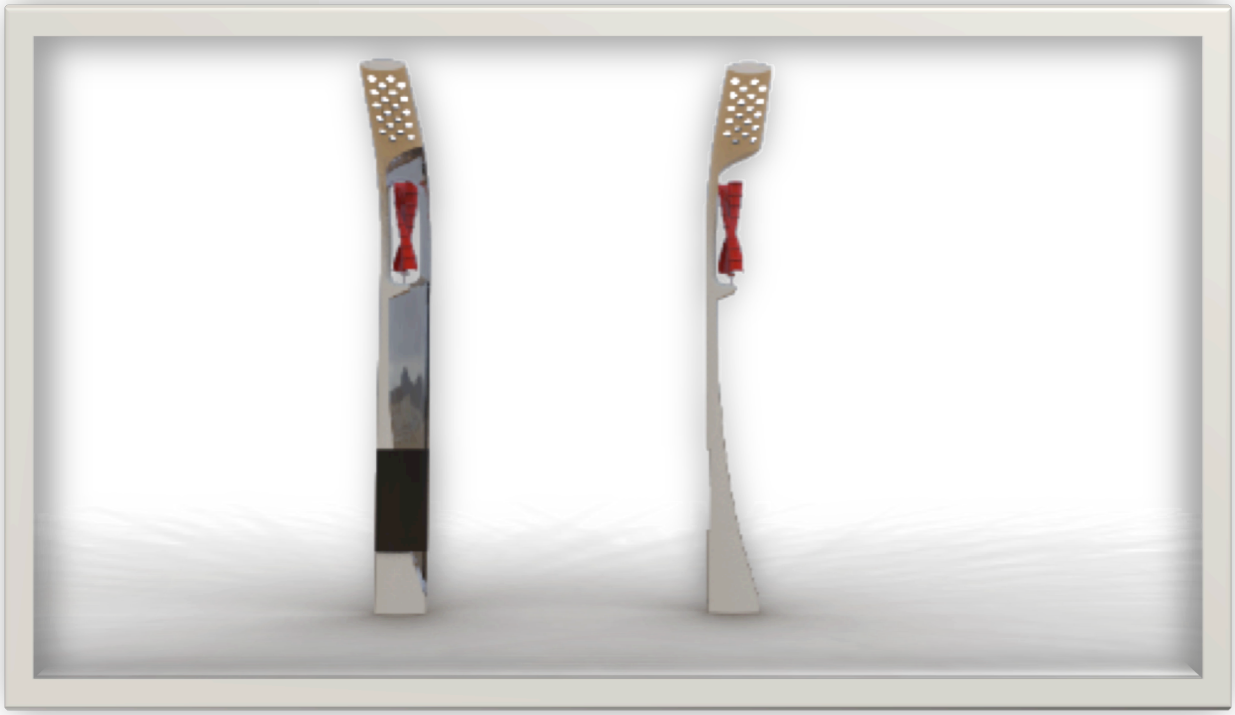
Urban Node Project
Final Report

neàpolis

Escola Politècnica Superior d'Enginyeria de Vilanova i la Geltrú
UNIVERSITAT POLITÈCNICA DE CATALUNYA



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Abstract

The world is continuously facing the evolution of technologies and environmental issues. The Universitat Politècnica de Catalunya and more precisely la Escola Politècnica Superior D'enginyeria De Vilanova I La Geltrú and a local company Neàpolis decided to initiate a project called The Urban Node in 2013. The idea and focus was to develop a innovative urban element that could gather information and interact with users whilst creating renewable energy. In 2013 two student groups worked on this project during their European Project Semester (EPS) and International Design Project Semester (IDPS). Given the size of the project, the previous groups could not complete the project, so during the 2014 spring semester an EPS group of student were assigned to the Urban Node project.

The main academic objectives for this semester and this project were; to complete the construction parts of the Urban Node, materials and dimensions, to start on the manufacturing processes in order to finally make a cost benefit analysis with a marketing study to deliver a full work on the project. For the Urban Node, the main objectives were to produce a product that is specifically designed for user interaction, to have additional features such a lighting and sensors and for the Node to produce energy using Solar Panels and Wind Turbines as well as them being for a social and educational benefit. The design will also be used to encourage the development of smart cities through the implementation of smart designs.

This report concludes an introduction of the team and the project, a SWOT analysis of the previous projects, the groups' focus on the project management tools in order to organize the project, the construction of the Urban Node, the Companies' research, the strength analysis, the manufacturing processes, a marketing plan, the technical drawings and a cost analysis.

Key words:

Urban Node, innovative urban element, smart cities, innovative construction materials, Manufacturing processes.

Acknowledgement

First of all, we would like to thank our supervisors, Pau Martí, an Associate Professor at Universitat Politècnica de Catalunya, Josep Farré, CTO at Neàpolis Company and Félix Ruiz Gorrindo, building engineer at Néapolis. Thanks to them and their advice, we were able to conduct our project.

We would also like to thank the EPSEVG for giving us the opportunity to do the EPS here. Thank you to the seminar supervisors for their help and the knowledge they taught us. All their courses helped us at some point of the project and allowed us to have methods and results.

Special thanks to Joe Barr for the Technical Communication in English classes; he gave us important advice for the format and layout matters that were very helpful and to Nora Martinez for the methods she gave for project management.

Recommendations

The urban node project is a global project between Néapolis and EPSEVG. For two years now more than 15 students have work on three different projects. Each project had a different scope in order to cover all different aspect of the project. Mainly the fields that were taken care of were:

- IDPS 2013
  - Design
  - Energy
  - Features
- EPS 2013
  - Data Acquisition
  - Intelligent Structure
  - Electronics
- EPS 2014 (us)
  - Construction
  - Manufacturing
  - Business

But the project is not completed yet; some steps still need to be achieved. The most important one is to build a relationship with the company Abertis in order to launch the production of a real prototype. Work on the electronic parts and the program of the interactive screen still need to be completed. A construction engineer student is necessary to supervise the manufacturing process

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Introduction

This project is produced from mutual work between international engineering students, the local company Neàpolis and a professor from Universitat Politècnica de Catalunya. The main purpose is to continue developing design of a new architecture furniture element, The Urban Node, which combines elements of: street lantern, informative point with interactive screen and a generator of electric power from renewable sources. It allows the placing of a new generation antenna and sensors inside. Characteristics of the Urban Node are: modular, sustainable and easy to maintain.

Information about Neàpolis

Neàpolis is an agency for technology focused on innovation, design, and entrepreneurship. They are providing education programming, space, and support to help collaborative practices and learning opportunities across a society stimulated by the entrepreneurial experience. As Public Innovation Agency for ICT and Multimedia, Neàpolis has been supporting Vilanova i la Geltrú and its region as a business location for IT, media and creative industries for last 8 years. Neàpolis improves local innovation and competitiveness including the endorsement of regional, national and international teamwork. Neàpolis is focusing on support of successful entrepreneurship especially in small and medium-sized companies, as well as involving them with application-oriented research and public funding programmes.

Objectives for Urban Node project

We were given objectives that project should fulfil. At the beginning Urban Node was defined as an idea of new kind of urban architecture with innovative functions. For that reason the objective of previous EPS and IDPS projects was to create a new element of urban furniture with variety of functions including: producing energy, being able to get different types of information and sharing it to a network. Urban node should be defined as ergonomic, ecological, useful, easy to maintain, secure, and aesthetic. For this project we are continuing work with the results obtained in the previous IDPS and EPS projects.

The main goals at the initial start of this project were the following: Urban Node should produce more energy that it spends. After research it was agreed to eliminate this objective, in order to it would be impossible to obtain satisfying amount of power, however we decided to keep wind turbine and solar panel as an additional source of energy. Other tasks that we must consider are line and modular design for Urban Node, it must be possible to install it with or without some elements like, interactive screen, wind turbine, solar cells, sensors, etc. Urban node must be designed with attendance of ecological features, its construction must satisfy next requirements: do not have pollutant elements, be persistent and be effortless to uphold, be safe, and be easy to recycle.

Another aspects that are substantial for project include study the possibility of smart structure of the Urban Node and analysis on present and potential applications. Design of Urban Node should be innovative and attractive. Areas that are necessary to develop are definition and explanation of the materials to be used in the construction of urban node, cost-benefit analysis, description of the manufacturing process, explanation of the marketing plan and product commercialization. The final target of our project is to present a complete proposal of Urban Node, that a company can produce, establish and commercialize.

1. An Introduction to the team

The Urban Node project consists of six different members from five different nationalities. Below is an introduction written personally by each member, introducing them selves and describing their course background and skills.

1.1. César from Grenoble - Industrial engineering

My name is César Penciolelli and I am a French engineer student from Grenoble in France. I study at Grenoble Institute of Technology in the industrial engineering school. I choose for my major Supply Chain Management. My studies are very special for an engineer student because I have 40% of my classes that are humanities and social science. Therefore I had classes such as Economics, Marketing and Strategy among others. This aspect of my studies gives me business skills that are really appreciated by companies. Still I have engineer science classes as well. I had some basics of industrial mechanics and automatic controls and also total quality management, industrial management, Lean Six Sigma, Methods in Tactical and Operational Supple Chain Management. It is also important for our school to give us a strong working experience. This is the reason why we have 3 different internships to do for a total duration of 10 months. We have also opportunities to study abroad as an Erasmus student. Thankfully I was given that opportunity and I choose to do my semester here at EPSEVG – UPC en Vilanova I la Geltru. I really wanted to come to Catalunya for the environment and the culture and also for the project. I like the idea of gathering different engineers and make us work on the same project. It is a very Interesting experience and I am glad that I am a part of it.

1.2. Antoine from Reims - Packaging engineering

My name is Antoine VILAIN and I am a French engineer student coming from Reims in France. I am actually studying in an Engineering school called ESIReims, specialized in Packaging. I am indeed studying all the materials and the processes, which allow creating and producing every kind of packaging. This education also propose a program about computer science, which gather programing, drawing on special software as Solidworks (CAD - Computer-aided design) or using measurement software to analyze all the proprieties of the materials. I think that increasing our experience, as the personal as on the professional plan was very important for my career and me. That is why I found the ESIReims very interesting because this school allows each student to do an internship each year for a total duration of 13 months. Moreover this school proposed to integrate an exchange student program called Erasmus. I have always been interested by discovering new cultures, meeting new people and improving my linguistic level. That is why, this year, it has been given to me the chance to integrate a studying program in Spain called European Project Semester taking part of the Erasmus exchange student. Therefore, I followed from February until June an education of Management and Marketing at the EPSEVG in Vilanova I la Gueltru that I directly put in application in the project Urban Node that have been assigned to me at the beginning of Erasmus.

1.3. Weronika from Lodz - Architectural engineering

My name is Weronika Wojtkowiak and I am an undergraduate student in my third year of Architecture Engineering at International Faculty of Engineering Department and Faculty of Civil Engineering, Architecture and Environmental Engineering of Technical University in Lodz, Poland. My course combines Architecture studies and Civil Engineering and all my classes and lectures are conducted in English. The main objectives of the training are: to acquaint the student with the basic knowledge and directional in the construction, architecture and urban

planning, and to familiar the student with the skills to use the techniques, managerial, information technology and foreign languages. I have sense of aesthetics, subjects like design and drawing are my interest, and I am also able to solve problems in an analytical, logical way. I am able to work in a team in effective way, for me it is easy to organize and plan the work. I am adaptable and flexible person; I know how to deal with unexpected situations where necessary. Principal subjects: Urban Design, Architectural Design, Fundamentals of Civil Engineering, History of Architecture and Town Planning, Computer Methods.

