Team 2: Aslan team

Wooden dome shelter

Interim Report

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Table of content

List of figures

List of tables

Glossary

Table 1: Glossary

Abbreviation	Description
NSPE	National Society of Professional Engineers
OSB	Oriented Strand Board
WBS	Work Breakdown Structure
R&R	Role & Responsibility

1 Introduction

1.1 Presentation

We are a team of international students and we are working together on our European Project Semester at ISEP. We all come from a different country in the world and we all study in a different field of engineering. Our team consists of the following members:

Joppe Balbaert - Civil Engineering - Belgium

Stancel Domenic Constantin - Environmental Engineering - Romania

Jaehyun Park - Chemical Engineering - South-Korea

Ramon Marimon - Electrical Engineering - Spain

Marine Cazelles - Packaging Engineering - France

Akos Serfozo - Electrical Engineering - Hungary

1.2 Motivation

The choice of our project is the result of a common interest in innovation and creativity. Indeed, since the geodesic domes exist, they have proven ingenuity of the concept. A geo-dome has a big volume for a small surface, so its decreased surface area requires less building materials. Furthermore, it allows an optimal air flow and a uniform temperature thanks to its concave interior. Many architects have used it to create various buildings such as concert halls, airports, churches or mosques.

From the 1970s onwards, the enthusiasm for geodesic domes decreased, until recently when a renewed interest in environmental preoccupations allows the return of these spherical structures [1]. Indeed, the excessive cost of energy is forcing individuals and countries to look for ways to minimize their consumption. Energy efficiency is the main reason for the comeback of geodesic domes. Thus, nowadays, the demand for this type of product increases whether it is personal or business applications: greenhouse, storage room, event domes for trade show, convention or party…

In this way, we chose this project that constitutes a challenge for our team. Indeed, succeed in applying modern technological know-how to geo-dome construction can help to make shelter more comfortable and efficient for a greater number of people. Thus, our aim is to develop a stylish geo-dome as sustainable as possible, while respecting the requirements and working as a team.

1.3 Problem

The project is to develop a multifunctional wooden dome shelter.

The main priority is to think about the best design and calculations for our dome among all the possible solutions. We will combine quality and cost efficient materials.

We are aware that during this semester we will have to face different challenges :

- To find a solution to implement an electronic door and window.
- To create a sustainable dome.
- To find the best junction nodes.
- To respect the imposed budget.
- To meet the deadlines.

1.4 Objectives

The goal is to design a wooden dome made of a support structure or a self-sustained cover with an articulate and automatic door and window. The dome must be a V3 or V4 geo-dome with a diameter of 6.8 m. The wooden dome should be constructed in a way that allows the structure to be permanent.

1.5 Requirements

The project requirements are:

Reuse provided materials,

Use low cost hardware solutions,

Comply with the following EU Directives:

Machine Directive (2006/42/CE 2006-05-17);

Electromagnetic Compatibility Directive (2004/108/EC 2004 12 15);

Low Voltage Directive (2014/35/EU 2016-04-20);

Radio Equipment Directive (2014/53/EU 2014-04-16);

Restriction of Hazardous Substances (ROHS) in Electrical and Electronic Equipment Directive (2002/95/EC 2003-01-27);

Mandatory adoption and use of the International System of Units (The NIST International Guide for the use of the International System of Units)

Use open source software and technologies.

1.6 Functional Tests

The functional tests will be executed on the prototype of the automatic window. The first test is the building of the prototype itself. The team will rate different aspects while building the prototype. In this way the weak points of the design of the prototype will be detected. For every weak point, improvements will be formulated.

Once the prototype is build, the second part of the testing can be done. The window will open automatically when the temperature or the humidity will be too high. The measurements will be done by a temperature and humidity sensor. If all of this works well, the second test can be considered as successful.

1.7 Project Planning

For the planning of the project, a Gantt chart was used. In chapter 3.2 will be discussed how the Gantt chart was obtained.

ID	Task Mode	Task Name	Duration	Baseline Duration	Start	Baseline Start	Finish	Baseline Finish
1		Planning	25 days	25 days	Mon 29/02/1	Mon 29/02/16	Fri 1/04/16	Fri 1/04/16
2		Task allocation	5 days	5 days	Mon 29/02/1	Mon 29/02/16	Fri 4/03/16	Fri 4/03/16
3		Gantt chart	5 days	5 days	Mon 7/03/16	Mon 7/03/16	Fri 11/03/16	Fri 11/03/16
4		Budget	5 days	5 days	Mon 28/03/1	Mon 28/03/16	Fri 1/04/16	Fri 1/04/16
5		List of materials	5 days	5 days	Mon 28/03/1	Mon 28/03/16	Fri 1/04/16	Fri 1/04/16
6		End planning phase	0 days	0 days	Fri 1/04/16	Fri 1/04/16	Fri 1/04/16	Fri 1/04/16
7		Research	20 days	20 days	Mon 29/02/1	Mon 29/02/16	Fri 25/03/16	Fri 25/03/16
8		Construction	20 days	20 days	Mon 29/02/1	Mon 29/02/16	Fri 25/03/16	Fri 25/03/16
9		Materials	5 days	5 days	Mon 7/03/16	Mon 7/03/16	Fri 18/03/16	Fri 18/03/16
10		Type of structure	5 days	5 days	Mon 29/02/1	Mon 29/02/16	Fri 4/03/16	Fri 4/03/16
11		Technologies	10 days	10 days	Mon 29/02/1	Mon 29/02/16	Fri 11/03/16	Fri 11/03/16
12		Automatic door s	5 days	5 days	Mon 7/03/16	Mon 7/03/16	Fri 11/03/16	Fri 11/03/16
13		Fixations	5 days	5 days	Mon 7/03/16	Mon 7/03/16	Fri 11/03/16	Fri 11/03/16
14		Production proce	10 days	10 days	Mon 14/03/1	Mon 14/03/16	Fri 25/03/16	Fri 25/03/16
15		Marketing	20 days	20 days	Mon 29/02/1	Mon 29/02/16	Fri 25/03/16	Fri 25/03/16
16		SWOT analysis	10 days	10 days	Mon 29/02/1	Mon 29/02/16	Fri 11/03/16	Fri 11/03/16
17		Segmentation an	10 days	10 days	Mon 29/02/1	Mon 29/02/16	Fri 11/03/16	Fri 11/03/16
18		Marketing strate	10 days	10 days	Mon 14/03/1	Mon 14/03/16	Fri 25/03/16	Fri 25/03/16
19		Competitors	10 days	10 days	Mon 14/03/1	Mon 14/03/16	Fri 25/03/16	Fri 25/03/16
20		Target	10 days	10 days	Mon 29/02/1	Mon 29/02/16	Fri 11/03/16	Fri 11/03/16
21		Logo/name	10 days	10 days	Mon 29/02/1	Mon 29/02/16	Fri 11/03/16	Fri 11/03/16
22		Sustainability	20 days	20 days	Mon 29/02/1	Mon 29/02/16	Fri 25/03/16	Fri 25/03/16
23		Type of resource	20 days	20 days	Mon 29/02/1	Mon 29/02/16	Fri 25/03/16	Fri 25/03/16
24		Life cycle	20 days	20 days	Mon 29/02/1	Mon 29/02/16	Fri 25/03/16	Fri 25/03/16
25		Eco-efficiency m	20 days	20 days	Mon 29/02/1	Mon 29/02/16	Fri 25/03/16	Fri 25/03/16
26		Ethical and deontolog	10 days	10 days	Fri 1/04/16	Fri 1/04/16	Thu 14/04/1	Thu 14/04/16
27		End of research period	0 days	0 days	Thu 14/04/16	Thu 14/04/16	Thu 14/04/16	Thu 14/04/16
28		Dome design	30 days	30 days	Mon 29/02/1	Mon 29/02/16	Fri 8/04/16	Fri 8/04/16
29		Brainstorming	5 days	5 days	Mon 29/02/1	Mon 29/02/16	Fri 4/03/16	Fri 4/03/16
30		Draw sketch	5 days	5 days	Mon 7/03/16	Mon 7/03/16	Fri 11/03/16	Fri 11/03/16
31		3D simulation	10 days	10 days	Mon 14/03/1	Mon 14/03/16	Fri 25/03/16	Fri 25/03/16
32		Cardboard model	5 days	5 days	Mon 14/03/1	Mon 14/03/16	Fri 18/03/16	Fri 18/03/16
33		Calculations	10 days	10 days	Mon 28/03/1	Mon 28/03/16	Fri 8/04/16	Fri 8/04/16
34		End of design phase	0 days	0 days	Fri 8/04/16	Fri 8/04/16	Fri 8/04/16	Fri 8/04/16
35		Development and construction	18 days	18 days	Mon 11/04/16	Mon 11/04/16	Wed 4/05/16	Wed 4/05/16
36		Blueprinting	2 days	2 days	Mon 11/04/1	Mon 11/04/16	Tue 12/04/1	Tue 12/04/16
37		Prototyping	5 days	5 days	Wed 13/04/1	Wed 13/04/16	Tue 19/04/1	Tue 19/04/16
38		Testing	2 days	2 days	Wed 20/04/1	Wed 20/04/16	Thu 21/04/1	Thu 21/04/16
39		Building	5 days	5 days	Fri 22/04/16	Fri 22/04/16	Thu 28/04/1	Thu 28/04/16
40		Final testing	2 days	2 days	Fri 29/04/16	Fri 29/04/16	Mon 2/05/16	Mon 2/05/16
41		Final adjustments	2 days	2 days	Tue 3/05/16	Tue 3/05/16	Wed 4/05/16	Wed 4/05/16
42			0 days	0 days	Wed 4/05/16	Wed 4/05/16	Wed 4/05/16	Wed 4/05/16
43		Wiki	75 days	75 days	Mon 29/02/1	Mon 29/02/16	Fri 10/06/16	Fri 10/06/16
44		Weekly report	15 days	15 days	Mon 29/02/1	Mon 29/02/16	Fri 10/06/16	Fri 10/06/16
45		State of the art	15 days	15 days	Mon 29/02/1	Mon 29/02/16	Fri 18/03/16	Fri 18/03/16
46		Final report	69 days	69 days	Mon 29/02/1	Mon 29/02/16	Fri 10/06/16	Fri 10/06/16
47			0 days	0 days	Fri 10/06/16	Fri 10/06/16	Fri 10/06/16	Fri 10/06/16

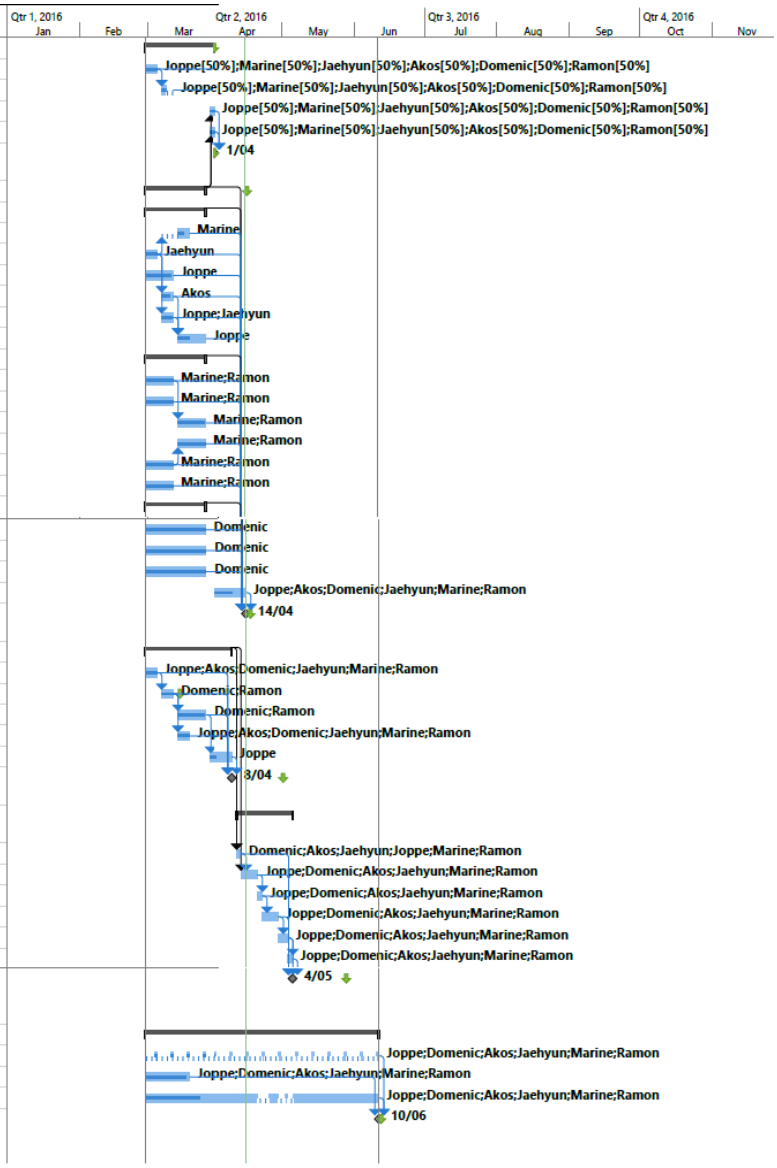


Figure 1: Gantt chart

1.8 Report Structure

Table 2: Report structure

Task	Description
Introduction	Presentation of the team, our motivation, objectives and requirements of the project, the main problems
State of the art	Presentation of the different products and technologies existing on the market, their strong points and weaknesses
Project Management	Organisation and management of the project including the tasks, responsabilities, cost
Marketing Plan	Analysis of the market and marketing strategy
Eco-efficiency measures for sustainability	Life cycle analysis and study of the economic, environmental and social impacts of our product
Ethical and Deontological Concerns	Reflection about legitimacy and legality aspects of our product
Project Development	Progress of our project during the semester (design, tests and results, construction etc.)
Conclusions	Final conclusion of our project and the acquired knowledges, discussions about the future possible developments

2 State of the Art

2.1 Introduction

There is a huge range of possibilities for geodesic domes as the choice of materials or the shape of openings and windows or the general aesthetics. Many applications are possible: bungalow, greenhouse, aviary, house, pergola, garden shed, etc.

In this way, in this chapter, we will describe the existing products and their functions. We wanted to compare the different technologies and techniques presents on the market and define their strong and weak points. We focused mainly on the design, the junction nodes, the materials and the functionality.

We based our research on websites, books, previous projects and experience but also on our own knowledges.

2.2 What is a geo-dome?

A geo-dome is a construction that has the shape of a hemisphere. There are different ways to obtain the shape, but for our project we are going to obtain it by obtained by putting together triangles. In this way, it is possible to construct a round form by putting together only straight beams.

The design of the geo-dome begins with an icosahedron shape. An icosahedron consists out of 20 triangles that all have the same size. In order to get the dome shape, every side of the triangle is divided into a couple of parts. If every side is divided in 2 parts, a V2 dome will be obtained, if divided in 3 parts, a V3 dome is obtained and so on. Once the triangles are subdivided, they are projected on the hemisphere. To get the final shape of the dome, the vertices of the projected triangles should be connect to each other with straight lines.

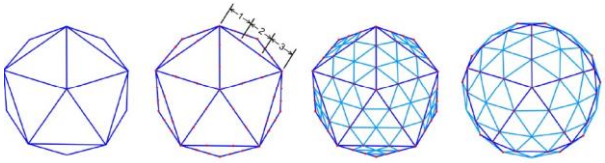


Figure 2: Steps to get a V3 dome [2]

The full process of getting a dome starting from a icosahedron will be elaborated further in chapter 7.2.2.1.

2.3 Use of geo-domes

Geo-domes can be used for multiple purposes. Every purpose will impose other requirements for the dome to fulfil. The more complex the function of the dome, the more difficult it will be to meet the requirements.

Resident domes

Figure 3: Resident dome AiDomes, [3]

To be able to live in the dome, the highest requirements will be imposed. The people living in the dome will request a certain amount of comfort. The level of comfort will depend on the desires of the client. Basic requirements for a resident dome will be the waterproofness of the structure, fire resistance and thermal comfort.

Greenhouse

Figure 4: Greenhouse dome [4]

The requirements for a greenhouse are less strict, because people don’t have to live inside. If there is a small infiltration of water, this won’t be a big problem.

Events

Figure 5: Event dome [5]

The domes for events are very different in requirements. If the dome is positioned inside it should not be waterproof. Aesthetic aspects are more important, because the dome functions as an eye-catcher. The dome for events should also be easy to assemble and disassemble because it should not stay in the same place for a long time.

