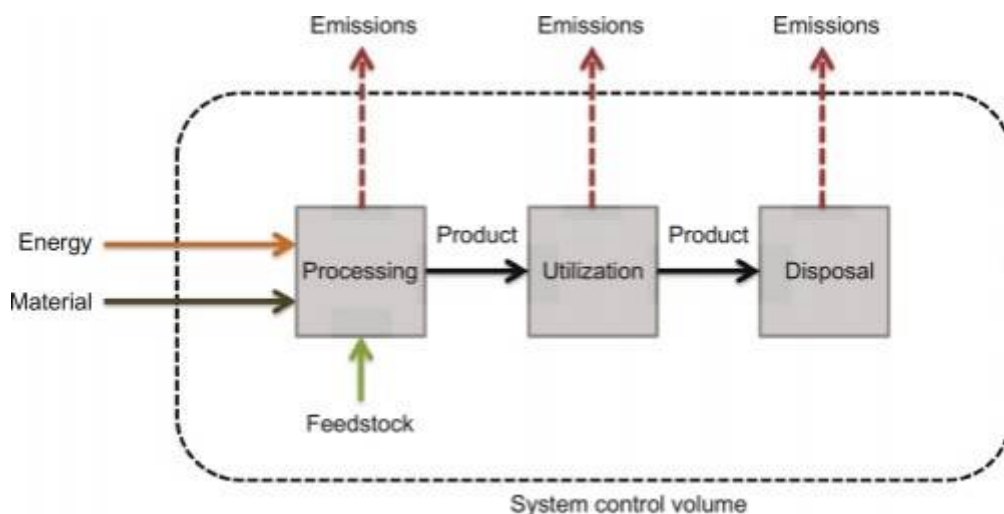


Figure 27: Full Life Cycle

In this chapter we'll try to follow the structure of a real LCA, starting off with our goal definition and scoping.

### Goal definition and scoping

We will be designing a flexible home-desk . The desk enables the user to adjust the desk according to their needs. It can be a sitting desk to relax, a normal working desk or a standing desk. This way, the user can decide what allows him best to focus. We're focusing on people who live relatively small and who have to turn their home into a working space. In terms of sustainability, we want the desk to be easy to disassemble, repair and recycle. Our focus is also on reducing the amount of VOC's that can be off-gassed by the furniture. On top of that, we should think of making our product more eco-efficient during its whole lifetime; think about energy-use, transport, ...

### Inventory analysis

We'll try to identify and quantify the use of energy, water, materials and environmental releases (e.g., air emissions, solid waste disposal, waste water discharges).

### **Impact assessment**

Here follows the estimation of the potential human and ecological effects of everything we identified in the inventory analysis.

### **Interpretation**

We will evaluate the results of the inventory analysis and impact assessment to select the preferred product, components, materials and processes to develop our desk. It's important to clearly state our uncertainties here.

## **5.6 Summary**

We don't want sustainability do be yet another part of the job, it should be a guiding influence for the whole project. We will develop our desk while always keeping in mind the three pillars of sustainability. Not only will we try minimizing our impact on the environment, we're also aware of the impact we can have on all of our stakeholders. When it comes to our community, locally and globally, we want to support them and give back, in every way we can. It is important that we have the support of our employees. Economically, we'll try make efficient choices that will not only benefit the environment, but also our company. Sustainability should be addressed at the beginning of the design stage to reduce negative impacts and the cost of implementation. We aim to design the desk in a way that it is easy to disassemble, repair and recycle. This way, we can prolong the life of our product. By ensuring our desk is robust enough, we avoid it getting thrown away at the end of it's life.

Next, we'll be taking a closer look at the ethical and deontological concerns related to our product.

## **6. Ethical and Deontological Concerns**

### **6.1 Introduction**

Since ancient times, back when people started to form societies, it became clear, that in order to have a control over people there need to be some rules to be followed. By the trial and error methods, humanity formulated some set of rules regulating our behavior towards each other. If these were neglected, there would be a complete chaos. Those rules have evolved and now are known as unwritten code of ethics. In this chapter, we will present some of the ethical concerns, by analyzing specific fields of ethical and deontological problems such as engineering, marketing, environmental and legal aspects.