1.4. Calley from London - Product design

My name is Calley-Ann Nixon, I am twenty-one years old and was born and have lived all my life in a small town called Stanmore in London. I study Product Design BSc at Nottingham Trent University School of Architecture and Design. This is in the Midlands in England in a city called Nottingham. I am currently in my third year at university and after my semester here I will return in October to complete my final year. I have completed a range of diverse and stimulating projects with high-end brands such as Oakley's and Hillary Blinds. I have explored many aspects of product design; from the understanding of user needs, to materials selection. I have a range of communication skills using media and methods from drawing, model making and building. I have experience with product proposals and presentations. I enjoy working as a team or in a close group as I think it can be really beneficial, especially in this case to work with other students with different experience, different education backgrounds, different courses and different cultures. It is a constant learning experience, which allows it to be educations as well as fun as we have built international friendships.

1.5. Dieter from Antwerp - Civil engineering

My name is Dieter Knops and I'm a student from Belgium. I study industrial engineering at the University of Antwerp. My specialisation of engineering is construction. This means that my knowledge for the project will especially be used for materials and strength analysis. The main part of my studies focus on calculation of structures and building techniques. Here are a couple of the courses I followed in Antwerp: reinforced concrete, structural analysis, and finite elements. A small part from my studies is doing an internship. This was only 6 weeks but on these weeks you learn a lot, like things you can only learn by doing it in real life. When I heard that I could do the European Project Semester I was very pleased. The opportunity to work in a group with different nationalities while completing an interesting project is a big surplus for my working career. Because later working in-group is very important as an engineer. Also improving my knowledge of English and learning the basics of Spanish will be a surplus for my career. At last we can't forget to mention the opportunity to go to Spain. Getting to know the Spanish culture is a very nice way to go on Erasmus.

1.6. Gerard from Barcelona - Mechanical engineering

My name is Gerard Soriano Martinez and I am from Barcelona, Spain. I am studying Mechanical Engineering in Universitat Politècnica de Catalunya of Vilanova i la Geltrú (EPSEVG). This semester I am doing the final project degree in the European Project Semester (EPS). The principal subjects I have studied are: Design, Manufacturing and Packaging Process, Technical Drawing, Thermal, Fluids, Mechanics, Structures, Business and Marketing.

2. SWOT Analysis of the previous Urban Node projects

The SWOT analysis technique has been used to study and understand the previous projects strengths and weaknesses and to identify the opportunities that can be developed upon and the possible threats that are current or potential issues. The analysis was carried out using the report from the previous project groups, The EPS and The IDPS.

2.1 Strengths

The first section of this study analyses the strengths of the Urban Node, looking at the three main key areas including: The Ergonomics, The Aesthetics and The Function. The study then Reviews and highlights the key topics within these main areas.

2.1.1. Ergonomics

Ergonomics is designing a product to suit its target users, allowing the product to be easy to use and simple to understand, ensuring that the user has full control and an adequate understanding of the product and how it works. With this there is a need to take into account the safety aspects of the design. Ergonomics clearly defines the relationship between the user and both the product and its use, by providing them with their Ergonomic needs.

User Profiles

User Profiles are your target market: Whom you are designing the product for. The Urban Node has ten main preferences of its users. They include;

Adults	Families	Children	Retired people	Tourists
Wheel Chair Users	People that suffer from walking disabilities or balance problems	Visually impaired, people	Learning disability or hearing impairment	Homeless people

Picture 1: Table of the potential users of the Urban Node

In conclusion, this is a large number of target users and it is clear the previous group researched and looked into as many different target markets and users as they could that they felt would encounter an experience with the urban node at some point in the products life time period. This in effect will result in high demand for the node in terms of having a large group of target users. This will then ensure that making the product is cost efficient, as the product will effectively be pro-active continuously as its viable for all users.

Anthropometrics

Anthropometrics is the science that studies the sizes of the human body, in order to establish the differences in individuals, groups, etc. The previous project groups used Anthropometrics to

influence the shape, the dimensions and the size of the Urban Node. The groups had two main focuses in mind, which were the touch screen and then the maintenance of the Node. This is a positive strength aspect as it shows that there has been actions taken to the Ergonomics of the product to ensure that it is suitable for all users, taking into consideration the elderly, tourists and disabled/ people with disabilities. This results in no additional changes needed in order to modify it for those particular consumers or consumer needs.

Shape

The ergonomics of the shape of the urban node has been specifically designed using as discussed above anthropometrics. This ensures that the design and shape of the node is made to suit the users to ensure that it is as comfortable and east to use as possible. The functions have been placed to meet the needs of the users. An example of this would be the touch/interactive screen. This is beneficial to the node, as it will affect the users experience in a positive way.

2.1.2. Aesthetics

The aesthetics of a product or design are always based solely on the appearance. For example, what the product looks like? How attractive is the product? Is the product eye catching? Will it attract and draw in the intended market? Is the design innovative yet still attractive to the consumer? Does it look better than any competitor's designs that are currently out on the market?

Shape

The designed shape of the Urban Node is Aesthetically and visually pleasing. Its innovative yet functional. It is clear that the shape of the Node resembles a 'smart city' as the design is modern and very different to anything that is currently on the market. The design of the shape is simple resulting in the manufacturing process being a lot simpler in comparison to some of the other initial ideas the previous group had which would have caused a lot of complications when it came to producing the Node.

Solar panels

Solar panels have never been seen as an aesthetically pleasing product but more of a beneficial one because of its sole purpose. The previous project groups have chosen to place the panels on the top of the Urban Node as in this position because of the height of the node it will result in the panels being most efficient. The chosen place will not be visible to passers by but only people that are above the node for example planes. This means that the group have ensured that the node is still aesthetically pleasing with the corporation of the solar panels as they will not be seen so in a sense they are aesthetically pleasing too.

Wind turbine

The design of the Wind turbine is aesthetically pleasing as it's a bright color (red) making it stand out as more of a statement rather than trying to filter it into the design with out it being noticed. The area they have placed it will mean that it is beneficial in producing energy as it will still be accessible by wind but the have incorporated it into the modern feel of the design.

Lighting

LED lighting has become more popular in recent years. Not only because there are energy saving but because they are also aesthetically pleasing. They are seen as modern technology and have been used in stylish home product as well as outside utilities. The lighting of the node fits in to the sleek design on the node, allowing it to keep its modern design but at the same time be energy efficient. It will enable the node to have a nighttime 'glow' as well as completely changing the aesthetical state of a standard node. Many streetlights or nodes have continued to have the basic design of one main bulb, where as this node is unique with having many small ones. It also once again makes the design more energy efficient.

2.1.3. Function

The function of a product is the focus on how it works. Whether or not it completes the tasks in which is was intended to when it was first designed. Does it work efficiently and serve the purpose of the design on the product.

Lighting

The chosen Lighting is LED's. The one main advantage of the function of using the specific type of lighting is that they are up to twenty times more energy efficient in comparison to standard lighting yet at the same time they are producing the exact same amount of lighting. They have an average lighting time of 50,000 hours in comparison to the 1,200 hours standard light bulbs have. As one of the main and crucial objectives of this node is that it should be energy efficient this type of lighting will be perfect for the design.

Interaction

Interaction when analyzing a product is seen as the communication between the user and the product itself. It focuses on how the user interacts and the communication in which they have with the product. It portrays whether or not this is a positive experience for both parties. The Previous project groups have analyzed six main topics with regards to the Urban Nodes interaction. They include: Affordances, which is the perceived and actual properties of a product, showing how it can be used. Visibility, allowing the user to see the state of the device and the possible actions. Showing the most important ones and covering the ones, which are rarely used. Feedback refers to letting the user know which actions have been made and what state the device is currently in. Constraints are restricting the type of actions that can be made in order to avoid mistakes. Mapping indicates which elements are connected, giving a clear relationship between the controls and effects. Consistency refers to using elements that the user is already familiar with, mostly used with interfaces. This is a strength as it adds to the positives aspects of the Node. One of the most important functions of the Node is the interaction between the user and product as every product is designed for an intended user and market. It needs to be clear and structural, in order to ensure the users experience is a positive interaction, allowing the product to be easy to use and helpful as well as informative to the user at all times ensuring it is successful for its intended use. In addition as an opportunity the node could potentially allow the user to have control over the lighting.

Energy Generation

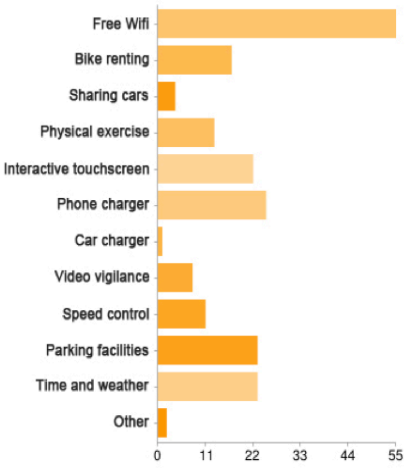
Energy Generation is as simple as it sounds. It is the providing of energy. This design has two combined main energy producers, a wind turbine and a solar panel. The function of the wind turbine for the Node is that the turbine will be operating on the principle flow of atmospheric air, which is generated by high and low wind pressure. The speed is then determined of the difference between the pressure systems and then converting the wind motion into mechanical motion, which can then be transformed into energy. The function of the solar panel works from the process of converting light photons into energy volts, which is more commonly known as the photovoltaic effect. These two choices are definitely strength as they provide renewable energy that can then be sent back to the grid. It will ensure that the Node is providing enough energy in comparison to what it consumes.

Internal Structure

All wiring and the sensors will be kept within the inside of the node. This will ensure that the design is aesthetically pleasing as well as safe. It is extremely important that all electrical components are kept well inside the node to ensure maximum safety for its users. This is a benefit to the node as it eliminates any possible future threats of the product as well as meeting mandatory rules and regulation of designing this type of product. This ensures that the internal structure is near and compact as well as easy to maintain as all technical components will be together ensuring that there is not need to take apart the node for basic maintenance of the structure and for the regular maintenance of the product.

Features

Features when describing a product, determine what the most important aspects are, taking into account the user needs, wants and demands from the target market. When decided the features of a design, you should always take into consideration what the product should provide for its user using the information of research of that are the users key needs and wants. The previous project groups looked into many different aspects and criteria in order to decide the features that the Node should have. Having such a large target market can be difficult as each group of people have their own needs, demands and wants and all this needs to be taken into consideration.



Picture 2: Features wanted by the market

The groups carried out a survey asking the general public the three feature of the function of a smart city design that they would prefer to have. The choice included Free Wi-Fi, Bike rentals, sharing cars, physical exercise, interactive touchscreen, phone charger, car charger, video vigilance, speed control, parking facilities, time and weather and other. From the survey, above this text, it is very clear that the feature, which has the highest demand, is free Wi-Fi. This means that the Wi-Fi is almost certain when deciding the main functions for the Node. After that there were the top three. Which included phone charger services, parking facilities and time and weather. This portrays that the above needed to be taken into consideration for the features of the Node too. The groups have looked at lots of possible features and carried out research in order to see whether or not it is in agreeance with local people of Vilanova. This is a key strength, as it will give knowledge into what is already wanted and can be incorporated into the continuation design process. The research methods can also be used after the ideas of the initial features of the Node have been decided. This research method will result in the function of the Node being a key selling point as the features would have been chosen by the target users and the target market as theoretically they have chosen what they feel will be most in demand and most useful to the people of Vilanova. It would also be a good idea to ask big companies such as Indra and popular phone companies what their preferences for the features are for the node.

2.2. Weaknesses

This next section of the study analyses the weaknesses of the Urban Node, looking once again at the three main key areas including: The Ergonomics, The Aesthetics and The Function. The study then Reviews and highlights the key topics within these main areas.

2.2.1. Ergonomics

User profiles

As there is a large amount of user profiles to take into consideration, this will mean that the node will have to be very complex and diverse in order to meet each and every one of its users needs. This in effect could cause too many problems and complications in the process of designing the node. For example if some one is blind there will need to be braille or the use of voice interaction. However this design will not suit some one with a hearing impairment, as they will need the design to be more tactile and visual. This however will be a weakness not only within the actual design process but it will also link in to the weakness of maintenance of the Node. By having lots of different features and functions specifically for minimal target users,

which is the small majority such as the visually impaired, people with hearing disabilities etc. The node will then become a more complex design resulting in a greater number of functions that will potentially need a great deal of maintenance and cause potential problems.