2.4 Wooden domes

In this chapter we will discuss different geodesic domes that are already build all over the world. We will mainly focus on the different possibilities for the connections and the type of wood used for the beams and panels.

2.4.1 Dome kits

Dome kits is a company based in the United States of America. They offer multiple solutions for domes, in wood as well in metal. We will only focus on their wooden domes. Dome kits let their clients decide if they want to build the dome themselves or if they want the help of the company as a general constructor. They have already been building domes for 35 years, so they can rely on a lot of experience.

2.4.1.1 Connections

For the connections, dome kits proposes two options. The first option is to make the connection a connector, the second is to do it without one.

Without a connector

For the connection without a connector, the ends of all the beams need to be cut in specific angles. The most visible of the angles is the triangle shape at the end of the beam you can see if you look at the beam from the top. The size of this angle depends on the number of beams coming together in this connection. If 5 beams come together, each angle measures 72°, if 6 beams come together, every angle measures 60°. If you look at the beam from the side, you can also see an angle at the end of the beam. This angle measures 9° and the dome it rounded shape.

Figure 6: Angles at the end of a beam [6]

Once the beams are cut at the right angles, they are connected using 76 mm woodscrews. Once the screws are drilled into the beams the connections are made. But dome kits still adds an extra connection at the lower parts of the dome. The weight of the higher parts and the loads working on them, should be transferred to the ground trough lower beams. This will cause a higher loading on the lower beams. This load will push outwards on the lower beams. For this reason, dome kits has decided to add extra steel straps on the outside of the connections of the lower beams. They have two possible solutions for this. The first one is a simple steel strap screwed onto the beams.

Figure 8: Strap for reinforcement [7]

The second solution is the “Simpson Stronge-tie Gazebo”. This is a prefabricated connector designed for the connection of 6 beams. This connector covers the whole connection. This can be useful if your connection does fit perfectly to assure the waterproofness of the connection. The disadvantage of this connector is that it adds an extra cost to the project. Every connector costs around 10 €.

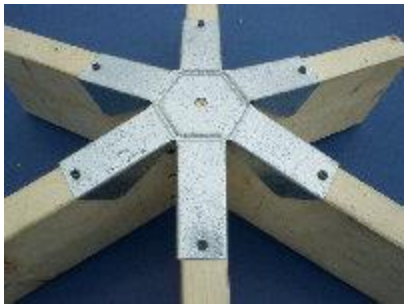


Figure 7: Simpson Strong tie Gazebo [8]

With a connector

The connection with the use of a connector is almost the same as the connection made on the lower beams when using no connector. An important difference is the preparation of the beams. The beams only have to be cut to one angle instead of two. This will save time during the preparation of the beams. The end of each beam has to be cut at an angle of 9°. This cut is needed because the size of the connector on top is the same as the size at the bottom. This system uses two “Simpson Stronge-tie Gazebo” connectors for every connection. In total this will imply the use of 122 connectors, adding an extra cost of 1 220 €.

Figure 9: Use of the Simpson Strong tie Gazebo [9]

This type of connection can also be reinforced for the lower parts of the dome. Dome kits does this using simple straight steel straps. The three straps pass through the connection and are connected to the beam at the opposite side. This doesn’t affect the waterproofness of the connection because the connector has a metal plate on top of the connection.

Figure 10: Straps for reinforcement [10]

Apart from the extra cost of the connectors, there is another disadvantage. The connectors are designed for hexagonal connections, but there are also 6 pentagonal connections to be made. Dome kits doesn't have a prefabricated connector for this connections. They will adjust a connector for a hexagonal connection to fit the pentagonal connection. This is done by using pliers and a hammer. This will have reduce the advantage you normally have when using connectors, because the angles have to be checked thoroughly.

Figure 11: Pentagonal connection [11]

2.4.1.2 Materials

Dome kits uses multi-layer plywood for all of their panels in wooden domes. The reason they prefer this material over OSB or particle board plywood is the fact that it is has a better moisture resistance. Another reason to choose multi-layer plywood is its better strength.

Dome kits uses Southern Pine lumber for the beams in the wooden domes. This type of wood is widely available in the United States of America where Dome kits is operating from. It is used for the construction of houses. Even though Southern Pine is a softwood, it still has good strength characteristics because it has a high density.

2.4.2 Timberline Geodesics

Timberline geodesics also is an American company that is specialized in construction wooden domes. This company, based in California, lets their client decide whether they want to build the dome themselves. We will discuss their choices on connections and materials, since they are different than those of the dome kits company. Another difference with the standard dome is the structure, this will also be discussed.

2.4.2.1 Connections

Timberline geodesics uses a connector called "Timberline's SteelStar Connector" to make the connections between the different beams. This connector is made out of a 3.5 mm thick plates in hot rolled steel and a steel pipe in the middle. The advantage of this system is the fact that the angles in both directions are fixed once the connector is finished. This reduces the chances of making mistakes during the construction phase of the dome.

Figure 12: SteelStar Connection [12]

The connector has a breaking resistance of 12 000 pounds, which is 53,3 kN. This resistance is four times higher than the resistance needed in the Timberline domes. The beams also touch to the steel pipe. This will reduce the shear force working on the bolts, since the weight is transmitted over the steel ring.

2.4.2.2 Materials

For the panels in the dome, Timberline also uses a plywood as their material of choice. On their website they specify choice as “1/2“ 5-ply Structural Grade #1 plywood”. This means that the plate has a thickness of 12.7 mm and the plate consist out of 5 layers of wood. The #1 structural strength of the panel.

The beams are made out of fir, more specifically Structural Hem fir or Douglas fir. Fir can withstand considerable compressive forces (50 kN/m²). This type of wood also is the resource for making plywood [13].

2.4.2.3 Structure

The general shape of the dome is very similar to that of the standard domes. It consists out of pentagons and hexagons. The difference with the others domes is the fact that Timberline inserts what they call studs in between the beams of the triangles. These studs will increase the stiffness of the triangles. Another advantage is that the span length every panel has to cover will be smaller. This will allow the panels to be thinner and therefore cheaper. But this advantage will be neutralized by the need of extra material for the studs.

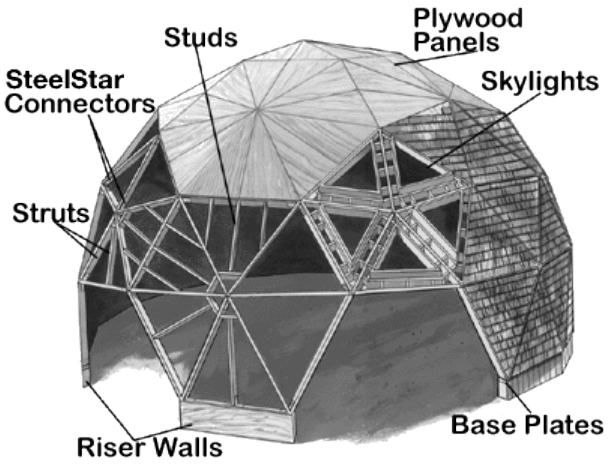


Figure 13: Structure Timberline Geodesics [14]

2.5 Advantages of geo-domes

In this paragraph, we will discuss the advantages of a geo-dome. It is important to know the advantages of a dome, because they have to be retained during the design process of our own dome.

2.5.1 Big volume, small surface

One of the main advantages of a geo-dome is the fact that a sphere encloses a big volume for the a minimal surface area. This can be seen in the fact that the isoperimetric quotient is 1 for a sphere [15]. The consequence of this is that the geodesic dome can be considered as an efficient shape in terms of use of materials. Another consequence of this characteristic is energy efficiency. The domes loses warmth trough transmission during the winter. This result of this effect is directly related to the surface of the surface area. The bigger the surface area, the bigger the loss of warmth during the colder winter period.

2.5.2 Aerodynamics

Another advantage of the shape of a geo-dome can be found in aerodynamics. Heavy winds on the structure will be guided around the structure. The formula of the force caused by wind contains a drag coefficient. The drag coefficient of a hemisphere 0.42 [16]. When comparing this number to the drag coefficient of a cube, which is 0.8, there can be concluded that the drag coefficient of cube is almost two times bigger. The force acting on a building in the shape of a cube with the same surface, will be twice as high compared to a building with a hemisphere shape. It can be concluded that forces due to wind will have a smaller effect on a hemisphere. Smaller forces acting on the structure, will reduce the cost of materials, because the strength of the beams will have to be lower, which will make the beams less expensive.

2.5.3 Air circulation

The hemisphere shape of a geo-dome also has an advantage regarding air circulation. When air flows over a curved surface, like that of a geo-dome, its speed will increase. At the apex of the surface, the pressure of the air drops [17]. This phenomenon will generate an air flow through the dome. This air flow will spread the warmth or the cold. This will result in a temperature that is the same in the whole dome. If there is need for heating in the summer or for cooling in the winter, the natural air flow will work as a fan.

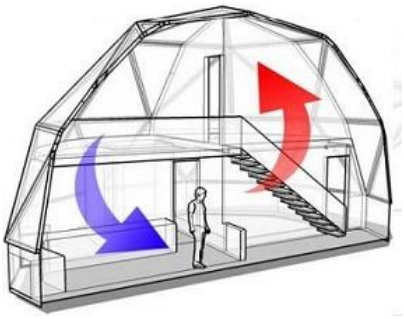


Figure 14: Natural air circulation in a dome [18]

2.6 Disadvantages of geo-domes

If the geo-dome would only have advantages, it would be used a lot in the whole world, but it is not. The disadvantages of geo-domes can give an insight on the problems that will appear during the design of the dome. In this way we can pay attention to solve those problems during the design phase.

2.6.1 Complex design

The first big problem with the geo-dome is that it is a complex shape. Contrary to a cube shaped building, it is not so easy to design. The calculations for the strength of the beams, the connections between the beams et cetera are much more complicated and they will take more time. This will increase the price of the building. This extra cost can be reduced by standardization of domes.

2.6.2 Waterproofness

The geo-dome is constructed out of a lot of triangles. To get a good approximation of the hemisphere shape of the dome, the area of each triangles can't be too big. Like this there will be a lot of seams that can cause problems for the waterproofness of the building. The dimensions of each part of the construct need to be very accurate and every part needs to be placed in an accurate way. To be able to do this, skilled workers and machines with high precision are needed.

2.6.3 Need for custom fitting

Most of the buildings nowadays consist of rectangular shapes. This is the reason why construction materials are mostly available in a rectangular shape. Windows for example are widely available in a rectangular shape, but not in a triangular shape. The size of the windows also isn't free to choose like in a cubic building. For these reasons customization of windows will be needed, which also implies a higher price per window.

The curved walls will also cause problems for the interior decoration of the dome. Standard furniture is rectangular so the user has two options. The first option is to buy custom furniture, which will increase the price. The second option is to use the standard furniture, but that will cause a loss of space close to the walls [19].

2.7 Conclusion

In this chapter we discussed different possibilities for wooden beams regarding materials and connections. This information will help us making the right choices for our own design. We also discussed the advantages and disadvantages geodomes have. This will help us to find the weak and strong point of geodomes in order to maintain the strengths of the concept and to try to find a

solution for the weaknesses.

3 Project Management

3.1 Scope

3.1.1 Introduction

Scope management includes performing all things which need for finishing project successfully, excludes unneeded work, controls and defines range of deliverables. We use open source software to accomplish our project, select low-cost materials for project by making some materials list.

3.1.2 Product description and Project explanation

We want to make wooden dome shelter which have a variety of purposes, which is used camping place for people or shelter for poor people, like a homeless. This dome is made of eco-friendly and cheap materials and equipped with controller for adjusting humidity and temperature in the dome. Of course, this controller will be able to refresh air from dome outside. Additionally, this controller is automated by arduino and some installation.

3.1.3 WBS (Work Breakdown Structure)

WBS is to divide works in project up to level possible to manage. This diagram is useful for growing up accuracy for deciding timetable and cost as well as making project manager select member and allocate work. The following table is consist of deliverable oriented resulting from activity. The activity is made by tasks.

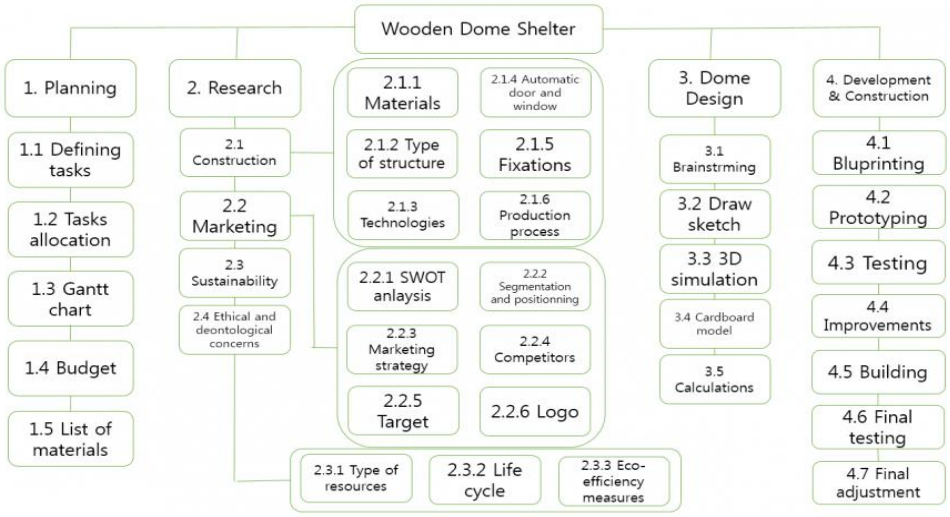


Figure 15: WBS

3.2 Time

3.2.1 Introduction

Time management involves activities about controlling and establishing plan to finish the project until deadline.

3.2.2 Time management process

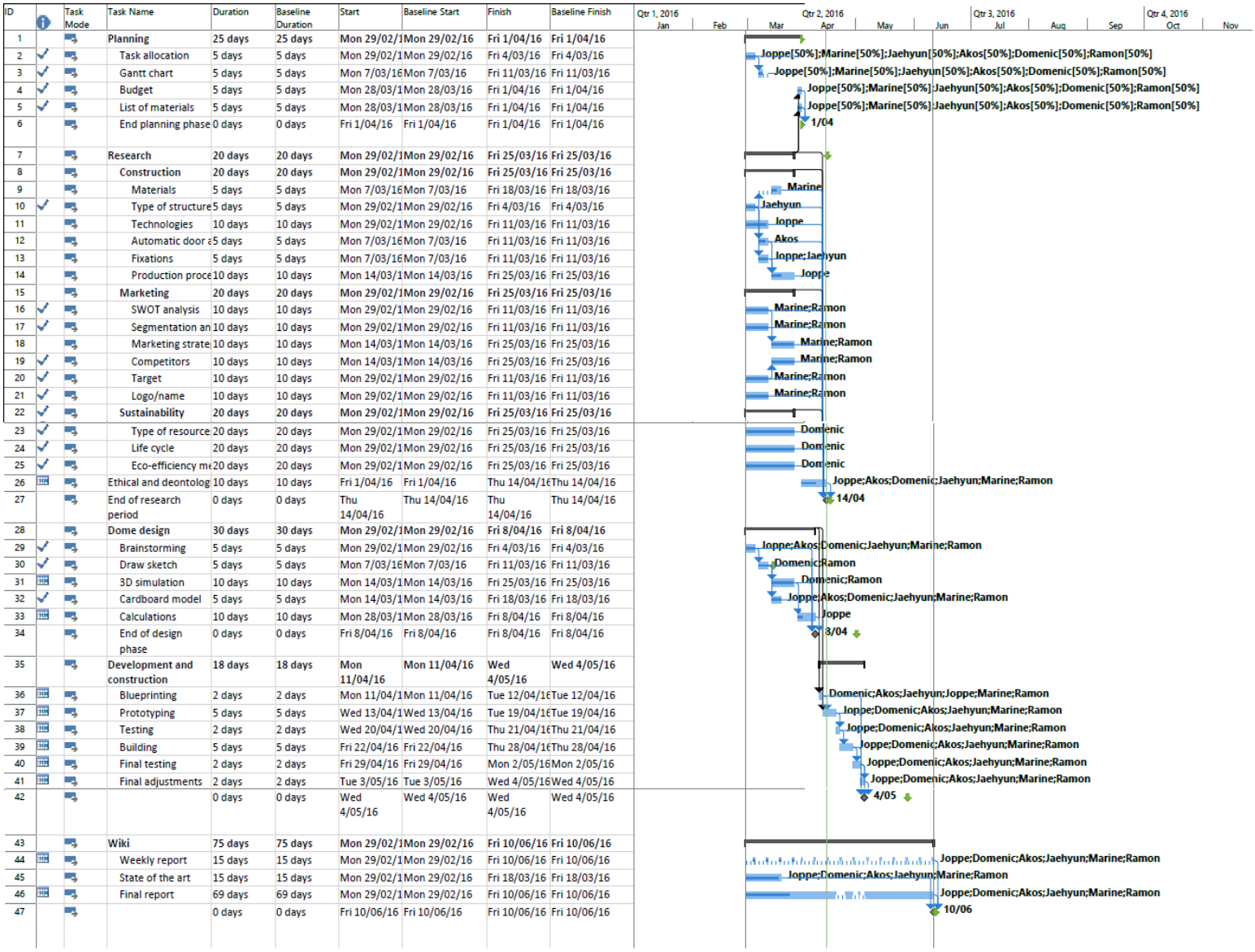
It is composed of serial step like that. When we make Gantt chart, refer to this information.