### **6.2 Engineering Ethics**

Engineering is one of the most important and learned profession. Following that statement, engineers are expected to exhibit the highest standards of honesty and integrity. This field of study has a direct and vital impact on the quality of life for all people. Accordingly, the services provided by engineers require honesty, impartiality, fairness, and equity, and must be dedicated to the protection of the public health, safety, and welfare. Engineers must perform under a standard of professional behavior that requires adherence to the highest principles of ethical conduct [70].

**The seven canons** reflect an attempt to span the potentially infinite range of circumstances in which an engineer's commitment to these fundamental principles may be put to the test. Today these canons read as follows:

1. Engineers are responsible for holding paramount the **safety, health, and welfare** of the public and shall strive to comply with the principles of sustainable development in the performance of their professional duties.
2. Engineers shall perform services only in **areas of their competence**.
3. Engineers shall issue public statements only in an **objective** and **truthful** manner.
4. Engineers shall act in professional matters for each employer or client as faithful agents or trustees, and shall **avoid conflicts of interest**.
5. Engineers shall build their professional reputation on the merit **of their services** and shall not compete unfairly with others.
6. Engineers shall act in such a manner as to **uphold and enhance the honor, integrity, and dignity** of the engineering profession and shall act with **zero tolerance** for bribery, fraud, and corruption.
7. Engineers shall continue their professional development throughout their careers, and shall provide opportunities for the professional development of those engineers under their supervision [71].

### 6.3 Sales and Marketing Ethics

The whole market is associated with constant rat race and if an up and coming company wants to enter the market, it must take into account constant rivalry and competition for the client. In order to attract this customer, companies use all kinds of marketing tactics. Often these tactics can be viewed as „dirty” tricks, unprofessional such as misleading commercials or information that spreads around a product or service. Modern sales management is a complex mix of marketing, people management and negotiation skills and professional selling. On top of that a sales strategy needs to be planned, so good planning skills are also required. As can be seen the whole marketing and sales world is a pretty complex structure and for that to be as fluent as it is there need to be some set of rules. Here are **8 principles of ethical marketing** [72]:

1. **Truth** and **honesty** are appreciated and respected in all types and marketing areas.
2. Marketing personnel must follow their **personal ethics** in their professional activity.
3. Advertising for your product should be **easily distinguished** from news and entertainment.
4. The marketing department should be **honest** and **transparent** about who is sponsoring their

products.

5. Consumers must be treated **fairly** and **respected** based on a nature of a consumer and of a product.

6. **Consumer privacy** is appreciated and respected at all times and at all costs.

7. Marketing must comply with **rules** and **regulations** issued by the government or organisations.

8. Ethics should be discussed **openly** and **honestly** in all marketing decisions.

When it comes to our marketing, we've decided that truth and honesty are the most important factors. We will try not to false advertise and speak openly and transparently about our product. We will also pay attention to the environmental ethics which is next point which we will analyze.

## 6.4 Environmental Ethics

Environmental ethics is a branch of ethics that studies the relation of human beings and the environment and how ethics play a role in this. Environmental ethics believe that humans are a part of society as well as other living creatures, which includes plants and animals. These items are a very important part of the world and are considered to be a functional part of human life. [73]

Dramatic growth of worlds population led to drastic climate changes. Human acts result in such an environmental pollutions as Industrial and Household Waste, Acid rains, Ozone Layer depletion, Deforestation and Global warming. In order to prevent this fast-spreading danger we need to follow some rules. Of course when it comes to environmental ethic code it is a never ending list. There are three main types of Environmental Ethics [74]:

1. **Social ecology** which is the study of human beings and their relation to their environment.

2. **Deep ecology** promotes that all beings have an intrinsic value.

3. **Ecofeminism** is a branch of feminism that helps us look at earth as a woman so that we can respect it in a better way

We, as a team will also follow some environmental ethics aspects. We will try to make our product as sustainable as it can be and of course as least harmful for the environment and that will be done by using eco-friendly materials. We will also reduce packaging, reuse some materials and expand the product's lifespan. After it won't be useful it will be easy to recycle.

## 6.5 Liability

Liability concerns are the legal aspects that are important during designing a product. It aims to make sure that the product follows adequate directives and laws.