Anthropometrics

One main weakness of using anthropometrics is that it takes into account the average, so for example the average body mass. This is great when designed a product for specific target market e.g. children but when designing this type of complex product with many different types of users and target markets it means that the design will have potential to illuminate some of these users unless certain adjustments are taken into consideration. A prime example of this would be wheel chair users. The screen needs to visible and accessible for wheel chair users but at the same time suitable for tall people. The only way to get around this problem is to have the screen adjustable. This would then change the complexity of the design, which also could then create further complications.

2.2.2. Aesthetics

Shape

The weakness of the shape chosen by the previous project it is modern. Although this can be seen as a positive aspect it is important that the designers take into consideration that Vilanova is a small town. The buildings are traditional along with the residents. Therefore by putting a 'smart city' product into a town such as this although the product its self may be aesthetically pleasing in a town like this it could look odd. Not fitting in with the architecture of the town as well as upsetting the local residents.

Lighting

The aesthetics of the lighting id different to competitors designs of current Urban nodes and street lamps, but however the shape its self of each of the lighting components could be more innovative and used to allow the design to stand out even more. This would then allow the lighting to become a main feature and an even more important aspect of the product.

2.2.3. Function

Lighting

One of the observed weaknesses of the function of the LED lighting is that although it can be weakened or dimmed just like a standard bulb, it will mean switching some of the small single LEDs off. This could be a problem as it would really decrease the amount of lighting that is given off from the lamp, in effect this could make the lamp a lot let efficient in comparison to a standard bulb. This is because of the complexity of the design.

Interaction

Interaction has six main topics as previously mentioned: Affordances, Visibility, Feedback, Constraints, Mapping and Consistency. Analyzing the principles for interaction, which are chosen. There is a need to take into account users that will struggle with the interaction its self. An example of this would for tourists. Their main requirement in order to interact with the product would be that the Node has the ability to change the language preference. The problem with this if it is not taken into consideration is it will decrease the number of target market users as well as the opportunity for the Node to go international or even global. In effect decreasing the use of the Urban Node and then the product becomes less cost effective.

Energy Generation

As previously discussed the previous project group had made the choice two have two main energy generators. Wind turbines and solar panels. The weakness of reinforcing this into the

urban node design is that in order for solar panels to produce a highly sufficient amount of energy it would mean the panel would need a large surface area this it would be extremely unattractive and would result in the balance on the top section losing security and could potentially be dangerous. For the wind turbine, you need as much open space as possible therefor the Nodes need to be as tall as possible. Increasing the use of materials and in effect affecting the overall cost of the Node.

Internal Structure

Because all the components to the function of the node will be kept inside this means that there needs to be a part of the node specifically designed in order to allow easy access for maintenance this in effect will make the design complexes as some sensors in order to work most efficiently will need to be on the outside of the node. An example would be the humidity sensor.

Features

As previously discussed, the project groups looked at the following features; Free Wi-Fi, Bike rentals, sharing cars, physical exercise, interactive touchscreen, phone charger, car charger, video vigilance, speed control, parking facilities, time and weather and other. The conclusion of the survey is that Wi-Fi is highly in demand, followed by phone charger services, parking facilities and time and weather. From the group however, they stated that they believe the users do not necessarily know their needs for the future. An example of this they gave, was that there were no votes for having the ability to charge an electric car via the Node.

The weakness that really stands out is that the previous project groups argued that electric cars will be a product that in the near future the demand will increase greatly which means having a charger on the Node would have a great impact in the future. However it is arguable that the Node should be designed for now as if you focus on the design looking too much into the future this could complicate every thing. An example of this is perhaps in the near future there will be re-charging phones and there will no longer be a need for chargers. It is important to take into consideration the previous groups survey and its results and their opinions as well as it is equally important to carry out further research in order to limit down the feature of the function of the Node to the most important and the most in demand as well as taking into account possible changes for the future.

Maintenance

There are three different sectors of maintenance that will be required for the Urban Node, which include: Corrective maintenance, which involves repairing all system failures and incidents. This maintenance will need to be available consistently for issues such as; the replacement of Lamps light bulbs, repairment of Urban node's exterior, replace and or adjustment of the programing of the Node. Preventive maintenance, which involves periodic reviews of all components and elements of the Urban Node. This maintenance will ensure and put into place the prevention of any damage of failure of the Node before they occur. It is necessary for the state inspection brackets (corrosion, anchors, covers), Inspection of the Lights (box wiring, moorings, closing, cleaning), Inspection of the Lamps (moorings, close, cleaning), Inspection and testing of the programming system and/or the ignition system and checking illumination and intensity offered.

General Maintenance, which involves checks and inspections. They will be carried out by the authorized installer on average every five years depending on the KW installed capacity as the features and the function of the outdoor lighting installation are modified and will degrade over a period of time. Overall using the above collated information the amount of maintenance needed for the Urban Node, it is clear that there will be a need for structural maintenance as well as maintenance for potential and all possible circumstances that cannot be predicted. This is a weakness as it is time consuming and can become costly.

2.3. Opportunities

This next section of the study identifies the opportunities for the design and future of the Urban Node. Focusing on six topic areas and discussing the correlation between each opportunity and how some on them interlink with each other to create further opportunities.

Location

In Villanova there is plenty of location for the Urban Nodes, which will still entitle them to function to their full potential. This could result in the design being interchangeable depending on the location for each node. For example Nodes that will be placed on the Ramblas will need to be an extended version of the Nodes that will be placed on the beach. The reason for this is because there are a lot of buildings, shops and palm trees within the area of the Ramblas. Research on wind power systems and solar systems state that they both need to be in clear open space with limited restriction; especially for the wind turbines. This would result in them needing to be a lot taller in order for them to reach their full potential and produce as much energy as possible. The overall conclusion of this opportunity is that there could be potential to develop the Urban Node idea based on the increasing demand for the node in other parts of Villanova town.

Tourism

If the Node is able to function and interact with users with different languages, other than Castellano as well as having the ability to change and accommodate its function and processes in order to make it understandable for all nationalities, this will not only be a tourist asset to Vilanova but it also means that it has the potential to be produced in other countries if there is a demand for it without needing to be amended or adjusted.

Smart City

By producing and manufacturing the Urban Node and having it in Vilanova, this will mean that Vilanova town is taking a big step into becoming a smart city. There is no precise definition of a 'smart city' however, the concept of a smart city is one who is dependent and aware of its citizens and consists of six smart city factors; Smart Mobility, smart environment, smart people, smart living, smart government and smart economy. This would definitely increase Vilanova's status as a smart city in the views of the local residence and well as passing tourists.

International

As previously discussed in the topic of tourism it is clear that if this product is successful then it has potential to fill the demand of other countries. If the product went international it would then result in perhaps the change of the design, improving and adjusting the aesthetics, ergonomics and function for each particular country. An example of this is Chinese people. They tend to have a much lower height average than countries in Europe there for the touch screen would need to be located a lot lower than its current place.

Globalization

If this product becomes successful and there is a demand internationally then this in effect would result in a demand for the Node Globally. This would be a great challenge as the needs and wants of users in different countries can vary a great deal as previously discussed in the above paragraph.

Maintenance

The need for regular maintenance can be seen as an opportunity as it will provide jobs for local residents. This will also in effect encourage people from the town of Villanova to play a role in the Urban Node bringing together the town and its people.

2.4. Threats

This last section of the study identifies the potential and current threats for the Urban Node. Focusing on four key topic areas.

Competitors

After independent research it is very clear that Urban Nodes are now becoming more developed and the designs are increasing in complexity. This increases the pressure to produce a unique design that eliminates any form of competitors.

Cost

The average cost of the node is going to be expensive. A price breakdown will be clearer after the cost analysis. However, the higher the cost including the maintenance needed the less likely there will be a demand for the node, of perhaps the quantity of the Nodes.

Maintenance

As previously discussed under the weakness's section it is clear that the Urban Node will need three main types of maintenance; Corrective, Preventive and General. If looking at the regularity of the information for this maintenance, it portrays that the Urban Node will need a lot of time and if effective this will become costly. This is definitely something that would need to be taken into consideration.

Smart city

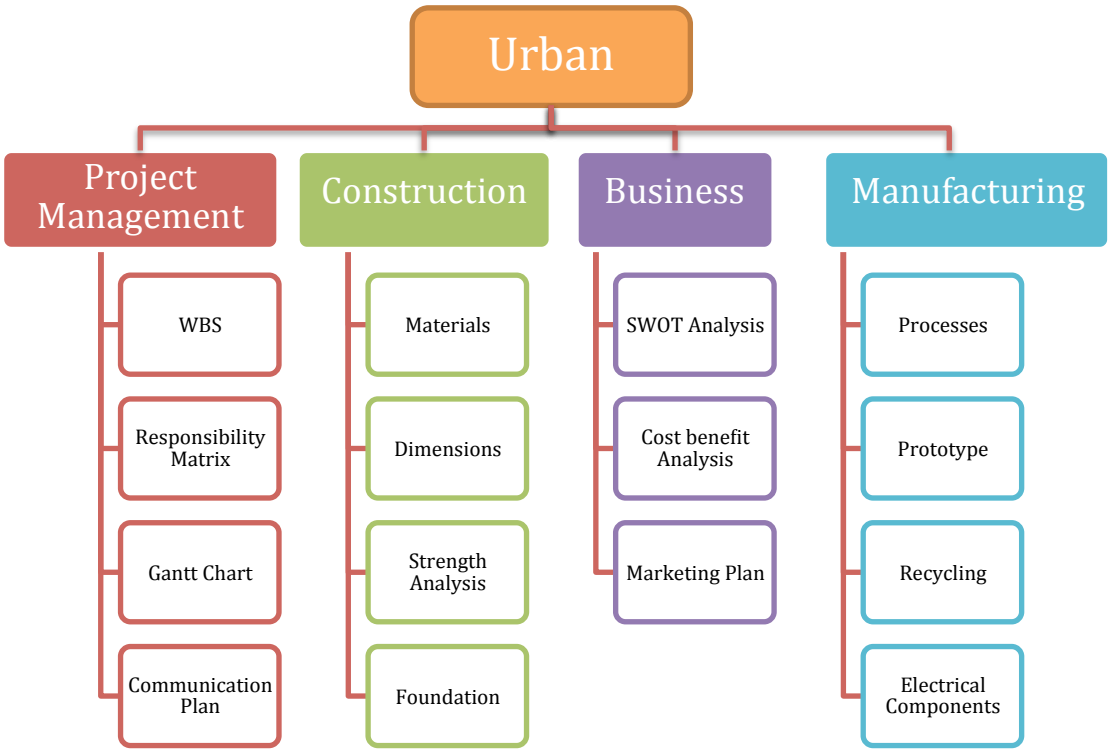
One of the main problems with trying to turn Vilanova into a smart city is that it has always been a very proud and traditional small town. By implementing these modern and high tech nodes could cause the local residents of Vilanova to become distressed and want their town back to being traditional. This could become a potential threat if actions are not taken to ensure that this does not happen. A good idea would be to produce a life size model and to place it in an area in which the nodes will be. Then this will show the peoples reaction to the node and whether or not it will have a positive or negative impact on the people. Another good idea would be to carry out surveys and questionnaires to passers by to get a more in-depth view on peoples opinions and feelings towards the node. This will then prevent a possible threat turning it into an opportunity.

3. Project Management tools

Once we were aware of the projects states and issues, we were able to move on to the next phase of the project. In order to start this project properly, we wanted to incorporate some management tools. Therefore we would have a structure for our work. This phase includes organizing tools such as responsibility matrix or work breakdown structures as well as planning tools like a Gantt chart and a communication plan to facilitate the exchanges of information.