Tabel 3: The process of time management

Division	Number	Name of process	Main deliverable
Plan	1	Define Activities	Activity List
Plan	2	Sequence Activities	Project Schedule Network Diagram
Plan	3	Estimate Activity Resources	Activity Resource Requirements
Plan	4	Estimate Activity Durations	Activity Duration Estimates
Plan	5	Develop Schedule	Schedule Baseline
Plan	6	Control Schedule	Change Requests

3.2.3 Gantt chart

Gantt chart can design efficiently time for member, set the timetable for preventing waste of time, allocate tasks to member. At the same time, this makes member know the progress of the project.



ID	Task Mode	Task Name	Duration	Baseline Duration	Start	Baseline Start	Finish	Baseline Finish
1		Planning	25 days	25 days	Mon 29/02/1	Mon 29/02/16	Fri 1/04/16	Fri 1/04/16
2		Task allocation	5 days	5 days	Mon 29/02/1	Mon 29/02/16	Fri 4/03/16	Fri 4/03/16
3		Gantt chart	5 days	5 days	Mon 7/03/16	Mon 7/03/16	Fri 11/03/16	Fri 11/03/16
4		Budget	5 days	5 days	Mon 28/03/1	Mon 28/03/16	Fri 1/04/16	Fri 1/04/16
5		List of materials	5 days	5 days	Mon 28/03/1	Mon 28/03/16	Fri 1/04/16	Fri 1/04/16
6		End planning phase	0 days	0 days	Fri 1/04/16	Fri 1/04/16	Fri 1/04/16	Fri 1/04/16
7		Research	20 days	20 days	Mon 29/02/1	Mon 29/02/16	Fri 25/03/16	Fri 25/03/16
8		Construction	20 days	20 days	Mon 29/02/1	Mon 29/02/16	Fri 25/03/16	Fri 25/03/16
9		Materials	5 days	5 days	Mon 7/03/16	Mon 7/03/16	Fri 18/03/16	Fri 18/03/16
10		Type of structure	5 days	5 days	Mon 29/02/1	Mon 29/02/16	Fri 4/03/16	Fri 4/03/16
11		Technologies	10 days	10 days	Mon 29/02/1	Mon 29/02/16	Fri 11/03/16	Fri 11/03/16
12		Automatic door a	5 days	5 days	Mon 7/03/16	Mon 7/03/16	Fri 11/03/16	Fri 11/03/16
13		Fixations	5 days	5 days	Mon 7/03/16	Mon 7/03/16	Fri 11/03/16	Fri 11/03/16
14		Production proce	10 days	10 days	Mon 14/03/1	Mon 14/03/16	Fri 25/03/16	Fri 25/03/16
15		Marketing	20 days	20 days	Mon 29/02/1	Mon 29/02/16	Fri 25/03/16	Fri 25/03/16
16		SWOT analysis	10 days	10 days	Mon 29/02/1	Mon 29/02/16	Fri 11/03/16	Fri 11/03/16
17		Segmentation an	10 days	10 days	Mon 29/02/1	Mon 29/02/16	Fri 11/03/16	Fri 11/03/16
18		Marketing strate	10 days	10 days	Mon 14/03/1	Mon 14/03/16	Fri 25/03/16	Fri 25/03/16
19		Competitors	10 days	10 days	Mon 14/03/1	Mon 14/03/16	Fri 25/03/16	Fri 25/03/16
20		Target	10 days	10 days	Mon 29/02/1	Mon 29/02/16	Fri 11/03/16	Fri 11/03/16
21		Logo/name	10 days	10 days	Mon 29/02/1	Mon 29/02/16	Fri 11/03/16	Fri 11/03/16
22		Sustainability	20 days	20 days	Mon 29/02/1	Mon 29/02/16	Fri 25/03/16	Fri 25/03/16
23		Type of resource	20 days	20 days	Mon 29/02/1	Mon 29/02/16	Fri 25/03/16	Fri 25/03/16
24		Life cycle	20 days	20 days	Mon 29/02/1	Mon 29/02/16	Fri 25/03/16	Fri 25/03/16
25		Eco-efficiency me	20 days	20 days	Mon 29/02/1	Mon 29/02/16	Fri 25/03/16	Fri 25/03/16
26		Ethical and deontolog	10 days	10 days	Fri 1/04/16	Fri 1/04/16	Thu 14/04/16	Thu 14/04/16
27		End of research period	0 days	0 days	Thu 14/04/16	Thu 14/04/16	Thu 14/04/16	Thu 14/04/16
28		Dome design	30 days	30 days	Mon 29/02/1	Mon 29/02/16	Fri 8/04/16	Fri 8/04/16
29		Brainstorming	5 days	5 days	Mon 29/02/1	Mon 29/02/16	Fri 4/03/16	Fri 4/03/16
30		Draw sketch	5 days	5 days	Mon 7/03/16	Mon 7/03/16	Fri 11/03/16	Fri 11/03/16
31		3D simulation	10 days	10 days	Mon 14/03/1	Mon 14/03/16	Fri 25/03/16	Fri 25/03/16
32		Cardboard model	5 days	5 days	Mon 14/03/1	Mon 14/03/16	Fri 18/03/16	Fri 18/03/16
33		Calculations	10 days	10 days	Mon 28/03/1	Mon 28/03/16	Fri 8/04/16	Fri 8/04/16
34		End of design phase	0 days	0 days	Fri 8/04/16	Fri 8/04/16	Fri 8/04/16	Fri 8/04/16
35		Development and construction	18 days	18 days	Mon 11/04/16	Mon 11/04/16	Wed 4/05/16	Wed 4/05/16
36		Blueprinting	2 days	2 days	Mon 11/04/1	Mon 11/04/16	Tue 12/04/16	Tue 12/04/16
37		Prototyping	5 days	5 days	Wed 13/04/1	Wed 13/04/16	Tue 19/04/16	Tue 19/04/16
38		Testing	2 days	2 days	Wed 20/04/1	Wed 20/04/16	Thu 21/04/16	Thu 21/04/16
39		Building	5 days	5 days	Fri 22/04/16	Fri 22/04/16	Thu 28/04/16	Thu 28/04/16
40		Final testing	2 days	2 days	Fri 29/04/16	Fri 29/04/16	Mon 2/05/16	Mon 2/05/16
41		Final adjustments	2 days	2 days	Tue 3/05/16	Tue 3/05/16	Wed 4/05/16	Wed 4/05/16
42			0 days	0 days	Wed 4/05/16	Wed 4/05/16	Wed 4/05/16	Wed 4/05/16
43		Wiki	75 days	75 days	Mon 29/02/1	Mon 29/02/16	Fri 10/06/16	Fri 10/06/16
44		Weekly report	15 days	15 days	Mon 29/02/1	Mon 29/02/16	Fri 10/06/16	Fri 10/06/16
45		State of the art	15 days	15 days	Mon 29/02/1	Mon 29/02/16	Fri 18/03/16	Fri 18/03/16
46		Final report	69 days	69 days	Mon 29/02/1	Mon 29/02/16	Fri 10/06/16	Fri 10/06/16
47			0 days	0 days	Fri 10/06/16	Fri 10/06/16	Fri 10/06/16	Fri 10/06/16

Figure 16: Gantt chart

3.3 Cost

3.3.1 Introduction

The purpose of cost management is to estimate production cost needed for performing activities, to decide total budget for project, to control it by using the budget approving only so that project can be completed.

3.3.2 Composition of cost management

The estimation of production cost needs for information like scope, schedule, manpower, risk. And at the step of deciding the budget, by adding up the production cost assigned for each activity, the total budget is made up. At the step of controlling production cost, it renews about cost baseline whenever changed.

3.3.3 Cost analysis

3.3.3.1 Direct Cost

Materials : We make the list about all required materials to accomplish wooden dome shelter project. And then also consider comparing price and quality of each materials for selecting best materials. This made us choose one in many options.

Labor : in real life, we should include labor cost to the budget. Legal minimum monthly wage in Portugal is 545 euros for 40 hours per week. Assuming that hourly wage is around 4 euros, 3 hours per day, for 3months, 6 people (team member), total wage is 4320 euros. But we don’t consider about labor.

Operating/tools cost : it includes all costs for making the process or energy costs or manufacturing product.

3.3.3.2 Indirect Cost

It is cost which cannot be estimated by any standard Because it is non-realistic, cannot be charged specifically for any object for estimating in directly. it is distinguish 2 type of costs, fixed cost, variable cost. And for example, cleaning services, maintenance, engineering, equipment, buildings, interest (debt), and insurance, etc.

Tabel 4: Resource list for a window only

Wooden beam 3 m 80 x 160 mm (to be cut in half)	1	€ 10.95	€ 10.95
Wooden beam 3m 25 x 100 mm (to be cut in half)	1	€ 1.75	€ 1.75
Bag of screws length 40 mm diameter 5 mm	1	€ 1.75	€ 1.75
Bag of screws length 40 mm diameter 5 mm	1	€ 1.75	€ 1.75
Dobradiçafohladupla (x2)	2	€ 1.45	€ 2.90
Esquadragalvaniz (x3)	3	€ 1.75	€ 5.25
		Total price	€ 24.35

Leroy Merlin Gaia

	Number	Price per unit	Total price
Plastic ecoglass 1000 x 1000 x 2 mm	1	€ 39.99	€ 39.99
		Total price	€ 39.99

ElectroFan

	Number	Price per unit	Total price
Arduino Uno R3	1	€ 17.39	€ 17.39
TowerPro Servo motor SG90	1	€ 6.23	€ 6.23
AM2302 DHT22 Temperature And Humidity Sensor Module	1	€ 9.82	€ 9.82
		Total price	€ 33.44

PTRobotics

	Number	Price per unit	Total price
Breadboard 400 Pontos Transparente Red	1	€ 5.90	€ 5.90
Jumper Wires Standard 11cm M/M Pack of 10	1	€ 1.85	€ 1.85
Switching Power Supply 12V 1A	1	€ 3.87	€ 3.87
		Total price	€ 11.62

Our budget is 100 euros, but we already did obtain permission about a little bit excessive budget from clients. (So it doesn't matter.)

3.4 Quality

3.4.1 Introduction

Quality management includes activity and process deciding for quality goal, policy, responsibilities. It has close relevance to scope of project, is influenced by schedule and production cost. The quality is feature of production or service which meet to needs of clients. Project team should establish suitable quality policy according to the progress of the project. We should do solution about 3 questions for quality assurance. Does our product meet for needs of client? Do we improve to find solution about potential problem of the product? Is the product conducted examination complying with quality standard?

3.4.2 Quality assurance & control

It goes through 4 stages. First, at the time we designed prototype of product, we decided the elements of wooden dome consumers want. Second, when we select materials for product from resource, we should check quality for each material. Additionally, we make a plan to transport, pack, keep it a storage. while wooden dome is made, inspect the quality of product through a variety of tests including sampling. Finally, after completion of product, make a guideline for consumers to minimize error, flaw caused by wrong use. Furthermore, accept feedback about error occurring in the future from them and update the product according to that.

3.5 People

3.5.1 Introduction

Human resource management or People management includes activities and process, which manage ourselves and constitute team for project. It need to be aware in terms of main resource creating project outcome rather than object controlled in person. At develop human resource plan, we assigned team member to task making each member maximize his/her ability to grow up perfection about project.

3.5.2 To build R & R

It means to build the relation between each process & role conducted by team members and responsibilities accordingly. the building of right relation inspires team with motivation and responsibility as well as better systematic performance. Finally, it helps us to manage project well. That's why we made the following matrix about our project.

Tabel 5: R&R Matrix

Black Box Diagram					I,C	R		A,C
Structural drafts			R					A,C
System schematics						R		A,C
Structural drawings			R					A,C
Cardboard model		R						A,C
Interim report							R	A,C
Leaflet		R						A,C
List of Materials	R		I,C			I,C		A,C
Final report							R	A,C
Paper					R			A,C
Poster		R						A,C
Video				R				A,C
Scale model							R	A,C
Wiki							R	A,C

R : Responsible

A : Approval

C : Consultant

I : Informant

T : Tester

3.6 Communications

3.6.1 Introduction

Communication management involves processing for conducting timely about creation, preservation, distribution for information of project. It must be need for communications with all stakeholders as well as each member.

3.6.2 Communication register

So the one of elements for finishing project successfully is considered for smooth communications among team members. Through the communication interacting and organic between members, it is important to make regular meeting as we can progress project more efficiently. We have brainstorming about agenda given to us to share the idea and update work conducted by each member on the wiki. And then every week we have a meeting with supervisors for taking feedback from them, improving the progress of project. Furthermore, seek a direction for improvement about project by discussing it frequently.

Apart from these meeting, we can contact each supervisor directing respective parts by using outlook in ISEP whenever we want to solve a doubt, ask something about that during the working according to R&R matrix for our project. Externally, we can communicate with potential consumer including client and advertise by using manual and video for product.

Finally, we are operating the facebook group chat to notice the date changed for meeting as soon as possible, share the output which needs for progress of the project, take action against other alteration.

Table 6: Team communication

What	Who	How	When	Why	To whom	Codification comments
Meeting with supervisors	Team members	In person	Every Thursday	To discuss the progress of the project	Supervisors	English and explaining in the correct technical terms
Team discussion	Team members working on the same thing	In person and via social networks	Multiple times a week	To discuss the development of the project	Team members	In English
Agenda	Team members	Via the Wiki page	every Tuesday	To inform about the topics of the meeting	Supervisors	In English and using short but clear language
Brainstorm session	Team members	In person	First weeks after receiving the subject	To share ideas	Other team members	Explain ideas using sketch to clarify
Visit to supplier	Team members	In person and via mail	Before and during order of the materials	To guarantee a correct delivery	Supplier	Use Portuguese terms to clarify what you need
Interim presentation	Team members	Oral presentation with powerpoint	21st of March 2016	To inform the teachers and supervisors about the progress of our project	Supervisors and teachers	Brief and clear explanation in English
Manuel	Team members	Written document	11th of June 2016	To explain how our prototype works	Client	Use simple non-technical language
Video	Team members	Video	11th of June	To give an impression of our EPS semester	Supervisors, teachers and everybody who is interested	Subtitles to improve the comprehensibility

3.7 Risk

3.7.1 Introduction

The risk management involves a set of processes : planning management, analysis, contingency plan, monitoring, controlling about project. Risk is an uncertain event or unknown condition. The priority of risk is made up for multiplying two elements : Probability, Impact. there are four Negative strategies : Avoid, Transfer, Mitigate, Accept and four Positive strategies : Exploit, Share, Enhance, Accept. the purpose of this part is prevention rather than reaction doing anything after happening risk problem. that's why we should establish the plan to prevent every predictable risk situations and contingency plan for unpredictable risk situations.