For the EPS project, our team must follow these European Union (EU) Directives in order to avoid product liability issues:



1. **Machine Directive** (2006/42/CE 2006-05-17): concerning machines and deals with such a dangers as explosions, vibrations, radiation, finger joints, dangerous substances in flight, force limits for the operation of machines, minimum safety distance. That directive is not strictly connected with our project [75].
2. **Electromagnetic Compatibility** (EMC) Directive (2004/108/EC 2004-12-15): intends to regulate side effects between electronic components that are connected/interface together, like electromagnetic radiation, fields in the vicinity of electronic components, etc. On the other hand this directive is more related to our project, as in our case we will have some electronic components [76].
3. **Low Voltage Directive (LVD)** (2014/35/EU 2016-04-20): deals with safety and health challenges with a use of electrical equipment with defined limits of voltage. This directive is also important for us, as we were thinking about adding a charging port to our desk [77].
4. **Radio Equipment Directive (RED)** (2014/53/EU 2014-04-16): regulatory framework for placing radio equipment on the market, ensuring no interference and data security regulation in radio communication with other devices. This directive is not strictly connected with our topic [78].
5. **Restriction of Hazardous Substances (ROHS) in Electrical and Electronic Equipment Directive** (2002/95/EC 2003-01-27): prohibition of the use of certain substances, with the aim to protect the environment and public health. This directive will be our concern as we are aiming to put a battery in our desk [79].

## 6.6 Summary

This chapter showed that in order to create, produce and sell a product you need to follow some ethical rules, which helped shaping today's market. Ethical code need to be respected in order to protect the environment, to create a good reputation and help expand brand's name in a good fashion and to add some values to the society.

When it comes to our team, we will strive towards an honest and transparent marketing attitude, we will also make sure to follow the standards. On top of that we will try to create as sustainable product as it can be, using eco-friendly materials.

That being said, in the following chapter we will show the actual steps of development of the product.

# 7. Project Development

## 7.1 Introduction

In this chapter, the development of our desk will be explained. We will illustrate the design proces, using sketches and models. The section of the components will showcase an overview of whatour product is made of, and why we chose those components in particular. We'll go deeper into the different materials and functionalities of our product. The tests and results will show the development of the tests performed with the prototype. In the conclision, we'll summarize all of the relevant points

of this entire chapter.

### 7.2 Proposed Solution

Illustrated in figure 28, is the black box diagram.

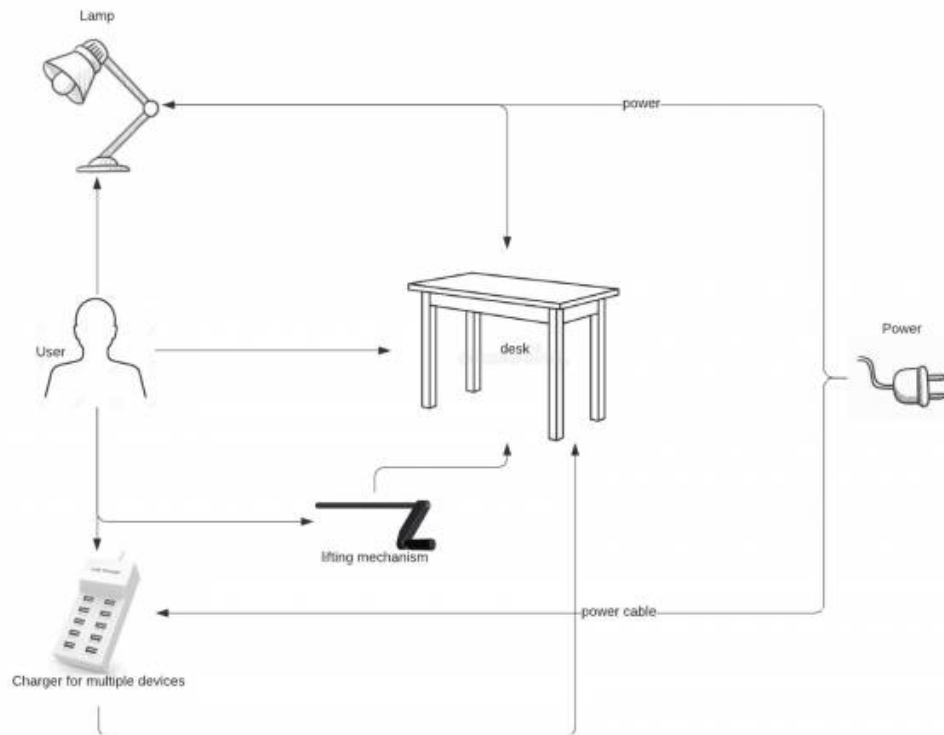


Figure 28: Black box diagram

Illustrated below in Figures 29, 30, 31, 32, 33 and 34 are some sketches.