3.1. Work Breakdown Structure of the project

WBS is often used at the beginning of projects so as to structure the project in different categories to have a quick overview of the project main characteristics.
We divided the Urban Node Project into 4 main fields: Project management, Construction, Business and Manufacturing. We managed to split all the tasks required in one of those categories.



Picture 3: WBS of the project

3.1.1. Project Management

First, we find the project management field; it is one of the most important aspects of the project because it allows us to have a guideline and an organization clearly defined for the rest of the project. It is also needed to going on with the other tools. The Responsibility Matrix and the Gantt chart are based on the WBS. Finally we will build a communication plan to make sure we are all agreed on the way we should exchange information and at what frequency we should see each other to make sure the project is going in the right direction.

3.1.2. Construction

The second category of tasks you can find in our WBS is Construction. In this section, we tackle all the building matters of the urban node. We updated the materials and dimensions

given information for previous year Urban Node projects. Once it is done we could move on to the strength analysis study. This task is really important and we need to be extremely cautious in order to avoid situation during the manufacturing process.

3.1.3. Business

Thirdly we have to take care of some business matters. Marketing plan or Cost benefit analysis are really important matters we need to study in order to make sure we avoid any unexpected problems. Actually, we have to make sure our product is suitable for the market and is also viable meaning it could bring a return on investment.

3.1.4. Manufacturing

In the part called, manufacturing, the objective is to define the manufacturing processes by working with local companies in order to boost the local economic actors. In this part, the matter of the components (sensors, antenna, etc.) will be discussed as well as the features of the Node (WIFI, plugs, screen, etc.)

3.2. Responsibility Matrix

The Responsibility Matrix is another important tool commonly use in project management. This idea is to list all the tasks that should be done and all the project members in a table. Then there should be one member responsible for each task with one or two support members. Different parameters should be taken into account to dispatch the task responsibility such as the backgrounds and the skills of the members. A calculation can also be made to dispatch equally the work. The next diagram is the responsibility matrix of the project. In order to balance the workload of each one, we have made a calculation on the bottom line of the table. Each member gets 2 points for being responsible for something and one as a support.

Tasks	Calley	Weronika	Antoine	Dieter	César	Gérard	Status
Materials		R		S		S	1
Dimensions (design)		R		S		S	1
Strength Analysis		S	S	R			1
Foundation		S		R			1
Cost benefit Analysis					R		1
Manufacturing			S			R	1
Recycling	S					R	1
Marketing Plan					R		1
Prototype	R						1
SWOT Analysis from previous project	R				S		1
WBS					R		1
Gantt Chart			R		S		1
Communication Plan	S		R				1
Responsible	2	2	2	2	3	2	
Support	2	2	2	2	2	2	
Total	6	6	6	6	8	6	

Picture 4: Responsibility Matrix of the project

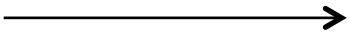
A project, by definition, is defined as a collaborative enterprise, involving research or design that is carefully planned to achieve a particular aim. Indeed, a project is a succession of chronological steps and actions, which allows its realization. For this, a tool has been developed in the beginning of the 20th Century, by Henry Gantt, which is called the Gantt chart.
The efficiency of this tool has been totally approved over the years, and is now used by most of companies whose search to realize projects in the best conditions and in the best times, always respecting the project budget.

3.3. Gantt chart

This year, for our project Urban Node, we decided to apply this method, this tool, in order to know how progresses the project, if we are respecting our time limits for each steps and if the project goes on correctly. The first step for the Gantt chart was to list all the steps that we needed to do to reach our goals.

Listing those steps was for us a way to keep a guideline, to know exactly what we have to do on this project. After several meetings with our supervisors of Neapolis, discussing about what would be proprietary for the project and what would be absolutely necessary to realize, we concluded that the realization of Urban Node in a scale 1:1 would be our objective.

In this part, you will find on here all the steps that we listed to complete our project.



At the beginning, the project should have been finished in the middle of June, right on time before the Final Report, but we met some problems during the realization of this project.
Indeed, we planned to do the strength analysis thanks to the Dimension part and the Material definition part, but we needed also the technical drawings of last year.
The problem was that after several week of search we couldn't still find them, contacting the last year project team.

It is at the end of May that finally we received the technical drawings from student working on this project last year, which allowed us to go on the next steps.

		Mod Tâch	Nom de la tâche	Durée	Début	Fin	Préc
1	✓		**1st meeting**	**1 hr**	**Ven 28/02/14**	**Ven 28/02/14**	
2	✓		WBS - Work Breakdown Structure	2 jours	Ven 28/02/14	Mar 04/03/14	
3	✓		Gantt Chart	5 jours	Mar 04/03/14	Mar 11/03/14	2
4	✓		SWOT Analysis	1 hr	Mar 04/03/14	Mar 04/03/14	2
5	✓		**2nd meeting**	1 hr	Ven 14/03/14	Ven 14/03/14	
6	✓		**Define Dimensions**	**7 jours**	**Ven 14/03/14**	**Mar 25/03/14**	
7	✓		Dimensions from 3d model - Design/Shape Aspect	2 jours	Ven 14/03/14	Mar 18/03/14	5
8	✓		Dividing to moduls	2 jours	Mar 18/03/14	Jeu 20/03/14	7
9	✓		Dimension of each moduls	3 jours	Jeu 20/03/14	Mar 25/03/14	8
10	✓		**3rd meeting**	1 hr	Mer 26/03/14	Mer 26/03/14	
11	✓		**Define Materials**	**5 jours**	**Mar 25/03/14**	**Mar 01/04/14**	
12	✓		Research and choice of materials	4 jours	Mar 25/03/14	Lun 31/03/14	9
13	✓		Choosing finishing layer	1 jour	Lun 31/03/14	Mar 01/04/14	12
14	✓		**4th meeting**	1 hr	Mer 09/04/14	Mer 09/04/14	
15			**Find Technical Drawings**	28 jours	Jeu 13/03/14	Lun 21/04/14	
16			**Strenght Analysis**	**14 jours**	**Lun 21/04/14**	**Jeu 08/05/14**	
17			Research for calculation method (in function of materials)	7 jours	Lun 21/04/14	Mar 29/04/14	13
18			Calculation	7 jours	Mer 30/04/14	Jeu 08/05/14	17
19			**Foundation**	**4 jours**	**Ven 09/05/14**	**Mer 14/05/14**	
20			Research for calculation method	2 jours	Ven 09/05/14	Lun 12/05/14	18
21			Calculation	2 jours	Mar 13/05/14	Mer 14/05/14	20
22	✓		Write the Midterm Report	15 jours	Mar 01/04/14	Lun 21/04/14	
23	✓		Proposition of the specifications	1 jour	Jeu 15/05/14	Jeu 15/05/14	21
24	✓		Waiting time - Answer from the company about the specifications	10 jours	Ven 16/05/14	Jeu 29/05/14	23
25			*Apply a patent*	3 jours	Lun 28/04/14	Jeu 01/05/14	
26			Write the Final Project Report	10 jours	Lun 26/05/14	Ven 06/06/14	
27			**Process Production**	**17 jours**	**Ven 30/05/14**	**Lun 23/06/14**	
28			Raw materials - Cutting - Bending - Welding - Grinding	15 jours	Ven 30/05/14	Jeu 19/06/14	24
29			Assemblement - Finished product	2 jours	Ven 20/06/14	Lun 23/06/14	28
30			**Quality control**	**9 jours**	**Mar 24/06/14**	**Ven 04/07/14**	
31			**Mechanical Testing Facilities**	**5 jours**	**Mar 24/06/14**	**Lun 30/06/14**	
32			Force transducer	1 jour	Mar 24/06/14	Mar 24/06/14	29
33			Tensile testing machine	1 jour	Mar 24/06/14	Mar 24/06/14	29
34			Elongation test machine	1 jour	Mar 24/06/14	Mar 24/06/14	29
35			Impact testing unit	1 jour	Mar 24/06/14	Mar 24/06/14	29
36			Bending testing unit	1 jour	Mar 24/06/14	Mar 24/06/14	29
37			Rate of burning unit	1 jour	Mar 24/06/14	Mar 24/06/14	29
38			**Tools for modules & tests**	**4 jours**	**Mar 01/07/14**	**Ven 04/07/14**	
39			Vemer (Tool for multi testing)	4 jours	Mar 01/07/14	Ven 04/07/14	31
40			Micrometer (Thickness)	4 jours	Mar 01/07/14	Ven 04/07/14	31
41			Ford cup (Viscosity)	4 jours	Mar 01/07/14	Ven 04/07/14	31
42			**Delivering product**	**5 jours**	**Lun 07/07/14**	**Ven 11/07/14**	
43			Packaging of different parts and transport from Company to place of setting-up	2 jours	Lun 07/07/14	Mar 08/07/14	41
44			Building of the urban node	2 jours	Mer 09/07/14	Jeu 10/07/14	43
45			Final Tests	1 jour	Ven 11/07/14	Ven 11/07/14	44
46			Cost Benefit Analysis	12 jours	Lun 02/06/14	Mar 17/06/14	31
47			**Marketing Plan**	**14 jours**	**Mar 04/03/14**	**Lun 24/03/14**	**4**
48	✓		Analysis of the market	2 jours	Mar 04/03/14	Jeu 06/03/14	
49	✓		Analysis of the competitors	3 jours	Jeu 06/03/14	Mar 11/03/14	48
50			Porter analysis	3 jours	Mar 11/03/14	Ven 14/03/14	49
51			Commercializing campaign	3 jours	Ven 14/03/14	Mer 19/03/14	50
52			Selling aspects	3 jours	Mer 19/03/14	Lun 24/03/14	51

Picture 5: Gantt chart

3.4. The communication plan

In every project, the sharing of information between two or more individuals or groups to reach a common understanding is probably the main asset for the success of a project. For it, another tool is widely used nowadays. It is called the Communication Plan, which allows to:

- Increased efficiency in new technologies and skills
- Improved quality of products and services
- Increased responsiveness to customers
- More innovation through communication
- Make teams work effectively

In this optic, here is the Communication Plan that we applied for our project:

What	Who/Target	Purpose	When/Frequency	Type/Method(s)
Initiation - Briefing	All stakeholders* Supervisors	Gather information from the previous year project for Initiation Plan. - Explanations of the project by the Supervisors.	07/02/14	Meeting and briefing
Distribute Project Initiation Plan	All stakeholders*	Distribute Plan to alert stakeholders of project scope. - Read the EPS and IDPS project of last year.	Before the first meeting: 28/02/14	Electronic document. Reports in PDF, by mail. Sent by our supervisors. PPM Templates: Project scope
Communication system	All stakeholders*	IT platform to communicate and share documents in real-time between all the members of the team	At the beginning: 10/02/14	Facebook group.
Project Kick Off	All stakeholders*	Communicate plans and stakeholder roles/responsibilities. Encourage communication among stakeholders.	Project Start Date: 28/02/14	Meeting - Work Breakdown Structure - Responsibility Matrix
Status Reports	All stakeholders and Project Office	Update stakeholders on progress of the project.	Every two weeks.	Documents posted of Facebook group. PPM Template: Status Report
Team Meetings	Entire Project Team.	To review detailed plans (tasks, assignments, and action items).	Every week between the members of the team. Every week with the supervisors.	Meeting at School (EPSEVG–team members) Meeting at Neapolis (with Supervisors) PPM Template: Minute meeting form – New one every week.
Project imperatives	Supervisors and Project team.	Work through issues and change requests here according to the imperatives.	Every week.	Meeting at Neapolis
PO (project office) Audit/Review	Supervisors and Project team.	Review status reports, issues, and risks. To identify and communicate potential risks and issues that may affect the schedule, budget, or deliverables.	Every week.	Meeting at Neapolis Project Office will produce report using their template.
Post Project Review & Post Project Presentation	Supervisors and Project team.	Identify improvement plans, lessons learned, what worked and what could have gone better. - Review accomplishments. - Do a training presentation.	Before the mid-term defense: 25/04/14 And also in June, before the Final Project Defense (9-13 June)	Presentation at Neapolis.
Mid-term Report	Project team.	Write the Project Mid-term report.	End of major phase of the project: Mid-term report - 28/04/14	Report of the project. PDF or Word document. Send it to the Supervisors.
Mid-term Defense	Supervisors, Project team, Teachers, Studies and students.	Presentation of the project.	28/04/14	Presentation at School (EPSEVG)
Quarterly Project Review	Supervisors and Project team.	Review overall health of the project and highlight areas that need action.	1 or 2 times after Mid-term report.	Meeting
Initiation of Manufacturing Process	Different companies	Redaction of the letter to find a company which will accept to begin the production.	07/04/14	Letter and Specifications of the Urban Node.
Presentations to Special Interest Groups: → Company	Project team, AMG (Academic Managers Group), Company.	Presentation of our project to the company which will manufacture the Urban Node. Communicate with other interested parties of changes that could be introduced.	Mid-May	Presentation/Demonstration to the company which will approve our project.
Periodic Demos and Target Presentations	Specific Focus Groups or End Users. AMG (Academic Managers Group), Students, Power Users.	To gain input from special groups and keep them abreast of the Project's status. Evolution of the Urban Node manufacture.	Once product has enough to "show". As you complete critical phases or make major enhancements. → Planned for June	Presentation/Discussion with the Company.
Submission of Final Report	Project Team	Submission to the supervisor of the Final Report.	09/06/14	Report of the project. PDF or Word document.
Final Project Defense	Supervisors, Project team, Teachers, Company, Studies and students.	Presentation of the whole Project.	16/06/14	Presentation/Demonstration at Neapolis