3.7.2 Risk register

This is a document included quality and quantity risk analysis, response result data about risk. so the following table has some situations for risk and our response for it

Table 7: Risk register

Risk	Description	Cause	Effect	Trigger	Response	Owner	Last review
Delay of delivery	Materials for prototype are delivered too late	Order is placed too late or the supplier has no stock	Prototype will not be completed in time (time & cost)	Watching in real time the status of the delivery	Change the supplier	Akos	14/04
Broken components	Materials breaking during the construction	Poor quality of the components or mishandling	Delay in the completion of the project (time & cost)	When doing a quality test after the delivery or seeing a team member not handle the materials correctly	Ordering spare parts	Ramon	14/04
Absence of team member	Team member not able to do the work or does not complete the work in time	Illness or bad cooperation	Quality of the work reduced (time)	Team member does not upload any intermediate progress	Other member of the team fills in the gap	Jaehyun	14/04
Miscalculations	Team member makes wrong calculations	Incapability or inattention during calculation	Dome collapse (time & cost)	Calculation programs giving errors or checking the work after each step	Recalculate correctly and redo the construction	Stancel	14/04

3.8 Procurement

3.8.1 Introduction

Procurement part includes some process which need for buying or obtaining output like a product or service for work of the project from the outside. During the progress of project, We should focus on minimizing delay of procurement for materials and other risks, this is very important to finish the project step by step, to grow up client's satisfaction. So this part is required to contact with seller regularly.

3.8.2 The process of procurement

Plan procurements : In this part, the potential seller for procurement should be identified. Also the way to procure materials for project is decided and is made into documentation.

Conduct procurements : Select each seller for best in the list which has many options.

Administer procurements : Manage procurements contract between seller and us, conduct change or measure for contract.

Close procurements : Finish to procure every materials for project, make a specific document about this for later utilization.

3.9 Stakeholders management

3.9.1 Introduction

During the progress of project, stakeholder management is also important part for success of project. Stakeholder is the person influencing team or influenced by team. This plan is consist of 4 steps.

3.9.2 The process for managing stakeholders

To distinguish stakeholder (stakeholder analysis)

We should correctly figure out that they have needs about product and service to produce output according to consumer's desires.

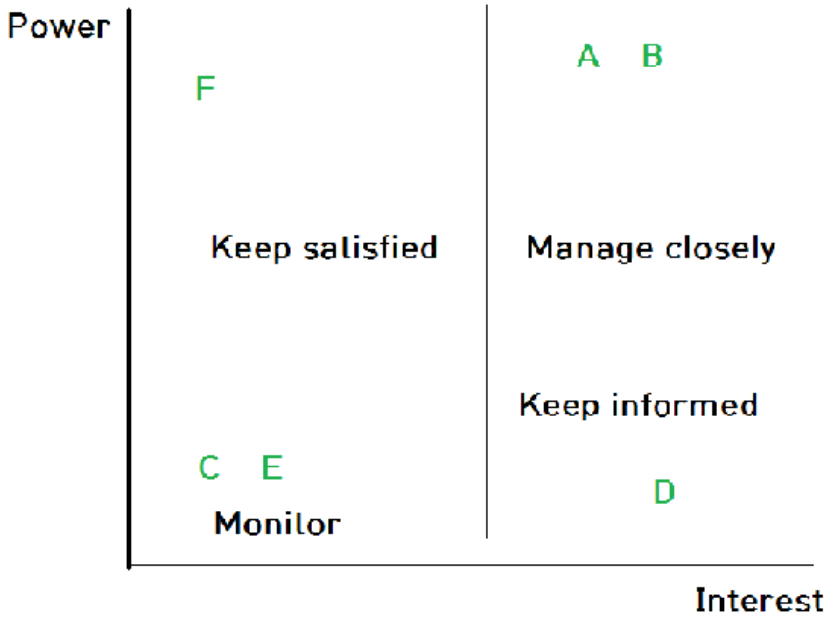


Figure 17: Stakeholder analysis

A : Team members

B : Supervisors

C : Suppliers

D : Teacher

E : Home university

F : ISEP

To manage stakeholder

This process is strategy for making distinguished stakeholders who have interested matter, needs on the basis of potential influence about success of project engage the project during the project life cycle.

Stakeholder register : it has information about client or needs they want. It helps us to improve the quality of product.

Table 8: Stakeholder register

Who	Role	Can influence	Is influenced	Expectations	Power	Influence	Stakeholder strategy
Team members	Developing the project	The whole project		Develop the project and get a good grade	High	High	Manage closely
Supervisors	Supervise the progress of the project	The project and the team members	By the team members	Receive an interesting project	High	High	Weekly reports and meetings
Suppliers	Supply materials	The timing and quality of the building of the prototype		Sell the materials	Low	Low	Inform
Teacher	Give information about different subjects	Team members and project		Receive an interesting project	Low	High	Ask for feedback on the project
Home university	Support student previous knowledge	Students		Student succeed to deliver a good project	Low	Low	Keep informed by sending final result
ISEP	Provide EPS semester equipment	Budget and scope of the project		Receive interesting projects	High	Low	Keep satisfied by delivering good work

To manage involvement

This part is step for solving the issue from them, satisfying their needs and expectation through communication. We should make them join with project in order to make them feel interested it. Whenever they request many change point, the team makes request document for internal review with it. And then we update management plan, document, etc

Control

We should adjust strategy and plan to make them participate in project, to control them. This part deals with information on the basis of work performance. The report about it is given to them and we make them keep being satisfied by having regular meeting.

3.10 Conclusion

In this chapter we discussed the different tools to help us manage the project. The next chapter will be about the marketing plan.

4 Marketing Plan

4.1 Introduction

In this chapter, it presents the marketing plan of team 2. First of all, it start analyzing the market situation that involve the company, studying all parts that influence in the project and investigating the principal competitors of the product. When the market study is finish, it continuous analyzing the targets of company outfit SWOT analysis. Later, there are the segmentation of market with marketing mix, and for finish, it found the budget with the respective prices that company have for to pull this company forward. For conclude, there is a conclusion of the marketing plan.

4.2 Market Analysis

In the market analysis we take a look on which is our market positioning, from now on, we make an analysis about the feasible markets to enter with our products. The circumstances of each market are shaped by it is customers and competitors. For this reason, it is very important know what the customers want and what the competitors offer. Therefore, the target of marketing is influence potential customers and gets an advantage over competitors.

4.2.1 Market Situation

Marketing must look at successful strategies to target your audience and ways to position your product that will generate profit and overall brand awareness. The fundamental basis of this is the knowledge and factors that make up the diverse environment of the digital market place. We have done our marketing plan about macro and micro environment.

Now, it has a picture with the different parts of macro and micro analysis.

Figure 18: Macro and micro environment [20]

4.2.2 Macro-Analysis

To refer to macro-environment we can say too pestel. To analyze the macro-environment market, we should separate this in five groups:

1. Social 2. Technological 3. Economic 4. Environmental 5. Political & Legal

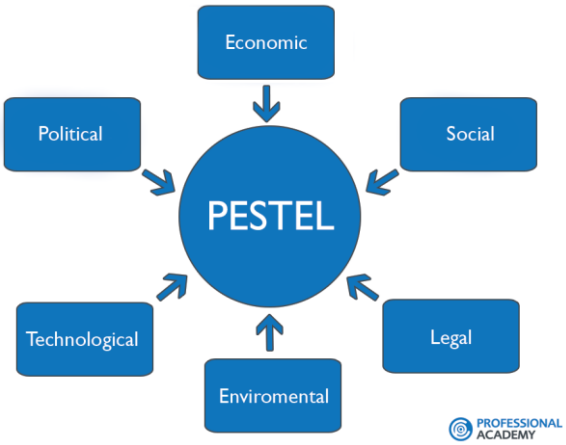


Figure 19 PESTEL factors [21]

4.2.2.1 Social

In 2008, for the first time in history, urban population outnumbered rural population [22]. This concentration of people can generate stress and this is only part of the impact that cities have on us [23]. For this reason, we give to people an opportunity to have a private space, where they can relax and pass some days away from the pollution generated by a city. Further, at present, the people tend to give importance to things with nature contact and this is what we are selling, relax time in contact with nature and off the stress of cities.

4.2.2.2 Technological

The technological factors have a crucial role within this project. To sell technologically our product we have to consider two aspects. On the one hand, we have to consider the conditions outside of the dome. Our product has an innovative design since it has not the shape of a traditional house and this is a positive point for us. On the other hand, we have to consider the conditions inside of the dome. We want implement sensors that can control the environment inside of the shelter cooling and heating and depending of this, modify windows open. Relative to the door and windows, these will be automatic, giving to our product a sophistication that differentiates us from the competition.

4.2.2.3 Economic

Right now, it is difficult to find a solid construct that gives the benefits that we are offering, with a cheap price. However, we give an economic solution for those who want to have an intimate space, outside the stress of the cities. One of the objective of our project is build a permanent dome using wood like principal material. Wood is the perfect material for get our target as it is a cheap material and offer the features of strengths that we need.

4.2.2.4 Environmental

Nowadays, one of the most important points for us is the environment. We want to have a eco-friendly image. Our marketing plan is focus the wood dome shelter like an ecological and environmentally friendly solution, thus be able to have the maximum potential users. We are offering a product build with wood, a biodegradable material that creates far less carbon dioxide emissions than competing building products. For this reason it is very important for us have this aspect with the public.

We must highlight that a big part of the dome is built with wood and the wood is the most sustainable building material available. For have a safety dome when this will installed outdoors, the wood has to be treated. Treated wood preserves this against termite attack and fungal decay, lengthening its serviceable life and extending his benefits [24].

4.2.2.5 Political & Legal

In the new market the ethical and political are very related. When we talk about ethics we talk about conscience of society and if we refer to political we refer to laws. Nowadays we must take care with the critical issues that include the ethics and politics. In our case, we have to have a consideration of the data protection and privacy.

- The Data Protection& Privacy: we have an ethic and lawful responsibility to protect the privacy of our customers and all people related with our company.

On the other hand, respect the policy of our country, our product is considered as a conventional house. For this reason, we do not have political regulations that have a negative or positive impact on our product.

4.2.3 Micro Analysis

Micro environment analisy refers to the things that company can control. Marketing section has a very important role in this part, because it should to put the product in the best position of the market. Micro marketing includes the control of the following points:

1. Suppliers 2. Intermediaries 3. Customers 4. Publics 5. Workers 6. Competitors

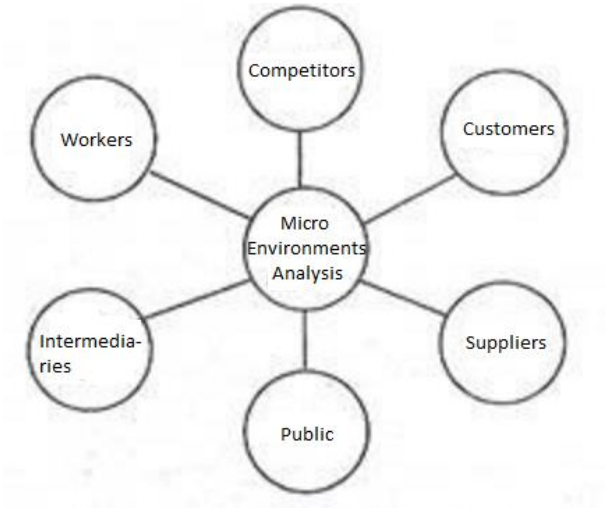


Figure 20: Micro-Environment [25]

4.2.3.1 Suppliers

It is important have much suppliers as possible for negotiate the price of materials. For the product, the main materials we use are oak wood, metallic connectors and some electronics components. In our case, we can get all these materials of too much providers. This is good for us because they make competition among themselves and these reduce the price of materials.

In the market, we can find two kinds of suppliers: wholesalers and retailers. Our future target is being a big company. We will go to focus with wholesalers because for large orders the price of materials decreases. Considering that retailers can be of great help when would appear some problem with the orders.

4.2.3.2 Intermediaries

The use of intermediaries results from their greater efficiency in making goods available to target markets. It is check that it is more effective for the sales have some distributors. We can see an example on the next picture:

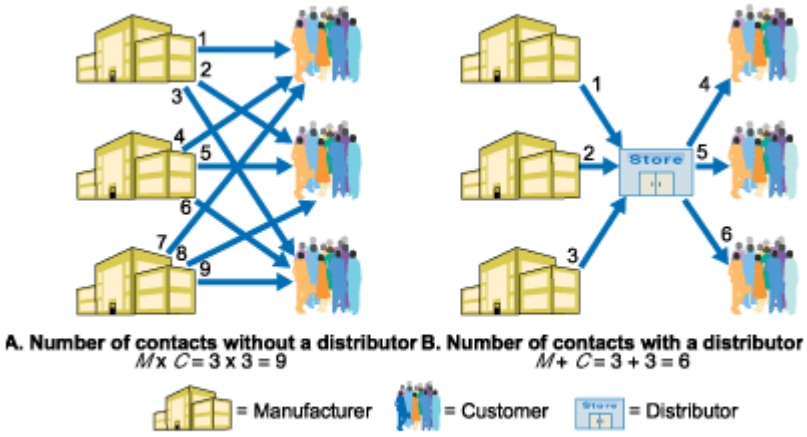


Figure 21: Marketing Intermediaries [26]

The intermediaries offers to the firm more than it can achieve on its own. It can arrive to the consumers easier. Besides, they can offer some aspects that we don't have: contacts, experience, specialization, scale of operation.

4.2.3.3 Customers

Finally, the most important aspect for us and all companies is the customers. It is our reason for existence, everything we do is around them. For this reason, our company wants involve the customers, using methods and tactics to develop long-term relationship. Marketing plan is not only for attracting the customer for one sale, because if the customer feels well, it will be loyal and for end up spending more in the long-term.

We are working with a special product that mixes the innovation with the traditional. Moreover, to get this product you need some aspects, the most important, space. We are talking about 6.8 meters of diameter, to put the buyers will have to have enough space.

Our product is focused as a living space, from these terms everyone can use it as the way they want. It can be used for a home, a cottage, a storage room, a chill out in the garden, etc. It offer to much possibilities to use.

Other important point is selling the product to small business, for example, to campsites. We will work in countries where the nature is plenty and where you can find many campsites.

We separate the customers in two groups: the buyers and the small business.

- The Customers

For sell the wooden dome shelter, we need have solvent customers with enough space for the dome. We must located on a site with these features. To give an example, we choose the state of California in United States. We select California because is a state of North America with a good economy and able to get our product. The population of California is around 37 million people, the population in households is around 36 million. Our potential customer is between 30 and 70 years old. With this filters, we can arrive to 17 million of customers approximately. After this, we would have to make market segmentation, which is about ten percent [27].

- The Small Business

When we talk about small business, we refer to campsites and something like that. For example, Spain is a country that has an abundant range of campsites. Nowadays, there are around 1200 registered camping's [28]. It is a good place for star to implement our business, as it is one of the countries with more volume buyers.

4.2.3.4 Publics

"A public is any group that has an actual or potential interest in or impact on a company's ability to achieve its objectives." When we talk about public, we refer to environmentalists, consumer protection groups, media persons, local people, etc. This market sector is very important for the well-being of the company for growth and strengthens. "Companies must put their primary energy into effectively managing their relationships with their customers, distributors and suppliers." Create a good environment among public, help us to get a distinction positioning verse to competitors [29].

4.2.3.5 Workers

Have a good relationship with the workers is a very important point if a business wants have a results. The workers are one of the pillars of the company. They have labour unions where protect their interests and improve their working conditions. The trade unions have objectives to achieve, always negotiating with the company. It is important for the company have a stable industrial relation to improve and grows the business. For us will be very important have happy workers for well-being of the company and for have a good positioning verse of market.

4.2.3.5 Competitors

Last but not least the competition. First, it is important to identify competitors and find out about their goals, knowing their potential strengths and weaknesses. We made a classification with our principal competitors and analyzing their products, to know better the market where we want enter.

- Pacific DOMES

It is one of bigger dome companies found it in the market. Is a United States company and dispose of a big range of products. It works with outstanding companies like: NASA, Toyota, Sony, Pioneer, etc. They sell his products like offering their clients quality assurance and project oversight, with the guarantee of made in USA. The products divides in four groups: event domes, shelter domes, greenhouse domes and playground domes. We analyze the company with two aspects strengths and weaknesses [30].

- Strengths: It is a big business with a good positioning in the market. I have a good marketing plan

with a big range of products to supply all customers.

- Weaknesses: Unlike us, they do not offer any wooden dome. This is a good point for us as we offer a more eco-friendly product. A weaknesses point to consider too is the expensive price of their products, decreasing in great measure their possibilities on the market.

- Timberline Geodesics

Timberline Geodesics is an American company that his principal product is wooden dome shelters for houses. They use connectors between the beams. They are in the market for more than 35 years and sell his products like practical and affordable for people to construct their own homes [31].

- Strengths

It is direct competitor for us, they sell a similar product and are focused to market opportunities like us. Offer a robust and permanent product and tries to be affordable for everybody. Maybe, we can follow his steps for break into the market more easily.