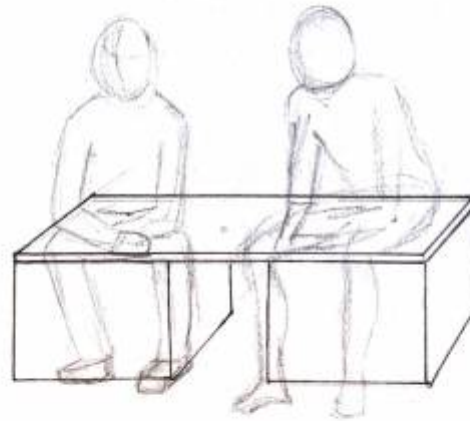


Figure 29: Sitting bench

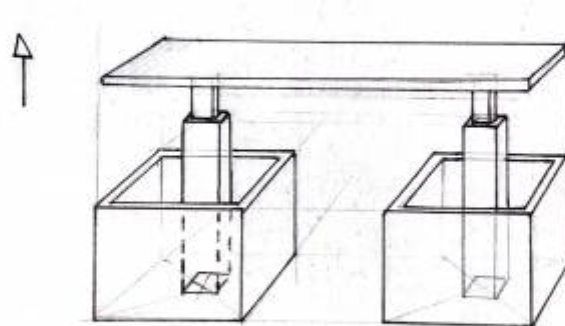


Figure 30: Sitting desk

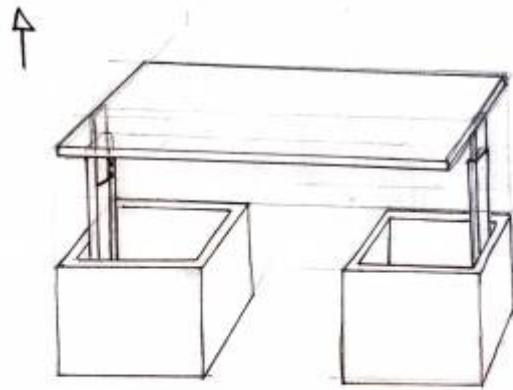


Figure 31: Sitting desk

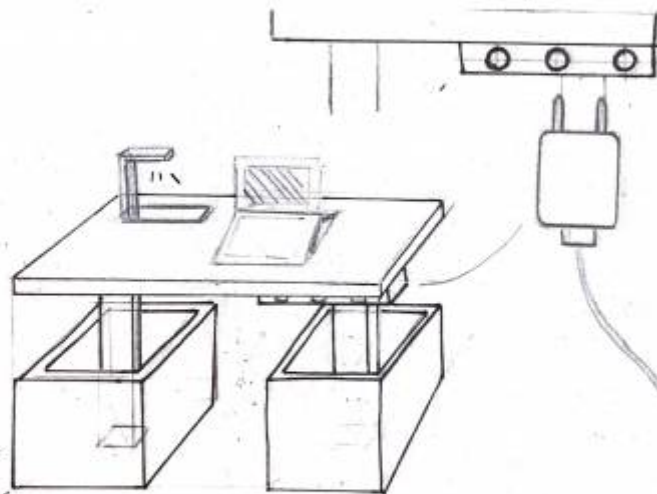


Figure 32: Charging ports

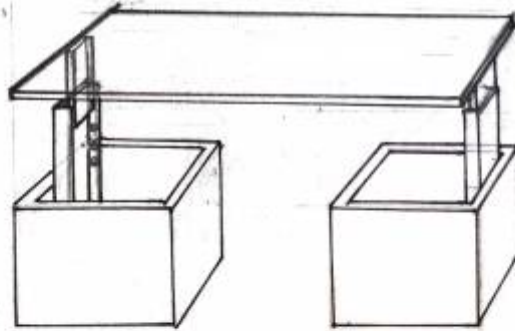


Figure 33: Sitting desk

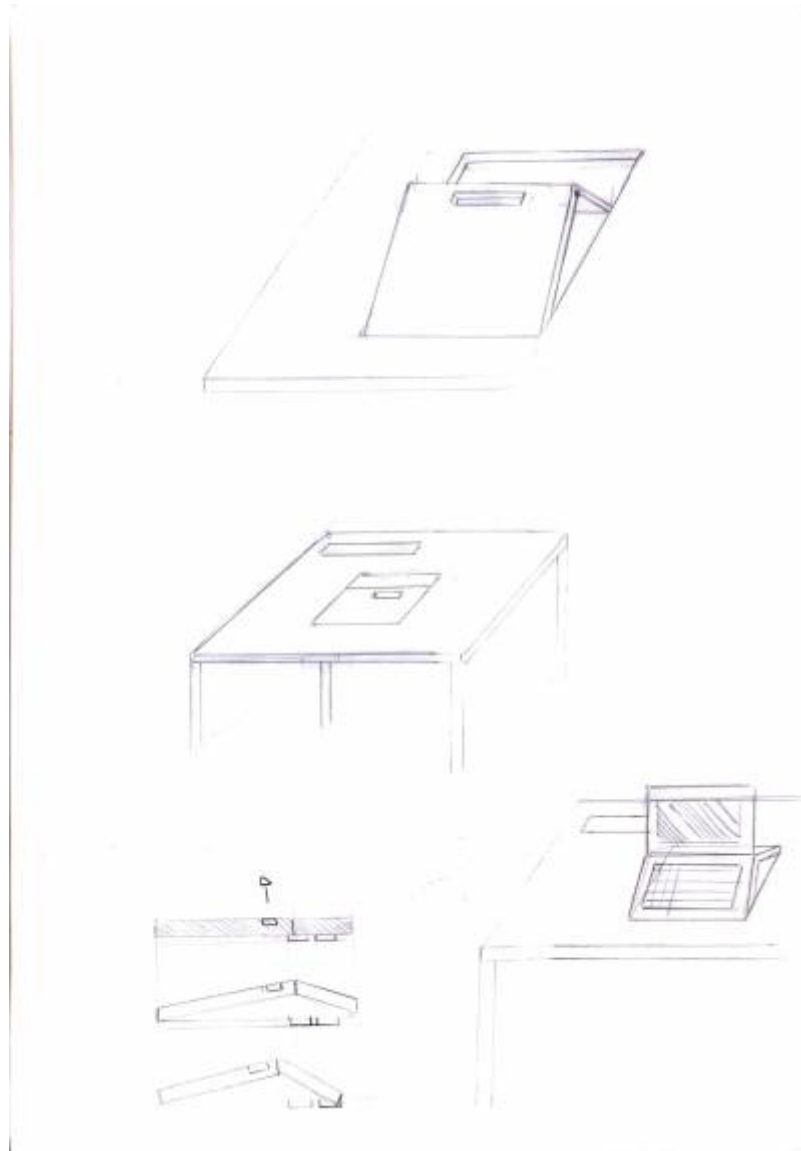


Figure 34: Laptop inclination




Figure 35 is our proposed solution using a wooden model; a flexible home desk that enables the user to adjust the height. It can be transformed from a bench into a sitting- and standing-desk.



Figure 35: Flexible Home Desk

### 7.3 Components

Table 10: Materials for building the table

Components	Material	description
	Pine wood	Pine is inexpensive, lightweight, and readily workable. It is often used to make rustic furniture pieces. However, it is prone to scratches and dents.
	Aluminium	Aluminium is affordable , very strong, very light and very resistant to corrosion.
	Bolt and Nut	

All components of the crank lifting system for making custom adjustments for height of table.



Battery lamp





Battery lamp with Large capacity battery & stepless brightness adjusted: Providing up to 5-6 hours on maximum brightness and 100 hours on the lowest setting, the 3000mAh built-in battery provides plenty of hours of use. Stepless brightness (from 10% to 100%) = unlimited lighting options for any modes as working, reading.

---

4 port charger



4 port charger that allows the user to charge multiple devices at once.

## 7.4 Functionalities

## 7.5 Tests and Results

## 7.6 Summary

*Provide here the conclusions of this chapter and introduce the next chapter.*

# 8. Conclusions

## 8.1 Discussion

*Provide here what was achieved (related with the initial objectives) and what is missing (related with the initial objectives) of the project.*

## 8.2 Future Development

Provide here your recommendations for future work.

## Bibliography

Will be added automatically by citing, in the body of the report, entries specified in BibTeX format and stored in the <http://www.epswiki.dee.isep.ipp.pt/doku.php?id=refnotes:bib> file

PS - If you have doubts on how to make citations, create captions, insert formulas, etc. visit this [page](#) with examples and select "Show pagesource" to see the source code.

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