- Stakeholders: "...any person or group who has a vested interest in the success of the project, i.e. either provides services to the project, or receives services from the project.
- Key stakeholder: "A person whose support is critical to the project – if the support of a key stakeholder were to be withdrawn, the project would fail."

Picture 6: Communication Plan of the project

3.5. The Business Canvas

3.5.1. Value Propositions

- What value do we deliver to the customer?

  Pedestrians can use the Urban Node as an informative point; they can get access to Internet, check whatever would be necessary. Our product has function of street lamp as well, it provides light on the street by LED lighting, and therefore in that matter it increases feeling of safety in surrounding. Urban Node is modern and well designed, it gives feeling of aesthetic to pedestrians, shape of it resembles idea of smart city that we would like to Vilanova i la Geltrú become in future. Urban Node has addition elements like energy generators: solar panel and wind turbine, they provide social benefit and increase awareness of renewable sources of energy among inhabitants.

- Which problems of our customer's are we helping to solve? Which customer needs are we satisfying?

  Our customer in case of getting lost can use Urban Node to confirm location, or to contact emergency services if dangerous situation would appear. We equipped Urban Node in mobile charger, as a result-discharged battery will not be a problem anymore. The Node will provide information and display data concerning weather for example: temperature, humidity, speed of wind etc.

3.5.2. Key Activities

For our Urban Node, we determined several key activities, which allow us to cell our product and to answer to our Customers requests. First of all, our product needs to be designed thanks to drawing software as AutoCAD or Solidworks. This is really important because when we will trough the production, the Company in association with us will need the technical drawing of this Urban Node and detailed as much as possible. We will have also to propose those technical drawing and all the specifications of our project to the Company. When the Company will accept specifications, the Urban Node Production will begin.

One point, which is really important before the installation of the Urban Node, is the Quality Controls. Indeed, I will allow us to know if the product, our urban node, is totally in accordance to our specifications. Otherwise, we will have to correct those problems in order this urban node works as we expected. When the Production will be done thanks to the company, we will have to deliver the product to the assembly place. Indeed, all the different parts of this Urban Node will be assembled to build it.

During the product delivering, for the Transportation of the production, we will have to do a small Packaging study, to know which kind of truck we will use to deliver the product and how it will be packaged in different parts on this one. About this transportation, there will not be problems of travel distance because most of the companies which we are in contact with in Catalunya, so even if during the delivering product there are traffic delays, it will not be a problem for the advance of our project. In order to know exactly where we are going, we created a Gantt chart and a Communication Plan. Those two management tools are really essentials for the success of the project because it allows us knowing exactly where we go, who is assigned to which tasks, how much time it will take, and also it allows knowing if we are respecting our deadlines or if we are in late.

3.5.3. Key Resources

The project Urban Node is a really complex project because it gathers a lot of different field of studies. Indeed, all those aspects will need to be taken into consideration: mechanical, design, marketing, management, cost analysis... That is why we needed team members with different backgrounds.

The team composition is the following one:

KNOPS	DIETER	Belgium	Constrution Industrial Engineer	University of Antwerp
NIXON	CALLEY-ANN	Great Bretain	Product Design	Nottingham
PENCIOLELLI	CESAR	France	Industrial Engineering	INSTITUT NATIONAL POLYTECHNIQUE DE GRENOBLE
SORIANO MARTINEZ	GERARD	Spain	Mechanic Engineering	EPSEVG
VILAIN	ANTOINE	France	Packaging Engineering	Université Reims Champagne Ardenne
WOJTKOWIAK	WERONIKA	Poland	Architecture Engineering	LODZ UNIVERSITY TECHNOLOGY

Picture 7: The Team

Even if in this team we don't seem all to be able to work on the same things, we can absolutely communicate and count on the other when we need their help. Every one of us is enough open-minded to realize the importance of the project and that every help is precious. We also need to know that our project is totally new and innovative. Nobody before already tried to create a post lamp street coupling renewable energies, street lighting and virtual tourism office. That is why we will apply a patent when we will be satisfied of our project and when we will have reached our goals, in order to respect our policy of intellectual property.

Moreover in this project, we are working in association with a three employers of the company Neapolis; a company specialized in innovation, in Vilanova. Those 3 members are also a precious help because they can advise us on what is the most important for the project steps and allows us to determine clearly where we have to go and how we get there, in other words, how to reach our goals at best.

In our project a Company will supply most of the Production of our Urban Node. Right now, we are searching for the best company, which could produce our Urban Node as soon as possible and by making sure that the quality will answer to our expectations. So, the Company in association with us will do the Production. They will be in charge of the production facilities, machines, all the manufacturing Process in their buildings. Of course it will be our task to define the manufacturing process but they will just have to apply it.

The communication also is really important in our project and it is probably one of the main assets to reach our goals. That's why in our project; we are using Facebook because a social network is really easy and useful to share information. With our customers, the company Neapolis that we are working with, we are exchanging information by e-mail.

3.5.4. Key Partnerships

From beginning of the project we have known that to find partners is the key for developing the Urban Node because we do not have any way for doing it for ourselves. So these partners are the most important step of the project and the key.

It has to remember that other steps of Urban Node are dimensions, materials, marketing, SWOT, etc. So for these reasons, it has to looking for a company/partner that can do the project as much possible close with our objectives. It not means that company has to do everything; objective of the company is help to become the project in a real lamppost doing a prototype in scale 1:1 and

then try to have clients, as it is possible. These key partners/companies have to produce and put the product on streets similar to our project. Also we have to know which kind of materials and technologies usually work to see if it is the best way for Urban Node. Providers give us the knowledge/key activities about company (for developing Urban Node): materials, manufacturing process, machines, cost analysis about every step and salaries, etc.

Selection process about which partners are better for us has been following two key resources. The first one has been the location, it means that it is important to have the company near project members because one of the objectives of them is visit the company and develop Urban Node. So this is the main point about company profiles. The other one has been professional and historical trajectory about the company. Also the projects have made until nowadays by company are important.

On the other hand we have support constantly from our supervisors from the university and from Neapolis Company. Their function in the project it is to help us to develop Urban Node and they try to guide us for doing every step as better as possible. Pau is the university's supervisor. He helps us in electronics fields because we do not have enough knowledge about it. Also he tells us everything linked with university. Josep and Felix are Neapolis' supervisors. Neapolis is the company that it has thought to build Urban Node. They say us about which lines we have to follow for doing Urban Node like objectives, budgets, functions, etc.

3.5.5. Customer Segments

- For whom do we create value with the results of our project?

Potential users of our product are pedestrians that hopefully would like to explore functions of Urban Node. To increase amount of users we equipped our product in a big touch screen that can combine the three options in one, size of it make it possible to use for adult, child and person on wheelchair. Sensor in screen will distinguish height of the person and present information at the height that would be needed. Other area of target market is Municipality Company that might take advantage of data collected by sensors placed in our product. We want to create valuable project keeping in mind features that are going to be substantial for interested manufacture companies, which might help us make our project more beneficial. In addition one of elements in our product is new generation antenna that would be interesting for telecommunication companies for which it would be possible to use it as a network transmission source.

- Who are the most important customers?

Our key customer is as well our most important partner. Neàpolis is an agency for technology focused on innovation, design, and entrepreneurship. They are providing education programming, space, and support to help collaborative practices and learning opportunities across a society stimulated by the entrepreneurial experience.

- Where do these customers get their satisfaction now?

Our project is innovative and combines lot of functions. There is not such product on the marker that can satisfy consumers listed previously at once; they can get their satisfaction in separate products. As an example, for pedestrians it would be informative points at streets, for manufacturing companies street lamps or architecture furniture. Companies collecting weather condition data can obtain that information from sensor-equipped products and network companies are using separately applied antennas.

3.5.6. Customer Relationships

Customer relationships plays a vital role in the success of the 'Urban Node' project as one of the main purposes of the function is user interface, which is the interaction between the user and product through the use of an electronic touch screen. The type of relationship that is required between both the user and the product is connection, interaction and information processes. The user needs to be able to understand and be able to interact with the interface; therefore it is imperative that the communication process is basic and simple for both participants. This can be presented through the performance of the product, the language preferences, display and layout and the use of colors and images.

The project is currently in the development phase, therefore there has been no definite decisions made regarding the functions of the user interface which results in no current relationships made between user and product as of yet. However, questionnaires and survey have been carried out in order to get a more in depth understanding of the users wants and demands for the node which can then be taken into great consideration when deciding the user interface functions.

By implementing user interface touch screens to the node, it is promoting and using a form of modern technology, working towards the process of Vilanova becoming a smart city. So the most significant way of being discovered by the target market of users would be through the use of other forms of modern technology, which can of course be done virally. An example would be social networks such as Facebook, Twitter and Instagram and their user population continues to expand. Another idea would be for the Node to have its own website where users can have the same interaction at home. However, this would need to be considered after the decision regarding user interface has been finalized.

As previously mentioned, surveys and questionnaire were carried out in order to understand and get an idea of what the users wants and needs are regarding the function of the Node. This form of primary market research can also be used to get information about the performance of the product and services. An effective idea would be to implement a life-size working prototype of the Urban Node into the town of Vilanova. Allowing local residents, tourist etc. to interact with Node, and then to fill out forms, surveys and questionnaires about their experience. Then using these results and the information gathered, the Node could be changed and adjusted accordingly. This will have a massive impact on the overall performance once the design is complete as it would have been improved and modified in order to meet consumer needs and the customer's relationship between the Node and user.

The most suitable way to attract our consumers is to make them aware prior to the implementation of the Node. This would build up the users anticipation and also create an awareness of the coming Product. An ideal example of this as previously discussed would be a life-size working prototype.

3.5.7. Channels

This building block describes the way an enterprise comes in contact with her customers. The marketing and distribution strategies will be explained here.

There are different channels the 'Urban node' will reach the customers. But first of all there needs to be an enterprise that is going to produce the 'Urban node' because this project is made by ideas of students in cooperation with 'Neapolis'. Neapolis is a city owned company. By sending mails and calling different enterprises we hope to find enterprises that are interested in

the 'Urban node'. If they are interested a presentation will be given for them to increase the change to convince them.