- Weaknesses

They are an important company of domes shelter but they do not consider the huge range of possibilities that domes have. They are focus only with wooden domes for live and that closes them many market opportunities.

- Dome Kits

In this case, they have both possibilities of connect the beams, with and without connector. Their products are centered on dome houses and their principal material is wood. They have extended information of domes like: the plans, the materials, the angles of beams and much [32].

- Strengths

Have a good market approach, for example, without connector they say that you can save $5000. They are giving a more economical solution to customers. Have a good web page where you can find all information that you need it about the domes that they sell.

- Weaknesses

It talks about a company with similar aspects with us. Principal weaknesses that it founds when selling their products do not have an easy way to find it and the information about it is very unspecific and poor.

4.2 SWOT Analysis

SWOT is an acronym that means: strength, weaknesses, opportunities, and threats. In these terms, SWOT analysis is an organized list of helpful and harmful. Strengths and opportunities are hopeful for the company. Weaknesses and threats are harmful for the company. After this, we classify it as internal or external aspects. Strengths and weaknesses are internal factors. Opportunities and threats are external factors.

When we refer to internal factors, we refer to those things that we can control and model as well as possible. About external factors, are those things that we cannot control related to the customer and competitor market. SWOT analysis is very important for planning process of the company, all the companies should have this control if they want to subsist and grow in the market [33].

Figure 22: SWOT Analysis

4.3 Strategic Objectives

“If you don't know where you're going, you'll probably end up somewhere else.”

Strategic objectives are one of the fundamental building blocks of a strategic plan. Indeed, to define carefully the strategic objectives is essential; it represents a starting point of a good marketing plan. It allows having a clear view of the ins and outs of the project. The objectives impose criteria that help in decision making and help to choose the best strategies and tactics. Furthermore, strategic objectives allow defining the level of success of the marketing plan and save time and money.

In this way, for our project, we have to define SMART objectives. The SMART methodology is very effective to structure its activities and develop concrete and relevant objectives at best. marketing objectives

Figure 23: SMART Goals[36]

At the end of 2016 :

Build the final functional product, ready for sale

Obtain funding to start production

Start the publicity campaign

January 2017 : Product launch

2017 :

Sell at least 5 geodesic domes in Europe

Build an E-commerce website

Improve distributor and/or supplier relationships

Develop and implement a promotional plan to drive increased business

To 2020 :

Achieve 5-10% market share in Europe

Increase revenue by 20% at least

Improve our service approach for new and existing customers

Set up a loyalty campaign

To 2025 : Start to expand sales to the global marketplace

4.4 Segmentation

A market is composed of thousands of people, all different from each other. However, these people have different tastes, motivations and behaviors. Segmentation is a market (or people) dividing method into subsections called segments (or consumer groups) distincts and homogeneous. Market segmentation is the first step in defining and selecting a target market to pursue [37].

An effective segmentation should be at the same time relevant, measurable, accessible and profitable.

The purpose of segmentation is to adapt the products to the needs of individuals. In this way, the Aslan team uses the following specific criteria in order to divide the market in effective segments :

Geographic

Demographic

Psychographic

Behavioral

Figure 24: Marketing Segmentation Criteria [38]

4.4.1 Geographic segmentation

The Aslan company is located in central and western Europe because of the presence of a temperate and mediterranean forest whose the type of wood is necessary for our dome construction. However, for the beginning, the firm decides to focused the market especially in Portugal and Spain where the forest area is greater than 30%. Furthermore, in Europe, all the countries have a mild climate without extreme conditions allowing the use of the dome during all the year.

Additionally, the installation of the wooden dome needs some space. In this way, the Aslan team chooses to focuse the marketing approach on people who live in the country or who have a garden.

4.4.2 Demographic segmentation

The Aslan firm focuses on the population with the following characteristics :

Age : 30-70 years old

Life cycle : in couple / married - preferably with children. We choose to target families in priority.

Income : medium to high

Type of accomodation & situation : house with garden - preferably owners

Professional situation : working or retired

4.4.3 Psychographic segmentation

Because the wooden dome could have a lot of uses, it is not possible to draw the exact model of the personnality and lifestyle of the typical consumer. But relating to all kinds of functionalities, the team can define some key features.

In this way, the ideal customer, from middle/high class, has a healthy lifestyle in harmony with nature. For example, he grows his own fruits and vegetables, plays sport, has pets or practices some outside activities. He likes to have a rest away from the city, enjoy his family life and the nature that surrounds him.

Aware of the current environmental problems, the client cares about his surrounding and wants to make more environmentally friendly and sustainable purchases. However, he is also preoccupied by his wellbeing and wants a product which can assure his comfort.

4.4.4 Behavioral segmentation

There is no special occasion to buy the product. However, it is a purchase which needs a certain time of thought and the agreement of all the people concerned. Customers only buy once this product. So, the company doesn't work on a loyalty program. Indeed, the usage rate could be important but not the frequency of purchase.

4.4.5 Levels of market segmentation

Each market is broken down into segments and for each level of a market segment, the Aslan company needs different information. In this way, the team has to choose one of the following levels in order to adapt the marketing approach :

Mass marketing

Segment marketing

Niche marketing

Micromarketing

Figure 25: Market levels [39]

The product is multifunctionnal. The firm can sell it in different segments, to different kind of customers without having to adapt. In this way, the team chooses to focus on segment marketing.

4.5 Strategy/Positioning

"Positioning is a marketing concept that outlines what a business should do to market its product or service to its customers." [40]

The main goal of the positionning is to create an image for the product in order to allow customers to situate it in the world of brands and distinguish it from others. Indeed, having a decisive and clear place in the mind of the target consumer give a important advantage. However, this competitive advantage exists only when the differentiation from the competition is creative, realistic and profitable.

To position the product, the Aslan company has to find a balance between 3 elements : the needs of customers, the image conveyed by competitors and the product (image, characteristics…) while identifying possible competitive advantages and choosing the right one.

4.5.1 Consumers needs

Nowadays, people are attracted by comfort and safety. The product is designed with the aim of reassuring customers. The Aslan firm provides a professional building which allows avoiding mistakes during the construction and an automatic access to the dome. Indeed, the wooden dome could attract some consumers by its technological aspect. It allows having automatic door and windows and simplifies the life.

Furthermore, the product targets consumers with environmental concerns. Like this, they can be interested by a dome made mainly with wood and glass which guarantees durability and sustainability.

4.5.2 Competitors image

The business has two typical competitors. The first one provides mainly event domes with a metallic structure and plastic cover at high price as *Pacific Dome* quoted above. Like this, he has a professional image and works with famous firms. Indeed, due to its high price, this kind of product is more destined for companies: it's a B2B (Business to Business) marketing approach. Furthermore, their domes are made without sustainable materials. The second one is more specialized in kit domes for greenhouse or shelter domes made with wood and plastic at a lower price. He targets normal consumers.

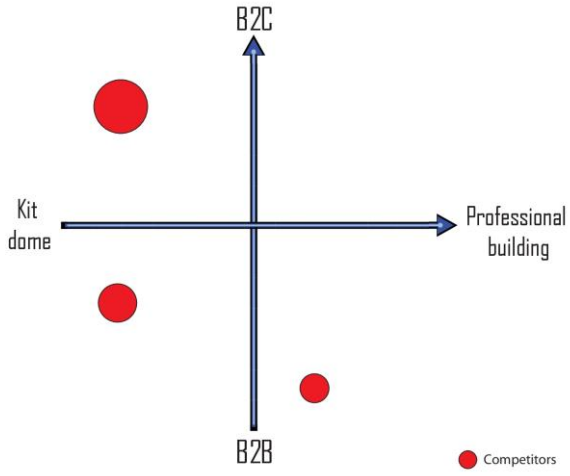


Figure 26: Perceptual map: competitors

4.5.3 Product

The team wants to provide a well-designed dome, aesthetic, made with sustainable materials at a competitive price. Develop with technological elements, the wooden dome has automatic door and windows. Furthermore, the company features the high quality of the product, designed for a long-life and eco-friendly use.

4.5.4 Conclusion

After analyzing these different aspects, the team highlights some important points. Firstly, to differentiate the product from the competitors, the company can focused on a B2C (Business to Consumer) marketing. The wooden dome is made mainly with sustainable materials and with automatic functions which represents a competitive advantage on the competitors. None of them offer this type of technology combined with an eco-friendly design. Furthermore, the Aslan company offers a professional building, which can differentiate the firm from the other companies specialized in B2C marketing.

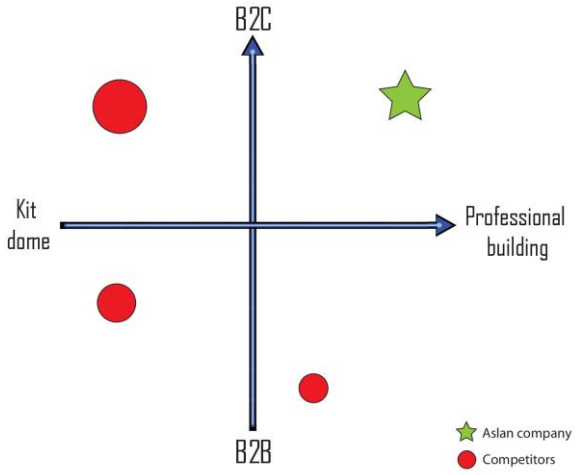


Figure 27: Positioning

4.6 Adapted Marketing-Mix

Putting the right product in the right place, at the right price, at the right time.

The marketing mix is a business tool in marketing. Also known as the 4 P's of marketing, this strategy includes 4 variables that play in the overall approach to marketing:

Product

Price

Place (or distribution)

Promotion

Figure 28: Marketingmix [41]

The goal is to make decisions that center the 4 P's on the customers in the target market in order to create value and generate a positive response. Some economists and marketers have made changes to this 4 P's theory. Today, we talk about the 5 P's adding the notion of People (Human Resources Management and optimization). Some even mention the 7 P's with the notions of Process (sales and service) and Physical evidence (Merchandising).

4.6.1 Product

A product is defined as *"a tangible good or an intangible service that is seem to meet a specific customer need or demand."* [42]. In this way, the Aslan team must ensure to have the right type of product that is in demand for our market. For this, the company has to determine all the characteristics of the product : design, technology, convenience, value, quality, branding or accessories.

First of all, the firm designed the product in an eco-friendly and innovative policy. During all the proceedings, the Aslan team kept in mind the initial objectives. The company wants a high quality dome at a reasonable price, designed to respect the environment, convenient for customers.

Trying to meet the customers' needs, it became clear that family consumers wished for comfort, eco-friendly and technological product. Thus, the team will built this product in such a way as to protect the inside from bad weather conditions : it withstand strong wind or snow conditions. However, the dome has to provide enough light and visibility on the outside which is made possible by the high number of windows. The Aslan company designed the dome as an high-tech item with

humidity and temperature sensors that control the windows and an automatic door. The geodesic shape is study to maintain an uniform temperature and an optimal air flow inside even in warm, still weather conditions. Furthermore, the product is mainly made with sustainable and recyclable materials. The brand encourages a more reasonable and green consumption. It is with this objective that the team appeals to local providers for the components. Then, to differentiate from the competitors, the Aslan firm doesn't sell only the dome as a kit item; the team also sells services. Indeed, the dome is built at customer's house. The firm provides a professional construction plus a quality after-sales service if the consumer is not satisfied by the product performance.

4.6.2 Price

Martin explains in his article about marketing mix that *"price covers the actual amount the end user is expected to pay for a product. How a product is priced will directly affect how it sells."* [43]

Indeed, an effective pricing strategy has to take into account the product's perceived and actual values. If the price is too high, it will make the costs outweigh the benefits in customers eyes, and they will therefore value their money over the product. On the contrary, if the price is too low in comparison to the competitors, consumers will think that the product is an inferior good with poor quality. In conclusion, prices help determine the perception of the product in customers eyes.

The dome is deliver with a professional building and technological elements. In this way, the Aslan company can't sell this product at the same price as a kit dome. The product perceived and actual values would not be in harmony. Quality is measured by various factors, with price being a measure used by many consumers. The client could think that our dome is of poor quality. The team doesn't play in this category. The Aslan firm wishes to appear as a high-quality and green brand. Puting a low price would mean destroy this image in the customers eyes. So, the business chooses to enter the market following a price-skimming strategy.

The concept of this strategy is to set an high but reasonable price for the new product. The objective is to obtain maximum revenue from the market before competition begins to appear. Like that, the Aslan company will be able to reimburse the first spending for production, to extend the range of products and to finance the R&D department. With time, prices could be estimated according to customers' demand, the type of use of the product or competitors pricing strategy. The firm has to be flexible and follows needs and wishes of the public.

Costs of delivery and construction are included in the price given to the customer. The payment policy involves that the client pay before delivery. The company accepts debit card, cheque and cash.

4.6.3 Place

The Aslan firm has to position and distribute the product in a place that is accessible to potential buyers. Distribution is a key element of placement. The placement strategy will help assess what channel is the most suited to a product.

There are basically two types of distribution approach : direct or indirect. Either, the company organizes and manages the distribution channel itself or the Aslan team decides to entrust this task to intermediaries.

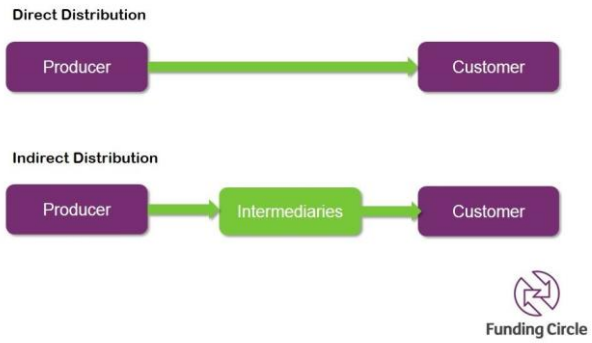


Figure 29: Distribution channels [44]

Given that the Aslan business provides a professional building, the team chooses a direct distribution channel. Customers can buy the product directly on the website or in some exposition shops. At the beginning, it can be more expensive to start running and require a significant investment: trucks, warehouses, logistics systems… However, once in place, a direct channel is shorter and so less costly than an indirect channel. Furthermore, it can allow a direct communication with the customer and a more effective control on all the distribution. Obviously, the Aslan firm will not be able to sell our product widely. However, at the beginning, the team prefers favour the relationship with the consumer. Furthermore, even if it is more difficult to manage, a direct distribution channel avoids disagreements and divergence of interest with external partners.

4.6.4 Promotion

Promotion is a very important component of marketing as it can boost brand recognition and sales. The marketing communication strategies and techniques include advertising, public relations, sales promotion and special offers. The marketers base their communication strategy on a model called AIDA :

Attention

Interest

Desire

Action

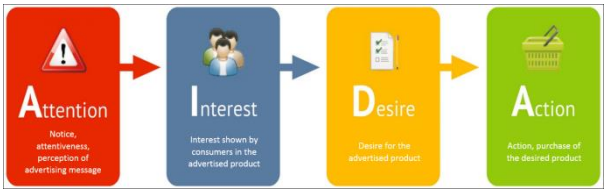


Figure 30: Aida model [45]

These are the four basic principles we need to take into account in order to encourage customers to buy the product. The Aslan company has to start by grabbing their attention, and getting them engaged, curious, or excited enough to keep reading. Then the firm builds their interest in what it has to offer and create a desire. Finally, the team has to persuade them to take action.

To promote the product, the company will base our promotion on the actual lifestyle of our target market. The team focuses on the 30-70 years aged people. Nowadays, people of any age are increasingly present on the internet and use social networking platform to communicate as presented in the following figure.