After an enterprise is found to work together with us we can use different channels to reach the customers. In the case of the 'Urban node' the customers we need to reach are cities who want to become 'smart' cities. 'Smart' cities has a lot to do with technology, so writing an article for a scientific magazine will increase the change of finding more customers. Another way to convince customers is by building a one-to-one prototype. Something people can see is always more attractive than ideas on paper. By inviting possible customers and giving a presentation to them the change is bigger to convince them. Especially when you also exhibit the product you want to sell. Making an interactive website will also increase the change of selling our product. Because of the modular parts of the 'Urban node' we can make an app on the website so customers can make their own 'Urban node' to their needs.

The website we just talked about is also a way to keep the customers up to date. If something changes about the 'Urban node' or there are more modules available this is the way to keep them up to date. Also for the customers who are interested there could be a mailing list to send newsletters.

A name is also important for a product for brand identity. The 'Urban node' purpose is to bring the residents of Vilanova together and connecting people, giving them information that they can share with each other.

The brand image we want to have is to make cities into smart cities. By gathering a lot of information of a city with different sensors and sharing it with the city we want to make smart cities. This information can also be shared with other cities or countries or eventually the world. The idea we have is to share information openly.

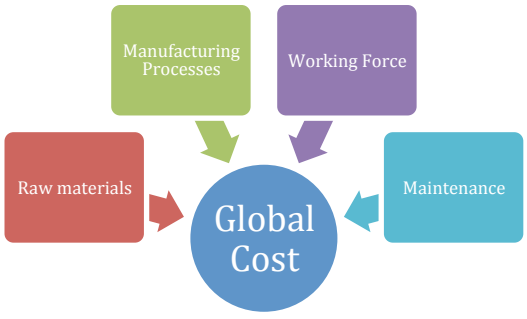
3.5.8. Cost Structure

The Urban Node is a complex product and therefore there many different cost breakdowns.

First you will find the Raw materials cost that goes with the pre-manufactured products such as sensors, wind turbine or solar panels. Such devices are quite expensive.

Secondly you have all the manufacturing cost to bend the steel to give the proper shape. The upper part will be made of fiberglass so here again it is really costly to manufacture such pieces.

Thirdly you have the working force cost. First for the manufacturing for example the operators you will have to pay. And then you have the cost from the maintenance. We do not know precisely what is going to be but it is something to take into consideration. The following figure summarizes those different costs linked to our product.



3.5.9. Revenue Streams

The Urban Node is a very innovative product. It is composed of many different features. Most of those features are linked to revenue streams. We have the wind turbine and the solar panels connected to the grid to power the node or to give it to the grid when it is not needed. Moreover we have many sensors that are meant to gather data that can be shared with the user such as temperature, air pollution, humidity and many others. There will be an antenna as well on the top of it in order to give a better connection for cell phone services.

Since it does not exist on the market yet, it is hard to evaluate the selling price. We know for sure that it will be an important source of revenue. But it is not the only type of revenue of our product. There are actually 3 of them. As mentioned previously these three streams are linked to the different features of want to include on the urban node.

Firstly, our product will produce energy thanks to solar panels and wind turbine. By connecting it to the grid, it allows us to sell this energy to the municipality. It is also important to notice that the efficiency of those panels and turbines is not good but in the years to come they should increase strongly which will be very beneficial for the revenue. It will enlarge the stream.

Secondly, one of the features we will have is a telecommunication antenna. With the increasing of service quality of phone operators, there is a strong need to add more and more antenna to the telecommunication grid. And we are going to get revenue from this since phone companies will be very interested to pay and get antenna of their own.
Thirdly, we will sell the data gathered through the sensors. An incredible amount of data such as temperature, humidity, air pollution and many others will be stored and they will be a source of a lot of information for studies for researchers but also infrastructure companies. People have been trying to link personal data with common data and we will be able to provide it to them. It is also going to interest city councils.

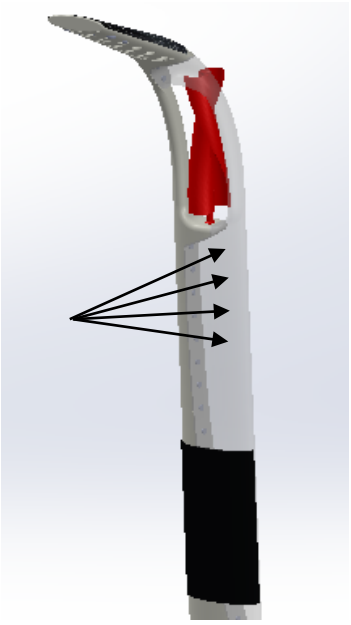
The different revenue streams have been detailed here but it is important to mention that it will be difficult to manage these 3 streams. They are completely different so they can be handled by only one person you need to have experts in each area that will be aware of the modalities and the possibilities our features offer so that the companies willing to use our node will be fully aware of every aspects.

4. Dimensions & Design

The dimension and the design of the Urban Node are probably the main aspect of our project because it will give the final appearance of our product. It needs to give the wish for the citizens to interact with this product using all its functions. That is why an attractive and designed aspect must be considered as a main objective.

4.1. Shape

The design of urban node is modern and eye-catching. Shape of it is streamlined that enable air to flow without any obstacles and go through turbine in most effective way. Urban node is made of steel 'spine' that can be connected with semi transparent lighting part. This part provides warm light on whole height of urban node, in contrast to usual street lantern light is not only delivered from above. (Schematized on the image opposite).



Picture 8: Lighting side part

Since the urban node is modular it is possible to remove lighting part in case of placing our product in places that additional light is not required. In that case the shape would be different, slimmer and curvier. Keeping this in mind it should be emphasised that Urban Node is not usual lamppost just with additional features, it is a multifunctional element of small architecture that can be adjusted to customer needs.

Idea of the shape and proportions of the design from previous year IDPS project was kept. Unfortunately, at the beginning, the technical drawings and other files with 3D model were missing, so our work had to be based on view of model plus drawing with height and size of interactive screen.

As a result, dimensions were estimated for further steps including calculations covering strength of materials and foundations.

- Height: 615 cm
- Foundation base: diameter 60cm
- Top of Urban Node: diameter 50cm
- Maximum height of screen: 182 cm
- Minimal height of screen: 88cm
- Section of the middle part 13x60cm

4.2. Elements of the Urban Node

Since the midterm report, solar panel was placed on the top of the urban node, because this place is exposed to sunlight the most. From the first assumptions the area of the circular surface was 0,196 m^2, it was not a lot, but it provides more social benefit than financial one. It is extremely important to increase awareness of usage renewable sources of energy. Solar panels create clean, renewable energy that will sustain and support the health of future generations. It supports national energy independence because solar electricity is used where it is generated. It was doubted if solar panel of that size is cost efficient, but we decided to leave it. In cost analysis in further parts cost benefit will be explained with details

Moreover, on the top we would like to place new generation antenna that would be responsible for Wi-Fi transmission. The adoption of smart antenna techniques in wireless systems is expected to have a significant impact on the efficient use of the spectrum, the minimization of the cost of establishing new wireless networks. After several researches, we found a model which could be usable: **5.8 GHz Omni Directional Antenna Series | 5725-5850 MHz, 8-12dBi** (Image opposite)

Picture 9: Model

For lantern it was decided to use LED lamp, main advantages of it are: long life, energy efficiency, ecologically friendly, durable quality, zero UV emissions, design flexibility, operational in extremely cold or hot temperatures, light dispersal, instant lighting and frequent switching, low-voltage. Place for putting sensors were under the LED lamp, we added small part there for reason of aesthetic, to hide sensors and use other material than steel (ex. fibre or PCV) not to affect results of measurements of sensors.

Following sensors were chosen to put in the Urban Node:

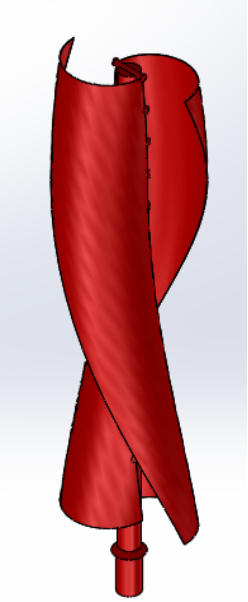
- Temperature sensor (information can be send to a weather database and also be projected n the screen for pedestrians)
- Barometric pressure
- Humidity sensor (sensor determines the humidity and gives accurate local measurements),
- Light sensor (this sensor is used for determining the brightness level of the screen and also it can choose when the light should be turned off)
- Infrared sensor (sensor is used for detecting the movement, if no one is present, the sensor shuts off the interactive screen)
- Decibel sensor (determine noise level, let the people a know if their environment is in accordance with standards)

Next element in the Urban Node is a wind turbine, near it was placed sensor that could measure:

- Speed and direction of wind (anemometer can examine if weather conditions are convenient for going to the beach to surf or sunbath. The wind turbine can shut off in case of critical wind speeds.)

- Pollution of the air (air quality sensor can check amount of: NH3, NOx, alcohol, benzene, smoke and CO2. Air pollution can be observed and steps can be taken to improve it regularly)

The vertical wind turbine is red, it marks out from rest of urban node. The purpose was to attract attention of pedestrians and make them more aware of renewable sources of energy, in that case wind.



Picture 10: Wind Turbine

For safety purposes Urban Node was equipped in CCTV Camera System. Main advantage is that it helps deter crime. The attendance of CCTV camera system for supervision will decrease little thefts and vandalism in the surrounding area. Since the actions would be monitored, less dangerous situations are likely to be created. Data from CCTV Camera System might be helpful as a proof in lawsuits. In legal cases of robbery and other forms of crime, videos and images given by the CCTV camera system can be provided as valid evidence. This supports making legal claims as well. Monitoring systems help maintain records, the images and videos captured by a camera system can be recorded and stored in the database. That would increase quality of public safety and security. On the image below are presented all the different type of CCTV Camera system that we could add on the Urban Node.

Picture 11: CCTV Camera's

In the lower part of urban node there is a screen. An idea from previous year project about big interactive one was kept. This solution includes a big touch screen that can combine the three options in one. Size of it enables usage for adult, child and the person on wheelchair. The infrared sensor can detect height of the person and display information at the height that would be necessary. The touch screen has a height approximate of 92,2 cm. All of the electronic parts and boxes will be placed in base of the Urban Node for easy accessibility if break down will occur.

Picture 12: Urban Node

4.3. Changes after midterm defense

Since midterm report it was managed to get technical drawings and 3D model made in Creo from previous year project. As it was mentioned on the Gantt Chart part, it is in the middle of May that a student of the last year project answered us and passed the drawings on to us. It was finally considered that the drawings were usable and so we used them to continue on our project.

As a result our first assumptions about dimensions that were calculated from proportions and two known dimensions turned out different. In that case it was decided to leave dimensions as

they were designed in 3D model file. In following height of Urban Node is 4,75m, from the ground to the top, instead of 6,20 that we assumed at the beginning. Now, including the dimensions of the foundation, the height of Urban Node reaches 5,05 meters. Thanks to 3D drawings we realized that the real area of solar panel is bigger, whole sloped blade can be covered with solar panels, area of it is 0.449m2

All elements that were planned to put inside Urban Node were kept, but to make it easier to maintain all sensors and computer would be placed in box in back part of Urban Node instead of placing some of them under the wind turbine.

Finishing layer of a steel part of urban node is paint, so it can be coated to surrounding that would be placed. It is really important for pedestrian perception that Urban Node can match architecture nearby and colour of one Urban Node is not dependent to others. Modern design and freedom of choosing colours will enliven the perception of Urban furniture in Vilanova i la Geltru, but at the same time will not stand out enough to disrupt the uniform character of public spaces.

4.4. Summary

To conclude, decisions that were made regarding this project fulfilled objectives given at the beginning. In consequence design is well thought out and justified. It was managed to keep pleasant design and make urban node easy to maintain. Energy generators provide "green" energy to grid making this product eco friendly. Thanks to modular aspect that is satisfied Urban Node can be changed in way that would be necessary in particular place. Interactive screen enable usage to any potential pedestrian: child, adult and person on a wheelchair. Multifunctional aspect is uncontested, all elements that urban node include make it universal architecture element.

5. Materials

In this part of the report there will be an explanation about the different kind of materials that were possible to use. By comparing the materials on different subjects (cost, strength, production) there is made a conclusion on what material is best to use.

5.1. Steel

Steel is a common used construction material. It's an alloy made up from iron and carbon. Typically the amount of carbon in a steel alloy is below 2,06 % depending of the chemical composition, above this limit they start speaking about other iron alloys like casting iron etcetera. Due of the carbon (and other alloying materials) the steel reaches its high tensile strength, hardness and ductility. Most common steel categories are S235, S275 and S355.

Picture 13: Steel plates

Construction steel has a couple of specific characteristics:

- Low carbon percentage
- Relatively soft material
- Forming: both cold and hot possible
- Good weld ability
- Big elongation

The density of steel varies between 7750 and 8050 kg/m^3. This depends of the different kind of alloying elements. The density of the material of the urban node is important because of the total weight of the urban node. A bigger density could mean that the urban node is going to be heavy. This is not the case for steel. Because of the good characteristics of the steel like high tensile strength etcetera they can keep the thickness of the steel very thin.

An extra plus about the steel is the cost. Steel is a common used construction material so there is a high production of steel what keeps the price down. The price varies between 400 and 600 euro's for normal construction steel for high numbered orders.

Corrosion is a disadvantage of steel. Because the urban node will be placed outdoors (Rambla and seaside) it should be protected against corrosion. A solution for this is going to be studied later on the semester.

Another disadvantage of using steel for whole the urban node is the interference with transmitting signals (WIFI). The inside of the urban node will work like a 'cage of Faraday'. But an easy solution to this is to put all of the transmitting signals outside the 'cage of Faraday'.

The production faze of the urban node with steel is quit easy. Welding the different parts together is the best and cheapest solution.

5.1.1. Corrosion

A characteristic of steel is that it can rust when it comes in contact with water. In Vilanova i la Geltru the Urban node will be in contact with rain, seawater and dogs piss. That's why there needs to be a protection of the steel because otherwise the strength of the steel will be lower. There are a couple of solutions to protect the steel.

The options are:

- Rust-resistant alloy
- Galvanization
- Cathodic protection
- Coatings and painting
- Bluing
- Inhibitors
- Humidity control

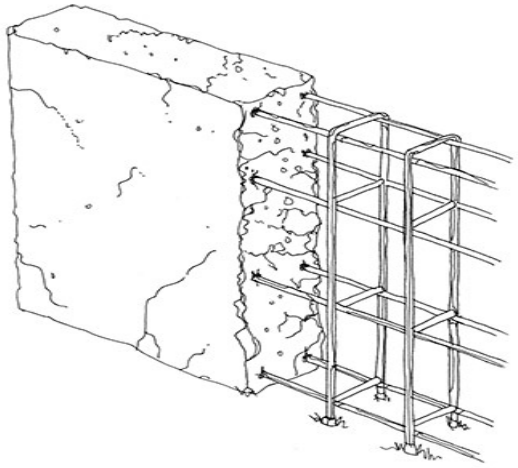
Picture 14: Corrosion

Some of these are not useful because they are not possible (humidity control, inhibitors (for inside systems)). Bluing cannot be used as well because it uses a water-displacing oil to protect. Because this is a product that people can use and touch this solution is also not good.

Now there are 4 left that are useful. But one of them is more useful than the others. Rust-resistant alloy, galvanization and cathodic protection are all very good to protect the steel from corrosion but coating and painting have an extra advantage. The Urban node needs to be painted anyway because it will not have the colour of the raw steel. The paint will isolate the steel from the environment. A disadvantage of this is that it needs to be maintained (a paintjob every year or every couple of years). But this needs to happen anyway so it seems like the perfect solution.

5.2. Reinforced concrete

Reinforced concrete is a combination of concrete and reinforcing bars. Concrete is capable of withstanding high compressing forces but it has no good resistance against tensile forces because of its granulated structure. The granules are kept together by cement. The strength of the concrete is determined by the strength of the cement. If the tensile forces on the concrete are to high there will be forming of cracks. If a crack gets formed the tensile forces will concentrate themselves around that crack and finally the concrete will fail. This is where the reinforcing bars have their function. When the tensile forces are to high for the concrete the reinforcing bars will take the forces. To be economically the structure is calculated and so they can see where the biggest chance on failing/cracking is, this is the place where the reinforced should be placed.



Picture 15: Example of reinforced concrete

Some other characteristics of reinforced concrete:

- Concrete and steel attach good together
- Thermal compatibility (no internal stresses will happen when the temperature changes)
- The concrete will protect the steel from corrosion.
- A good resistance to damage because of fire

The density of reinforced concrete is 2500 kg/m^3 depending of the amount of reinforcing bars. This is low, but the thickness of the reinforced concrete needs to be much thicker. This is because of the concrete coverage of the steel bars and the lower strength then steel.

The cost of reinforced concrete itself is not high. But because of the 'strange' design of the urban node the cost will be higher. This is because of the framework to pour the concrete and let it harden. The cost and working hours to build the framework will increase the total price of the urban node.

5.3. Fiberglass

Fiberglass is a fiber-reinforced polymer made of a plastic matrix reinforced by fine fibers of glass. These glass fibers are especially used as an optical fiber for telecommunication. It's a good way to transport light (signals) over long distances. But for the use of the urban node there will be no explanation about this use of the material. There will be an explanation about the structural use of glass fibers.

If they compare fiberglass with carbon fiber they see that the strength properties of fiberglass are a little lower and it's not as stiff. But the advantage of fiberglass is the cost of the raw materials; it's less then carbon glass. Also the material is less brittle. Other important properties of fiberglass are: lightweight, robust and could be used for many products (like the urban node).

Picture 16: Fiberglass mat

The density of fiberglass is around 2550 kg/m^3. This is low and because of the good strength characteristics the thickness of the urban node can be made very thin.

Another aspect that should be spoken about is the production. Making fiberglass constructions is a labor-intensive work. First of all there should be made a mall. If it is just a couple of the same constructions it is most cost efficient to make a new mall for every construction. But if it is for mass production they should think about making a fixed mall that could be used a couple of times. This is more expensive, but for mass production this cost will return itself. After the mall is made the production of the actual structure can start. This needs to be done in different layers, so it needs more time what means an extra cost.

So the total cost is going to be high because of the production part and also because of the high cost of the raw materials.

5.4. Vubonite

Vubonite is a material that was in research by the University of Brussels. It is made with Inorganic Phosphate Cement (IPC), it's the same material that dentists use for filling up holes in a teeth. When it is processed it is similar to polyester, but when it's hardened the characteristics are more like ceramics. A couple of advantages:

- No toxic gases while producing
- Tools can be cleaned easily by water
- No use of ceramic furnace necessary

The strength characteristics of Vubonite are very good; they are even better then fiberglass. Also like the fiberglass they can keep the thickness of the urban node very thin because of the low density.
But Vubonite has the same disadvantage as fiberglass. The production of the mall and making the structure itself takes time. This will increase the total cost. And with the high cost of the raw materials the total cost will be high.

5.5. Conclusion

In this conclusion there will be a comparison between the proposed materials. The items that are most important for the urban node are shown in the table below.

	Steel	Concrete	Fiberglass	Vubonite
Density (kg/m^3)	7800	2500	2550	Low
Strength	Strong	Ok	Strong	Very strong
Thickness	Thin	Thick	Thin	Thin
Cost	Cheap	Cheap	Expensive	Very expensive
Corrosion	Possible	No	No	No
Production	Easy	Easy	Difficult	Difficult

Picture 17: Table of comparison between the different materials

Vubonite scores the best on strength characteristics so this seems a good solution for the urban node. But the disadvantage of this is the total cost. They should try to make the urban node as cost efficient so this material is not good for this project. Also fiberglass has good strength characteristics but it has the same problem as the Vubonite. It is not cost efficient.

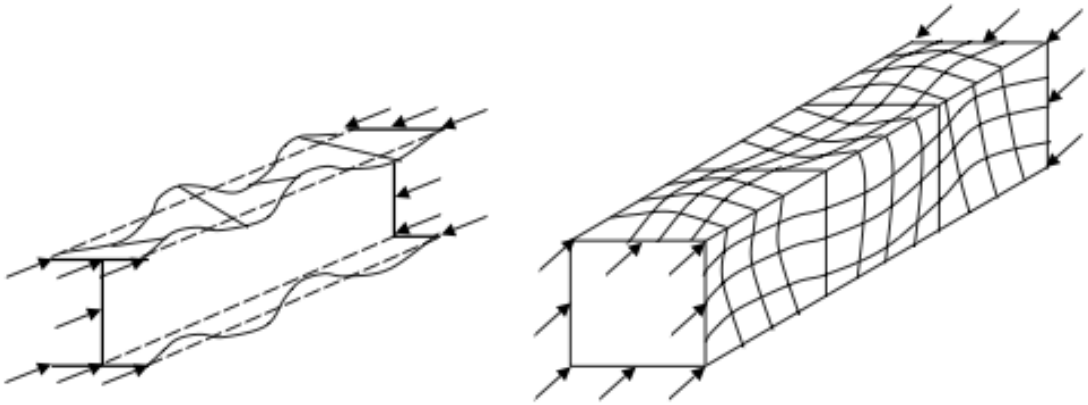
Steel and concrete don't have the problem of this high total cost. So these materials seem more useful for this project then the others. The problem with concrete is the thickness that we need to maintain. Because the urban node needs to be 14 centimeters at its smallest this material is also not the best to use, especially because there also needs to be place to put sensors and wiring.

With steel this problem will not be there. The thickness of the plates can still be very thin so there will be still be place enough to put the sensors. And the strength characteristics of this material are good enough for this project. The only problem with this material is that there can be corrosion. For this problem there are solutions like protective paint. The choice of the protection will be further explored in the continuation of the project.

6. Strength Analysis

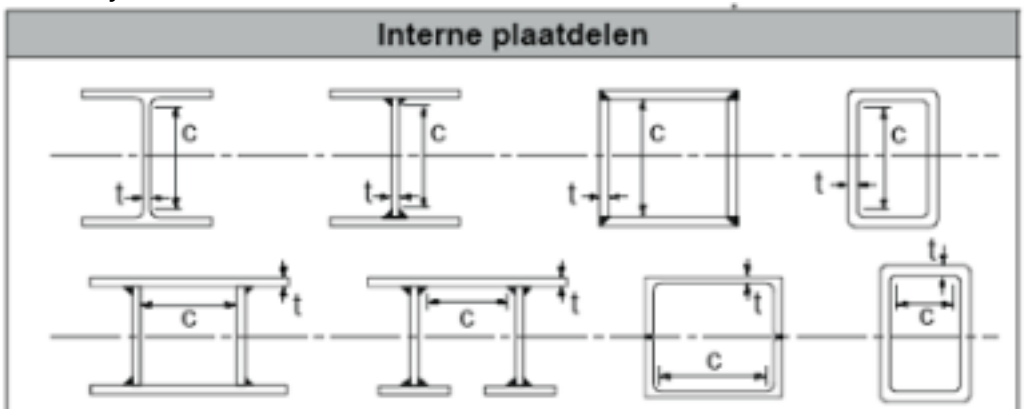
6.1. Classification of sections

Now that the material is chosen a strength analysis can be made of the urban node. To calculate the structure a simplification is made because the shape of the urban node is not a normal shape. The simplification is a hollow rectangular profile that goes from top to bottom. By using 'Eurocode 3' the classification of the sections will take place. This classification will depend on the slenderness of each part and the distribution of the compressive forces in the sections. There are 4 classifications, where classification 1 is better than classification 4. If a section is not strong enough local buckling can take place.



Picture 18: Local buckling

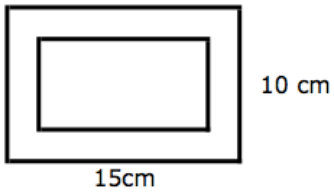
To classify the section tables will be used, like the one below.