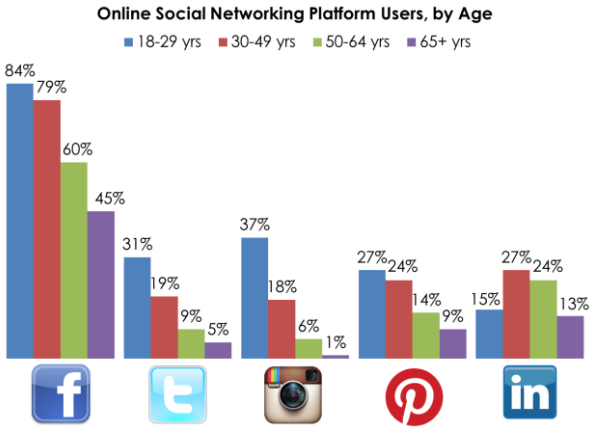


Figure 31: Online social networking platform users by age [46]

In this way, the Aslan firm decides to base the first promotional approach on internet. Facebook is one of the most famous and used social network. In order to catch customers' attention, the team has plans to create a Facebook group with a description of the product as well as a website to allow the most curious potential consumers obtaining more information about the dome and the brand. For a closer contact with the target market, the company will focus on direct mailing. Then, the Aslan team can increase the online promotional activities with advertisement and a mobile application. Furthermore, some people are not receptive to online publicity. Thus, in such a way as to convince them too, the company opts for more classic methods. For example, the team focuses on its eco-friendly image and an article in a newspaper could help it to make known the brand and promote the product. Thanks to leaflets and posters distribute in right place, the Aslan business can enough attract potential customers to make them want to have a look on the website. Then, to show them the quality and the performance of the product, the firm can participate to trade fairs such as the one taking place in Strasbourg in France : “Le Salon de l'Habitat” Finally, the Aslan company can attract potential customers with special offers.

4.7 Budget

According to the promotional strategy, the Aslan company will use different approaches. However, some will cost more money than other. The team has to distribute correctly our marketing budget and think about what type of strategies could have the most important impact.

In order to make known the brand and promote the product, the firm will use the following means and prices :

4.7.1 Online marketing

Facebook group: 0€

Website: at the beginning, the company will start with a showcase site designed with an online software to promote our product. Later, it can invest in a website designed by a freelancer and if the company is enough profitable, the Aslan team can build an e-commerce site.

Table 9: Sites

	Showcase site	**E-commerce site**
Online software (Monthly rental website)	€ 0 - € 30 / month	€ 10 - € 100 / month
Freelancer (web developer + web designer)	€ 500 - € 3 000	€ 1 000 - € 20 000

4.7.2 Print advertisement

Leaflets: 200€

Posters: 100€

Advertisement in newspaper: 300€

4.7.3 Others

Trade fairs: 500€

Travels (flight, hotel, restaurant): 1000€

Special offers : 500€

4.8 Strategy Control

There is no planning without control.

To maximize the return on the marketing plan, the Aslan company needs to put controls in place to monitor the plan's progress. Controls help to analyze the situation and determine if the actual plan's performances are in agreement with the initial expectations. Any changes that need to be made are done based on the analysis of the performance measurement indicators that the team decides beforehand.

In order to evaluate the current marketing strategies to identify needed adjustments and set guidelines for the future, the Aslan firm bases the strategy control on four major analysis :

Customer feedback

Target customer analysis

Market share analysis

Budgeting

4.8.1 Customer feedback

The customer is the focus of the marketing policy. In this way, the company has to evaluate his opinions, his degree of satisfaction in connection with our product. In order to reach consumers, the firm can invite them to complete a survey, answer to online polls on the Internet, offer opinions through a suggestion box or respond to interviews in person or by phone after they've purchased the product. The results of the research could influence the marketing plan.

4.8.2 Target customer analysis

During the building of the marketing plan, the Aslan team chooses to focus on a determined market with its determined customers : it identified a target customer base. Thus, the firm has to study if it correctly target the right type of consumer. In order to check if the offer matchs with the target customer, the company has to analyse the percentage of sales measuring units sold, revenue generated or profit amount and to identify the typical buyer profile thanks to customer feedback and market survey.

4.8.3 Market share analysis

Market share is the percentage of consumer sales dominated by the Aslan's product. According to the strategic objective forecast, the team should have 5-10% market share in 2020. To control the evolution of it, the company has to analyse the competitors sales, the new products launched on the market and compare the results with its data.

4.8.4 Budgeting

A marketing budget is a balance between the cost of generating the advertising materials and the revenue created by the marketing plan. Thus, the Aslan company has to look at the current costs involved with all aspects of the business and compare the numbers with the expected budget in order to identify the unexpected additional costs. By examining expenses, minimizing spending and maximizing profitability, the team could be able to maintain the budget.

4.9 Conclusion

The Aslan company established the marketing plan considering the actual environment such as the economic and cultural factors. Thus, the team defined the strategy according to the lifestyle of the target market.

After a market analysis, the firm drew the portrait of the typical customer: he is between 30 and 70 years old, has a family and a house with garden and he is aware of environment problems. Furthermore, the Aslan company chose to opt for a price-skimming strategy to enter on the market of B2C (Business to Consumer). It sells a sustainable and technological product with high quality distribute by direct channel.

The Aslan team chooses to be as close as possible to its customers and to establish with them relationships of sharing and trust.

5 Eco-eficiency Measures for Sustainability

5.1 Introduction

As a definition, a “green” building is any project involving construction or renovation made with special attention in terms of minimizing the impact on the design and / or construction and renovation operations might have on the environment. With these features in mind, it should be considered the following: increased energy efficiency , choice of materials that minimizes or eliminates toxic releases, reuse of existing materials, providing natural lighting and indoor air quality, flexible interior space and so on.

5.2 Environmental

The construction of a “green” building is a concept of ecological construction, which values (recovers) natural materials (wood, stone, bamboo, clay, straw, reeds, etc.) or non-toxic, renewable or recycled materials(metal, wood panels, used tires).

An ecological house must have a certain orientation to the sun which in return is ensuring some heat through a significant part of the house, and also, to imitate a natural ecosystem, in which all the components are in connection. In terms of the basic material from which houses can be built, we can talk about geodesic wooden domes (easy to install and maintain, with multilayered wooden panels glued with nontoxic additives, with the shape of a soccer ball cut in half, warm, durable, unique in appearance and does not require conventional concrete foundation).

Wood is a good insulator and it is also soundproof, so it can be insulated rather cheap. Thus, homes are warm in winter and cool in the summer and is recommended for crowded areas of major cities, as it ensures peace and comfort of owners, especially since the wood maintains optimal humidity inside the house, regardless of the weather outside. Wood ventilates the property and achieves a healthy and intimate environment.

Solid wood logs have the ability to absorb heat and release it when the temperature drops inside, helping to regulate the temperature in the house and reducing energy consumption. Solid wood houses are healthy because they ”breathe”.

5.3 Economical

In the category of eco-houses there are included passive houses - without energy consumption - and the ones that have the lowest consumption of heat. This system eliminates the heating costs in winter and cooling in summer, that are reduced by 50-58%. Energy is saved by insulating, heating and running water. The pipes can be buried in the polystyrene interior walls or placed in special channel system.

Wood is a sustainable material not by strength, but by the fact that it is a renewable resource. Wooden houses are environmentally friendly because they help saving resources. Wooden houses have the same properties for a generation, as well as other solutions, but at much lower prices.

Essentially, buildings made of wood have a multitude of advantages, starting from low costs, short implementation period compared with conventional construction systems and continue with increased thermal efficiency and noise.

The construction of these houses need to adapt to the latest requirements in terms of efficiency and energy conservation. Thus, ecological housing consumes 25% less resources than normal and have a lower negative impact on the environment. They are usually made of conventional materials and designed to use resources efficiently electricity, water etc.

5.4 Social

Our objective is to protect the forests and we do that by focusing on forestry products. Forests are the most important natural regenerating capital for human society that continuously produces goods indispensable for man, but it also provides environmental services,maintaining composition and purity of the atmosphere, improving climate, flow control of the hydrographic network, soil formation and conservation

But it is necessary to realize that forestry is a particularly complex subject to approach both scientifically and practically , assuming an extremely diverse range of goods and services provided by forest. As a consequence of the evolution of society and the requirements which it has from the woods, forestry evolved continuously. In the last century it has been a highly accelerated dynamic change beyond the development cycle of the forest. Forest management objectives change over time, because there are new requirements from society and new knowledge on the components of the forest ecosystem. Fundamental principles of forest management have appeared due to two processes:

overexploitation of forest resources;

more detailed knowledge of how forest ecosystems are structured.

Forest management development formed some general principles that constitute the present basis in this branch of production:

- Principle of continuity According to this principle the forest must be organized and managed in such a way that it has to ensure a constant or increasing production of wood and other goods every year while simultaneously exercise and optimize the basic functions and to ensure the preservation of life.

- Principle of grounding ecological forestry According to this principle cultivation of the forest must differentiate from management measures based on natural realities. Deviations from this principle, as a result of insufficient knowledge or a series of economic and political theories , have only managed to prove that on a large scale that the fundamental forestry is the only possible alternative.

- Principle of multi functionality According to this principle, farm forestry must organize and manage the forest so that it optimally and simultaneously fulfills all the useful functions for society. The goal of multifunctional forestry is to efficiently use all tangible and intangible resources the forest provides.

- Principle of selectivity The principle of selective nature of forestry work is based on making phenotypic selection (is based on how the tree looks) with systematic character (ie interventions are repeated at different intervals of time), in the afforestation domain of work, treatment work and regeneration cuttings.

- Principle of stability Repeated regeneration of cultivated forests leads to a lower stability over time, the differences from one area to another, from one historical period to another, take a toll because of abiotic, biotic and natural factors. The stability issues of the ecosystems has been much discussed in theory but it cannot be solved by specific foresting methods.

5.5 Life Cycle Analysis

Product life cycle refers to the average lifespan of a product: an analogy with (how products are born, grow, mature and then get older); depending on the period of life in which the product, and it's sales are influenced.

The entire product life-cycle management, from design and development to disappearance from the trade arena, includes the following phases: raw material acquisition, manufacturing, packaging, distribution, use, recycling and product recall from the market.

A definition of lifecycle is describing in detail all the phases of the "life" of the product, as follows: "the life cycle includes phases: conceptualization, development of project ideas, study engineering, process planning, manufacturing, operation, maintenance (repair) and withdrawal". The general definition of the life cycle of the product is made in SR EN ISO 14040: 2002.

The following form of the life cycle analysis is "consecutive steps and interrelated steps of a system-product, from raw material acquisition or generation of natural resources to post-use ".The life cycle the product could consist of phases: 1) concept / vision; 2) feasibility; 3) design / development; 4) production; 5) gradual withdrawal from service.

The stages of the product lifecycle are: conception, design, implementation, service. If this term is used as a marketing concept, the life cycle is "market-oriented", it refers to the commercial life of the product (product life market) and describes the development trend of turnover and profit a product throughout its commercial life.

Product lifecycle reflects the time and the evolution of the sales volume of the product and it's elapsed time from when the product released on the market and the disappearance of the product.

Typical life cycle phases of products subject to marketing are:

placing on the market (or launch);

growth;

maturity;

saturation;

decline;

The introduction (launch) is the period of slight increase in sales as the product is released. During this period the product cost is high, competition is conducted based on the performance and characteristics of the product. Due to market uncertainty, appropriate manufacturing strategy must be based on competitive criteria flexibility to cope with frequent changes in product construction.

Massive growth is between acceptance by the market of the product and the growing profits. Product prices may be lower than in the first period, competition takes place primarily on the basis of product quality.

Maturity is the period of slowdown in sales, sales intensity is maintained around a value that depends on the balance between supply and demand.The main concerns are to reduce production costs and increase productivity. Competition becomes most aggressive based on the price of the product.

Saturation is the period in which the product, although it reached the highest rate of acceptance by most buyers, cannot be sold on the market as before, because of the emergence of other superior products. Sales growth is slow or they cease. The decline is the period in which sales and profits decline in a rapid pace. Prices are lower, production is in overcapacity and there is a risk that in the end that the product is taken out of production because sales may reach zero or lower .

The graph of variation in the volume of sales of the product over time has the form of well-known curves “in S”. Normally, the curve “in S” shows an increase relatively slow at first and after a considerable period, it is rapidly “departing”. After this climb, the sudden growth slows down, the curve flattens and then it slowly decreases, corresponding with the final phase of decline. However, not all products have evolved sales volume curve “in S”. Some products are marketed to “fall” faster, (Kotler, op. cit., p.638). Such a life cycle where sales cycle stationed at maturity is called “hearth”.

Sales parking is explained, as a rule, in that there is a better alternative available. The plateau tilts slightly upward if sales are growing at a rate consistent with the economic growth. Sometimes the products that reached the stage of decline can be restored in the growth phase through a promotional campaign or repositioning.

5.6 Conclusion

Geodesic wooden domes offer a highly energy efficient housing due to their shape and highly resistant to natural disasters, storms and devastating earthquakes. But perhaps the most attractive quality of the dome shelter is the low cost of construction compared to an ordinary house on the same floor area.

Considering that fuel resources of the planet would last for only 3-4 generations, and this takes a disastrous effect on the climate, at the moment it is necessary to take measures to switch to renewable resources.

In addition, given that the European Union imposed that by 2020 CO2 emissions and energy consumption drop substantially and the increasing energy consumption to come from renewable sources, these measures are not only necessary, but mandatory .

In our project we are designing a sustainable building, so we are taking into account a number of factors such as orientation, geometric conformation, quality of materials and technologies used, making sure that they result with an impact as low as possible on the environment, while providing optimum comfort conditions and long term durability.

6 Ethical and Deontological Concerns

6.1 Introduction

Ethics are the rules you have to follow to live a morally correct life. This is a rather general concept, so it is difficult to implement in our project. Deontology is more suited to implement in our project. Deontology is the ethics of a profession. Every profession has its own deontology, in this project engineering ethics are discussed.

This chapter handles with some ethical and deontological concerns about our project. During the development process of the project and during our professional career, we will inevitably face some ethical problems. The ethical and deontological concerns have been divided in multiple categories: engineering ethics, sales and marketing ethics, academic ethics, environmental ethics and liability. We have to consider every of these topics in order to deliver a project that fulfils the expectations on the ethical level.

6.2 Engineering Ethics

Engineers have an important responsibility in the development of a product. They can influence a lot of different aspects during the design of the project. During this period, they have to act in an ethical way. This is a difficult task, because engineers are not specialized in ethics. For this reason, all engineering organisations have their own code of ethics. This code can help the engineers to make decisions and act in and ethically correct way. In this part of the report, we will discuss the code of ethics of the National Society of Professional Engineers (NSPE). This code of ethics will be useful to make decisions during our project.

The code of ethics of the NSPE has 6 fundamental canons [47]. We will discuss each of them.

Hold paramount the safety, health, and welfare of the public.

This first canon maybe is the most important. In the design and construction of the dome, safety will be the first concern. To guaranty the safety of the structure, we did simulations in a computer program to check if the beams and connections could withstand the forces acting on it. The results of this test should be successful before we continued the process of the construction of the dome. Another measure to ensure the safety is to follow the Eurocode design guidelines. This set of rules can be used to calculate the needed strength for the construction.

To ensure the health and welfare of the public, we made sure that all the materials we used in the dome are not harmful to humans or the environment.

Perform services only in areas of their competence.

This second canon of the code of ethics will be more difficult to follow. The EPS project we are working on is a multidisciplinary project. All of the team members have a different background. The project we are working on has aspects in which one or two team members are specialized. But sometimes we work together with the whole team on one aspect of the project, even though we don’t know much about it. To guarantee the quality of the work, we listen to the person with the most experience in this subject if we have different opinions. We also can go to the supervisors in case of doubt. They all have a different background as well, so they always have an expert amongst them.

Issue public statements only in an objective and truthful manner.

Public statements are the most powerful tool for the team to express their ideas. This is why we have to be careful what we say. If we give wrong or unclear information, this can harm our project. Even though we develop this project as if we want to sell it, we still have to be truthful in our communication, even if this would decrease the possibility of sales.

Act for each employer or client as faithful agents or trustees.

This fourth canon is less important for our project. In this project, our employers are ISEP and the supervisors. We can be faithful to them by working hard on the project. If a company would be interested in our project and they want to support us financially, we would have to discuss this with the supervisors. If we act like this the quality of the work won't be influenced.

Avoid deceptive acts.

This canon is related to the first one. If we pay attention to the safety of the project, we won't commit any deceptive acts. The risk of deceptive acts is rather small in our project, because it is mainly a theoretical project.

Conduct themselves honourably, responsibly, ethically, and lawfully so as to enhance the honour, reputation, and usefulness of the profession.

The last canon is more vaguely described. If we respect all of the previous canons, we will satisfy this last canon as well. If we follow all the rules, we won't harm the honour, reputation and usefulness of the profession of engineer.

6.3 Sales and Marketing Ethics

Nowadays, the market presents a clash of interest between the various players. Customers want to have a product with a good quality at the lowest price and companies would like to increase their profit as much as possible. Like this, a certain code of conduct, policies and practices called ethics are required to manage markets and marketing.

Marketing is one business function that interacts the most with markets. It is therefore not surprising to notice malpractices such as hoarding, price competitions, brand wars and use of unfair tactics. In such a way as to avoid this type of dishonesties with our customers, suppliers or competitors, we imposed an ethical conduct.

Customers do not want to feel manipulated by the brands they like. So, it is important for us to earn the client trust. We want to use ethical marketing as a way to develop a long-term relation with our customers and for this; we need to be transparent and understandable. The trust is based on honesty and an obvious commitment. We strive to offer a high quality product with fair prices. Therefore, it is also essential to have a good image: trust follows reputation. Thereby, we will not take advantage of dishonest advertising. We will only use this tool of communication to inform clearly and attract our potential customers without talking about the competitor's products in a negative way. Additionally, we will guarantee our clientele that our product is safe and all the necessary tests were done. Our credibility depends on our professional reputation and the performance of our product.

6.4 Academic Ethics

Academic integrity/ethics is the moral code or ethical policy of academia. This includes values such as avoidance of cheating or plagiarism, maintenance of academic standards, honesty and rigor in research and academic publishing [48].

Plagarism:

Plagiarism is the appropriation of another person’s ideas, processes, results, or words without giving appropriate credit, including those obtained through confidential review of others’ research proposals and manuscripts [49].

Cheatig:

Disseminating or receiving answers, data, or other information by any means other than those expressly permitted by the instructor as part of any academic exercise [50].

Nowadays when we have to create a product, we don't need or we cannot work only with own ideas, because probably somebody found out a good solution for the problem. In this case we can use an already existing idea or product, but with terms and not as our own idea. For example if we want to use a Microsoft office program we have to buy the licence, but we can use open source programs for free. Academic ethics leads us how we can use other's inventions in a legal way.

6.5 Environmental Ethics

It is obvious that environmental issues become serious quickly, day after day, and that human beings are directly affected by these problems. The world is most congested, polluted, urbanized and more stressed than ever from different points of view, but there are many encouraging signs, such as conducting numerous campaigns for public awareness, business organizations and environmental conservation

Environmental NGOs, which recieve more and more members,and “Environmental policies” are part of almost all programs of political parties, they all seem to indicate that people become aware of the importance of nature and hence their responsibilities to the environment.

However, environmental problems still exist; ozone layer is still getting thinner, biodiversity decreases, various useful land areas are reduced, while the lowland areas are covered with water.

It is clear that, to be an ecologist, it might not be sufficient to just use environmental protection or prevention of environmental problems through the perception of nature and human-nature relations. People do not integrate these changes in attitude, perception and environmental conscience in everyday life.

They do not live with nature in a friendly way, they do not change consumption habits and are not attentive to environmental values in their relationship with nature. It is necessary for people, especially for policy makers and environmental experts to harmonize and adopt ethical measures to scientific, technological, economic, social and legal aspects of environmental pollution control, to achieve real environmental protection.

6.6 Liability

During the beginning and an end of project as well as whole project, There are some standard and legal basis which must be complied for us. By observing the few things, we can get legal stability about project and legitimacy for selling our product. And because we don't want to damage for clients or users, like a collapse. If it happens, it is in contravention of European criminal law, we should take responsibility for professional negligence resulting in death.

So we should follow :

International Popular Standards for the project (ISO) [51]

Law (Environment) Cool Roof Council (EU-CRC) [52]

Law (Business for transaction) Civil and commercial matters [53]

Law (Labor) : European Labour Law Network ; But, this project is made by ourselves. that's why we didn't apply this standard. [54]

Machine Safety Directive [55]

Restriction of the use of Hazardous Substances in EEE (RoHS) [56]

The Low Voltage Directive (LVD) [57]

This restrictions or constraint have been established for possibility to make people be damaged or preventing such situations. That’s why we can consider formal qualification test on the basis of global standard.

6.7 Conclusion

The most important part of this ethics chapter is the engineering ethics. This contains the discussion of the code of ethics of the NSPE. The code of ethics covers a couple of issues mentioned in the other part of the chapter like the environmental and marketing ethics. The most important thing to remember from this chapters is to be honest to the clients, respect nature and think about the safety of the project. We also have to think about academic ethics and liability. This means that we can’t steal the work of other people and we also cannot break the laws we have to follow.

Codes of ethics are present in all the aspects of our life such as personal or profesional. In this way, our project have to follow a certain number of rules to respect the stakeholders' rights. We want to adopt a respectful policy with regard to our environment. Ethics represent an important part of the development of our project. Implementing ethical standards will help us to build an appreciative image of our brand and our company.

The next chapter will explain the development of our project from A to Z including all our reflection about our scheme.

7 Project Development

7.1 Introduction

This chapter explains our approach of the project. In this way, we describe the architecture with the structural design of our dome as well as the controlling system and the system schematics. We also present the constructional and electronic components we will use to develop our prototype. Furthermore, we depict the functionalities of our dome. And finally, we report the different tests we completed in connection with the project requirements and the obtained results.

7.2 Architecture

7.2.1 Structural design

7.2.1.1 Shape of the dome

As mentioned before in the state of the art, the shape of the dome is designed starting from an icosahedron. The design of the dome was done in AutoCAD, because of the fact that most of the group members have some experience with this program. In the next chapter, the steps to design the shape of the dome will be described chronologically.

The first step in the design process was the construction of a regular pentagon shape. This pentagon will be the base on which the icosahedron will be constructed. The length of the edges of the pentagon will be set to 500. This number has no unit and it is just a random number, the final result of the dome shape will be scaled to make sure the final dome has a diameter of 6.8 m. The pentagon can be drawn starting from one point and drawing lines with a length of 500 at an angle of 108°.

The next step is to find the top of the icosahedron. In an icosahedron, every edge has the same length, so the distance between every vertex of the pentagon drawn in step 1 and the top has to be 500 as well. This can be achieved by drawing spheres on each edge with a radius of 500. The point where all the sphere intersect will be the top point of the icosahedron. In AutoCAD the command “Intersect” will be used to determine this point. In the figure below, the edges of the icosahedron are drawn in red and the remains of the spheres are drawn in yellow

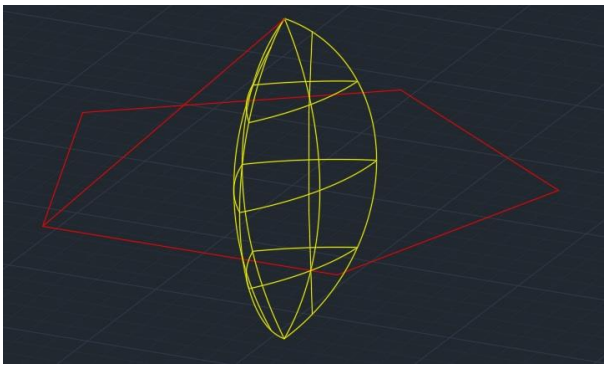


Figure 32: Construction of the top of the icosahedron

If the vertices of the pentagon get connected with the intersection point of the spheres, the top of the icosahedron will be obtained. The result can be seen in the figure below.

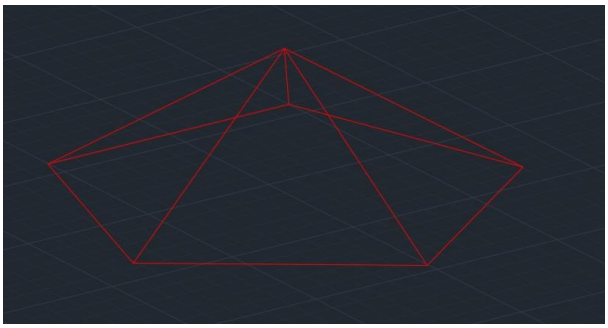


Figure 33: The top part of the icosahedron

Once the top of the icosahedron is obtained, it can be divided into parts. We decided to build a V3 dome, because it has only 3 different lengths of beams and the surfaces of each triangle is bigger. To get a V3 dome, each edge has to be divided into 3 parts. In the AutoCAD drawing, this will be done using the “divide” command. The parts that were obtained in the previous step have to be connected to each other. The result of this step can be seen below.

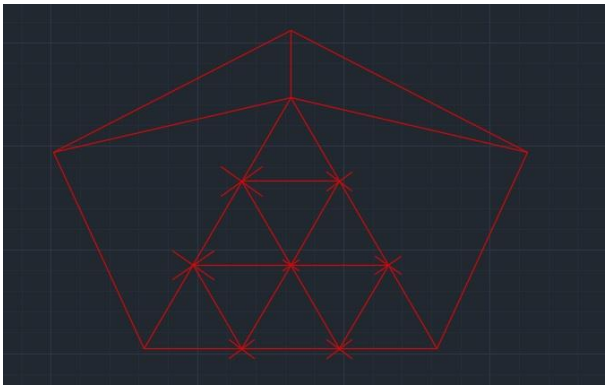


Figure 34: One face of the icosahedron divided in parts

The next step is to find the centre of the icosahedron. The formula to find this radius starting from an edge length of “a” is $r=a\times\sin(2\pi/5)$ [58]. If 500 is filled in as the value for a, the radius of the icosahedron is 475. To get the centre point of the icosahedron in the drawing, a line with a length of 475 will be drawn, starting in the top of the icosahedron. Once the centre point of the icosahedron is found the actual vertices of the dome can be found. From the centre point, lines with a length of 475 should be drawn going through points found in the previous step. The result of this process can be seen in the figure below.

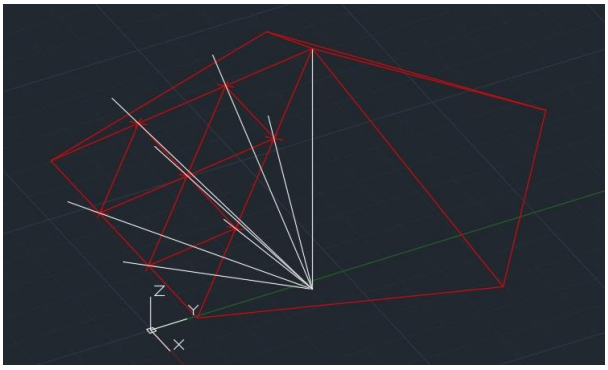


Figure 35: Finding the vertices of the dome

If the ends of the lines are connected to each other and the vertices of the icosahedron, the beams for one face of the icosahedron will be obtained. This can be seen in the figure below.

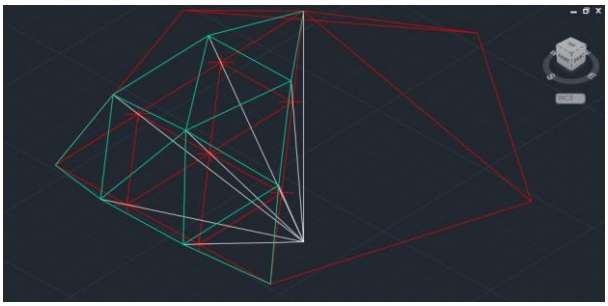


Figure 36: Beams of one face of the icosahedron

Once the beams of one face are found, the rest of the beams can be drawn using the “align” command in AutoCAD. The beams should be copied and saved as a block to make handling easier. Using the “align” command the top part of the dome can be easily constructed. The result will look like the following figure.

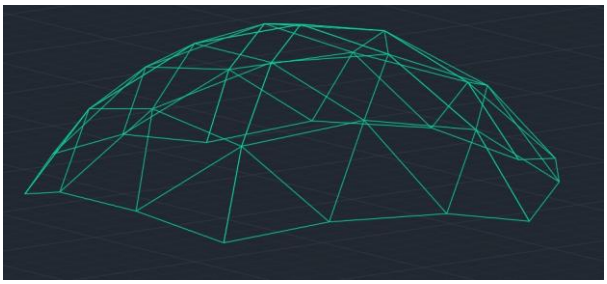


Figure 37: Beams of the top part of the dome

The lower part of the dome can also be copied in the same way. The lowest row in the of the copied face will be deleted to get an even surface on the bottom. In the next figure, all the beams with the same length have the same colour.

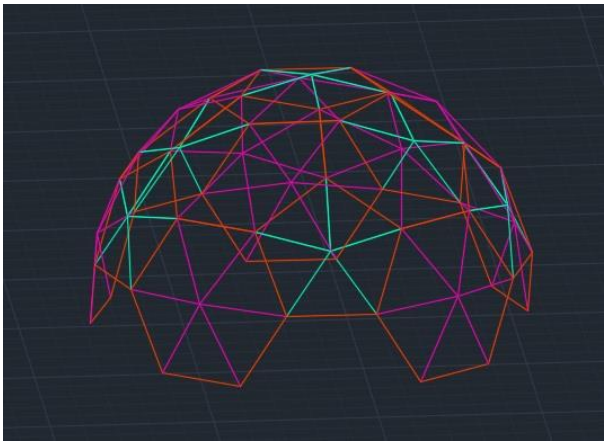


Figure 38: Beams of the dome using the same colour for the same length

The last problem that has to be solved is closing the remaining gaps at the base of the dome. The should be closed in a way that the base of the base of the dome remains flat to connect it easily to the foundation of the dome. If the order of the beams from the part above will be used, this is not possible. There needs to be a change in the angle and the length of the beams. This is solved by adding one other length of beam. This means that the dome now consists of beams of 4 different lengths (1185 mm, 1355 mm, 1372 mm and 1402 mm). The final result can be seen in the figure below.

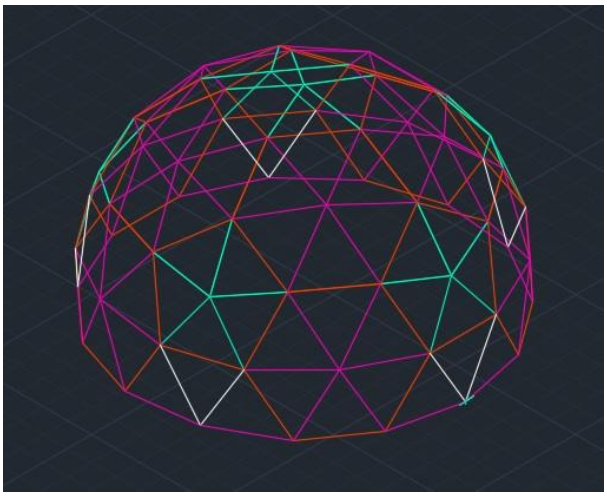


Figure 39: Final shape of the dome

This design will be used as a starting point to do the further calculations for the dome components.

7.2.2 Controlling system architecture

7.2.2.1 Black box

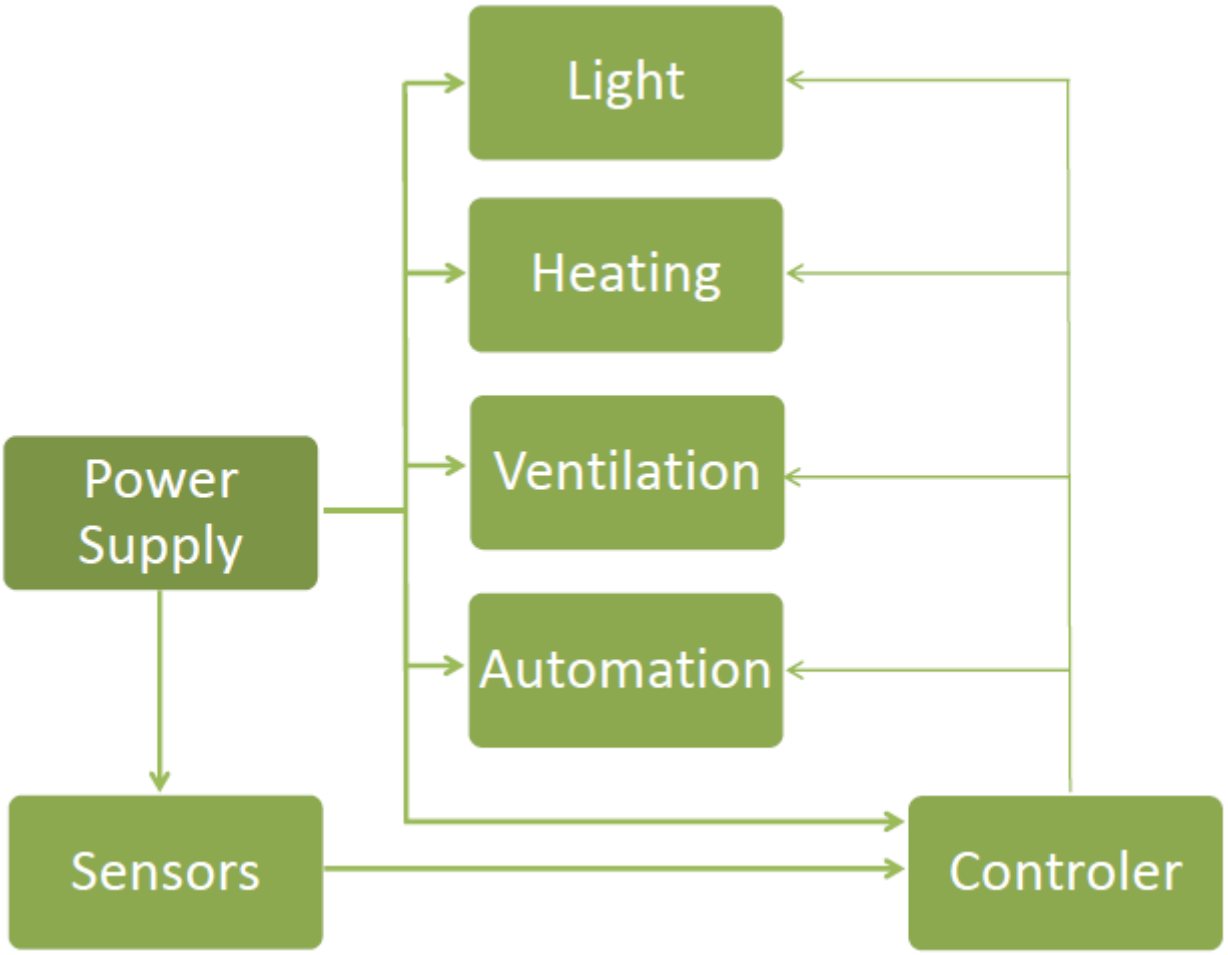


Figure 40: Black box diagram

7.2.2.2 System schematics

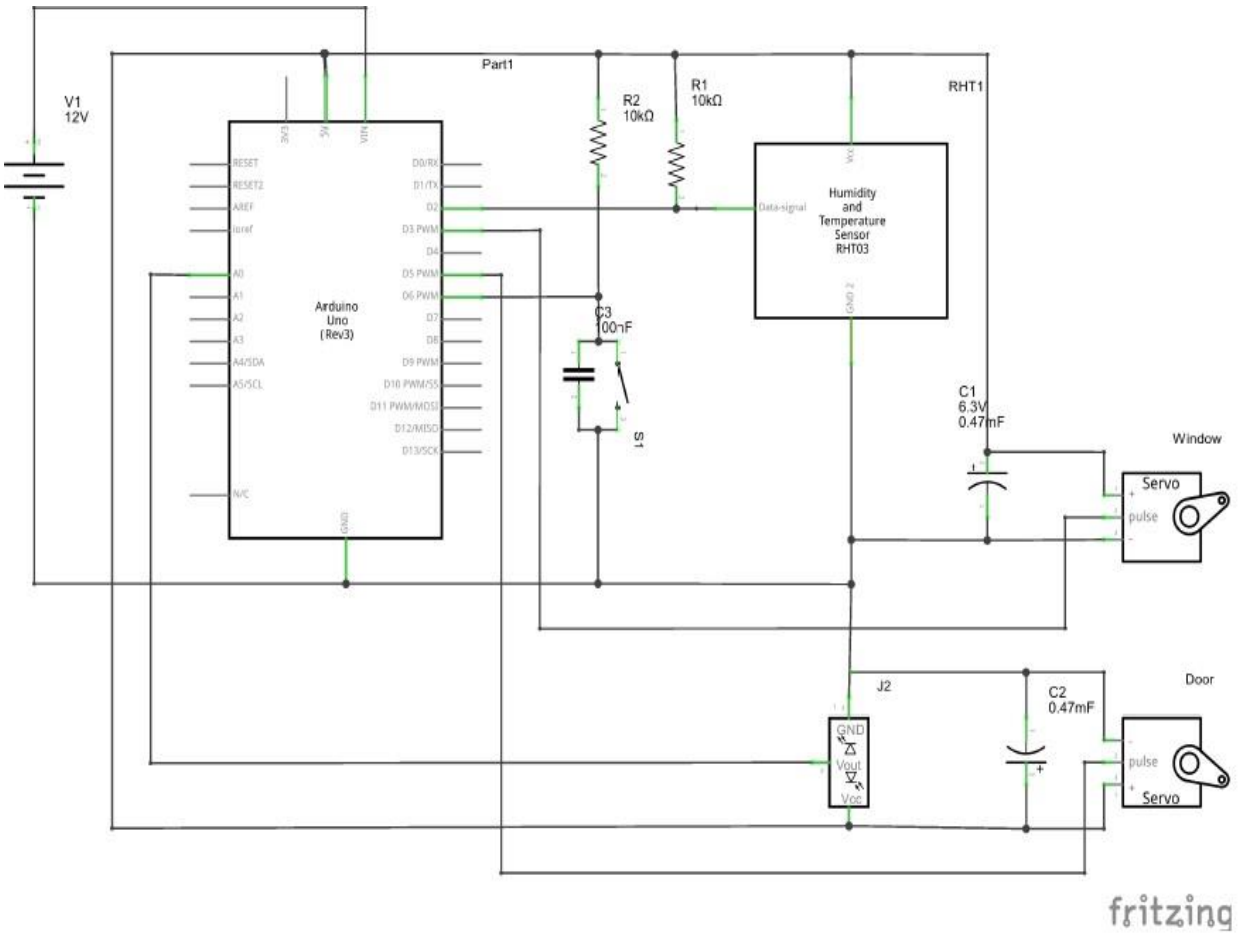


Figure 41: System schematics

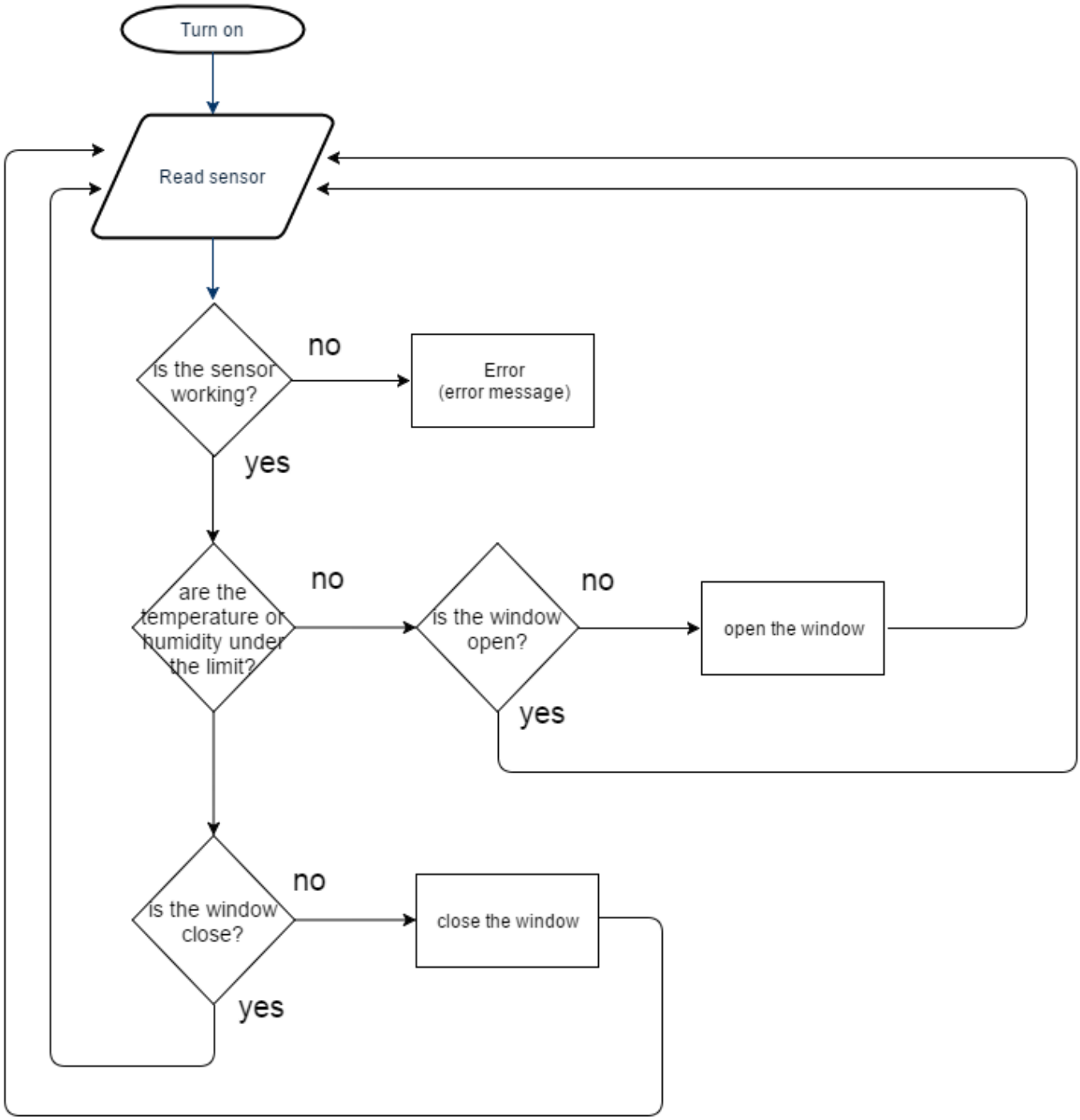


Figure 42: Flow chart

7.3 Components

7.3.1 Constructional components

7.3.1.1 Automatic window

In the proposal of our subject was mentioned that the dome should have an automatic window. In this chapter we will only describe the structural parts of the window. The motor will be discussed in the chapter “7.3.2 Electronic Components”. The dimensions of the window mentioned in this chapter are all scaled by 1:2 . The reason we did this is the fact that we will build a prototype with this scale.

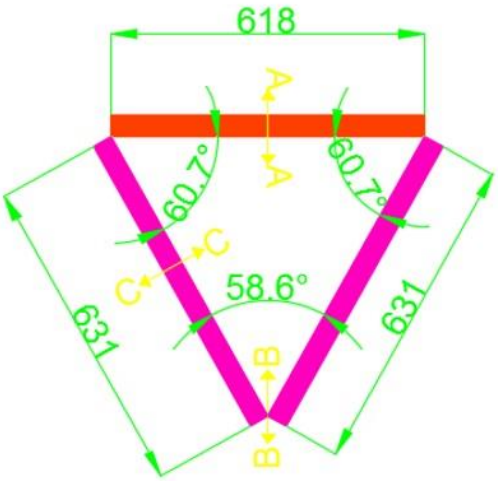


Figure 43: View of one triangle in scale 1:2

We decided to build an automatic window that has the shape of one full triangle. This will allow a maximal ventilation flow. One triangle in a scale of 1:2 has the dimension showed in Figure 40. This figure also shows the cutting lines that will be used in the following figures to explain the design of the automatic window.

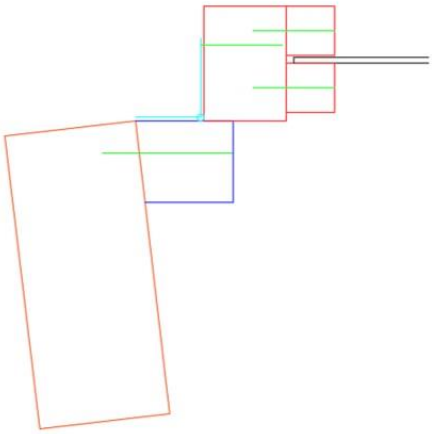


Figure 44: Cutting line A-A

The automatic window will be built at the inside of the triangle. The vertical positioning will be at the top of the beam. The reason for this is to prevent the accumulation of water inside the triangle and the maximisation of the incidence of light. This can be seen in Figure 41.

Figure 41 shows the view at cutting line A-A. This line cuts through the beam at the base of the triangle where the hinges are situated. The hinges are indicated in pale blue in Figure 41. The hinges are connected onto a wooden supportbeam (dark blue) which supports the window and connects the moving part (red). The wooden supportbeam also creates a flat surface for the window to rest on, which will improve waterproofness. The moving part of the window consist out of three wooden parts. The biggest part is connected with the hinge. The other two parts fit around the glass (black) of the window and connect it to the moving window frame. All the wooden components are kept together by woodscrews with a diameter of 5 mm.

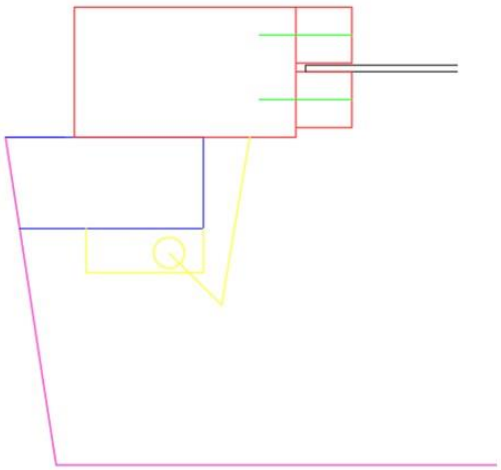


Figure 45: Cutting line B-B

Figure 42 shows the view along cutting line B-B, which show the point of the triangular window. At this end of the triangle the motor (yellow) is connected. The motor is connected to a supportblock (blue) that arises from the two supportbeams mentioned earlier coming together. The same goes for the moving part of the window.

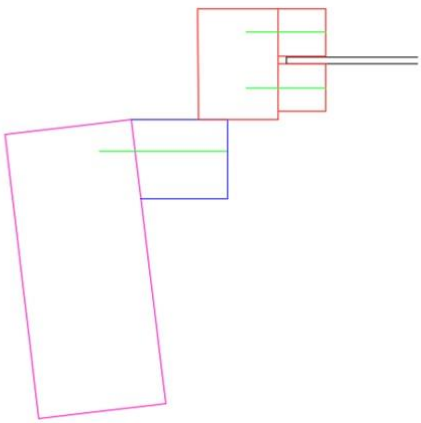


Figure 46: Cutting line C-C

Figure 43 shows the view at cutting line C-C, which gives at one of the two beams that don't have hinges. In this view can be seen as well that the moving parts of the window in red rest on the support beam in blue.

7.3.2 Electronic components

7.3.2.1Controller

We compared two controllers the Arduino Uno R3 and the Arduino Nano. After the comparison we chose the Arduino Uno.

Table 10: Comparison Arduinos

controller	Arduino Uno R3	Arduino Nano
Microcontroller	ATmega328	ATmega328
Operating Voltage	5 V	5 V
Input Voltage (recommended)	7-12 V	7-12 V
Input Voltage (limits)	6-20 V	6-20 V
Digital I/O Pins	14 (of which 6 provide PWM output)	14 (of which 6 provide PWM output)
Analog Input Pins	6	8
DC Current per I/O Pin	40 mA 50 mA(3,3 V)	40 mA
Flash Memory	32 kB	32 kB
SRAM	2 kB	2 kB
EEPROM	1 kB	1 kB
Clock Speed	16 MHz	16 MHz
Cost	17,39 €	23,70 €

7.3.2.2Temperature and humidity sensor

This kind of sensor is used for control the window operations . We compared two sensors. After the comparison we chose the DHT22. We chose this sensor, because it has higher quality and the bigger reliability.

Table 11: Comparison temperature and humidity sensors

temp & hum sensor	AM2302 DHT22 Temperature And Humidity Sensor Module	KY-015 DHT11 Temperature Humidity Sensor Module For Arduino
Operating voltage	5 V	5 V
Temperature range	-40-80 °C ± 0.5 °C	0 - 50°C + / -2°C
Humidity	20-90% RH ± 2% RH	20 - 95% RH + / -5%
Cost	9,82 €	4,39 €

7.3.2.3Distance sensor

More sensors are avialable on the market, but to our door opening solution need a distance sensor. If somebody come close to the door the sensor detects it and send the opening signal to the controller. We compared two sensors. After the comparison we chose the HC-SR04.

Table 12: Comparison distance sensors

distance sensor	**HC-SR04 - Ultrasonic sensor**	**URM37 V3.2 Ultrasonic Sensor**
power supply	5 V	5 V
current	<2 mA	<20 mA
effectual angle	<15°	n.d.
ranging distance	2 cm – 500 cm	4 cm-3 m
resolution	0.3 cm	1 cm
cost	5,51 €	13,50 €

7.4 Conclusion

We can conclude that we already have developed some things, but that we still have a lot of work to do. We have to find a solution for the connections and the automatic door.

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