Doorsnedeklasse	Belast op buiging	Belast op druk
1	$c/t \leq 72\cdot\varepsilon$	$c/t \leq 33\cdot\varepsilon$
2	$c/t \leq 83\cdot\varepsilon$	$c/t \leq 38\cdot\varepsilon$
3	$c/t \leq 124\cdot\varepsilon$	$c/t \leq 42\cdot\varepsilon$

Picture 19: Classification of sections

At the left there are the different kind of classifications with at the right of them the different requirements for load on bending and compression respectively. As said as before there will be used a simplification of the urban node to calculate the structure. The section of the urban node will be calculated like the following section. The thickness of the steel will be 5 millimeters and the quality of the steel is an S 235.



Picture 20: section of the urban node (simplification)

Now the control of the classifications can take place.

Steel: S 235 Yield strength = f_y = 235 N/mm² Elastic modulus = E= 210000 N/mm²

$$Strain = \varepsilon = \sqrt{\frac{235}{f_y}} = \sqrt{\frac{235}{235}} = 1$$

The thickness of the steel is know so 'c' and 't' can be taken out of the drawing.

$$Transversal \rightarrow \frac{c}{t} = \frac{14}{0{,}5} = 28$$

$$Longitudal \rightarrow \frac{c}{t} = \frac{9}{0{,}5} = 18$$

With this information the control of classification can take place.

Classification 1:

Load on bending	Load on compression
$\frac{c}{t} \le 72 \cdot \varepsilon$	$\frac{c}{t} \le 33 \cdot \varepsilon$
$\frac{c}{t} \le 72 \cdot 1 = 72$	$\frac{c}{t} \le 33 \cdot 1 = 33$

For both load on bending and load on compression the conditions for classification 1 are OK. So the strength analysis continuous with the formulas of classification 1.

6.2. Control on buckling

The steel profile will now be controlled for buckling. Here for the reduction factor for buckling 'X' needs to be calculated. If 'X' is smaller than 1 it should be used in the formulas and than they speak of a slender profile. The main formula for the reduction factor is:

$$X = \frac{1}{\phi + (\phi^2 - \bar{\lambda}^2)^{0{,}5}} \le 1$$

With the following factors:

Eulerian slenderness: $\lambda_1 = \pi\sqrt{\frac{E}{f_y}} = \pi\sqrt{\frac{210000}{235}} = 93{,}91$

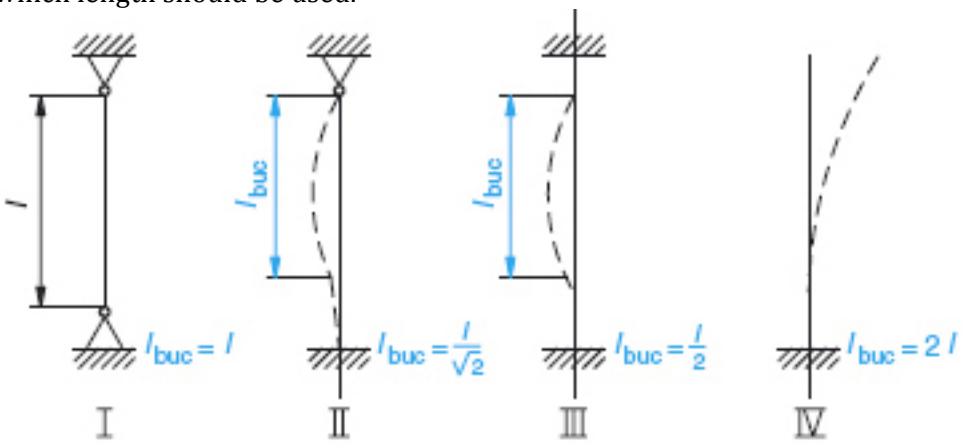
The radius of gyration 'i' should be as smallest as possible so the highest slenderness is reached. Here for the biggest moment of inertia 'I' is chosen.

Moment of inertia:

$$I_{total} = I_{Outerprofile} - I_{Innnerprofile} = \frac{b \cdot h^3}{12} - \frac{b \cdot h^3}{12} = \frac{150 \cdot 100^3}{12} - \frac{140 \cdot 90^3}{12} = 4000000 mm^4$$

Radius of gyration: $i = \sqrt{\frac{I}{A}} = \sqrt{\frac{3995000}{15 \cdot 100 - 14 \cdot 90}} = 40{,}8 mm$

For the slenderness the length of buckling (l_{buc}) should be decided. Next picture shows which length should be used.



Picture 21: length of buckling

Like the fourth picture the Urban Node has just one clamping. Therefore the length of buckling will be 2 times the real length.

The slenderness is calculated as following:

$$\lambda = \frac{l_{buc}}{i} = \frac{2 \cdot 6000}{40{,}8} = 294$$

The relative slenderness is like this (with $\beta_A = 1$ for classification 1, 2, 3)

$$\bar{\lambda} = \frac{\lambda}{\lambda_1}\sqrt{\beta_A} = \frac{294}{93{,}91}\sqrt{1} = 3{,}13$$

Now there is only one factor left to calculate:

$$\Phi = 0{,}5 \cdot (1 + \alpha \cdot (\bar{\lambda} - 0{,}2) + \bar{\lambda}^2)$$

Here is α the imperfection factor. To decide this factor first the buckling curve needs to be chosen with following table.

Cross section		Limits	Buckling about axis	Buckling curve: S 235, S 275, S 355, S 420	Buckling curve: S 460
Hollow sections		hot finished	any	a	a_0
		cold formed	any	c	c

Picture 22: Selection of buckling curve for a cross-section

This part of the table is about the hollow sections, like the urban node is. The quality of the steel is S235 and it is cold formed. Therefore buckling curve 'c' is chosen.

	a_0	a	b	c	d
α	0,13	0,21	0,34	0,49	0,76

Picture 23: values of the curves

So the value for the imperfection factor is 0,49.

So: $\Phi = 0{,}5 \cdot (1 + \alpha \cdot (\bar{\lambda} - 0{,}2) + \bar{\lambda}^2) = 0{,}5 \cdot (1 + 0{,}49 \cdot (3{,}13 - 0{,}2) + 3{,}13^2) = 6{,}1163$

Now the main formula for the reduction factor can be completed:

$$X = \frac{1}{\phi + (\phi^2 - \bar{\lambda}^2)^{0{,}5}} = \frac{1}{6{,}1163 + (6{,}1163^2 - 3{,}13^2)^{0{,}5}} = 0{,}08 \leq 1$$

Because of this it could be said that the profile of the Urban Node is slender and the calculation can be continued like a slender profile.

6.3. Compression load

Now the load on compression $N_{compression}$ can be calculated:

$$N_{X,Sd} \leq N_{b,Rd} = \chi \cdot \beta_A \cdot \frac{A \cdot f_y}{\gamma_{M1}} = 0{,}08 \cdot \frac{2400 \cdot 235}{1{,}1} = 41018N = 41{,}08kN$$

The Urban Node weighs 200 kilograms so around 2000 N.

$$N_{X,Sd} \leq N_{b,Rd}$$
$$2000N \leq 41080N$$

So the Urban Node can withstand the compressive forces.

6.4. Bending load

The load on bending can be calculated as well:

- Capacity of the section for V_{Sd}
  Sections who are loaded on bending and where no holes for bolts are located and for which:
  $V_{Sd} \leq 0{,}5 V_{pl,Rd}$
  can work on full moment capacity.
  $2kN \leq 0{,}5 \cdot 41{,}08$
  $2kN \leq 20{,}52kN \rightarrow OK$
- Design value for bending moment M_{Sd} must conform to:
  $M_{Sd} \leq M_{C,Rd}$
  $M_{C,Rd}$ is obtained from the following table:

	Klasse 1 of 2	Klasse 3	Klasse 4
$M_{y,Sd} \leq M_{cy,Rd}$	$M_{pl,y,Rd} = \frac{W_{pl,y} f_y}{\gamma_{M0}}$	$M_{el,y,Rd} = \frac{W_{el,y} f_y}{\gamma_{M0}}$	$M_{eff,y,Rd} = \frac{W_{eff,y} f_y}{\gamma_{M1}}$
$M_{z,Sd} \leq M_{cz,Rd}$	$M_{pl,z,Rd} = \frac{W_{pl,z} f_y}{\gamma_{M0}}$	$M_{el,z,Rd} = \frac{W_{el,z} f_y}{\gamma_{M0}}$	$M_{eff,z,Rd} = \frac{W_{eff,z} f_y}{\gamma_{M1}}$

Picture 24: table for bending moments

Again classification 1 is taken.
First the resistant moments need to be calculated:

$$W_{pl,y} = \frac{b_{out} \cdot h_{out}^2}{6} - \frac{b_{in} \cdot h_{in}^2}{6} = \frac{150 \cdot 100^2}{6} - \frac{140 \cdot 90^2}{6} = 61000 mm^3$$

$$W_{pl,z} = \frac{b_{out} \cdot h_{out}^2}{6} - \frac{b_{in} \cdot h_{in}^2}{6} = \frac{100 \cdot 150^2}{6} - \frac{90 \cdot 140^2}{6} = 81000 mm^3$$

Now the bending moments are possible to calculate:

$$M_{pl,y,Rd} = \frac{W_{pl,y} \cdot f_y}{\gamma_{M0}} = \frac{61000 \cdot 235}{1,1} = 13031818 Nmm = 13031 Nm$$

$$M_{pl,z,Rd} = \frac{W_{pl,z} \cdot f_z}{\gamma_{M0}} = \frac{81000 \cdot 235}{1,1} = 17304545 Nmm = 17304 Nm$$

As a last part the moment that grabs on to the Urban Node needs to be calculated. Here for the weight of the eccentric forces will brought into the calculation. This means the wind turbine that weighs 5 kilogram and is 30 centimetre out of centre. And also the top part with the solar panel that weighs around 50 kilograms and is 0,75 meter out of centre.

$$M_{Sd,y} = 50N \cdot 0,3m = 15Nm$$

$$M_{Sd,z} = 500N \cdot 0,75m = 375Nm$$

As a conclusion for the bending moments it can be decided that also this is strong enough.

6.5. Conclusion

So in total the Urban Node is strong enough for the different kind of forces that come on to the Urban Node. Calculated with the formulas given in Eurocode 3 the Urban Node is strong enough with steel plates of 5 millimetres.

7. Companies Research

7.1. Initial situation

The first step of the process of the company research has been focused to the development of the Urban Node. This is one of the main objectives for this project.

Different companies have been taken into consideration focusing on which one would be better to develop the project. These kinds of companies are Manufacturers as well as Infrastructure.

The Companies that are described are very important for the project because there has not been a set budget to develop Urban Node and it should be as efficient as possible in order to save money through these kinds of companies.

It is important to remember that previous steps of Urban node were to specify dimensions, materials, marketing, etc. So for these reasons, we are looking for a company that can help with the project as much possible keeping close with the objectives as previous explained. It does not mean that company has to do everything; the objective for the company is to help the project in a real lamppost by creating a prototype and then try to have clients, as it is possible.

7.2. Contact

This point explains how we have been in contact with the companies. It's completed in two different ways. The first option was a formal letter and after, a presentation about the project, Urban Node.

Letter:

A letter was written to companies for contact with them first time by email. In this letter it explained everything about Urban Node (who composes the project, objectives of the project, university, etc.)

After the letter was sent, the answer of every company does not depend on project members. If there is an answer from a company, the next step will be to have a meeting with their supervisors if possible, to speak about Urban Node and show the presentation of the project. This would also be beneficial to try to see the company for example their offices and workshops.

The letter can be seen and read in Annex 5.

Presentation:

After the letter comes the presentation like it mentioned before. Presentation can do by PowerPoint if company has a projector or by printed sheets (PDF).

Presentation has two objectives, show the project parts to company explaining every
Detailed part and try to convince the company to develop Urban Node. The parts showed are:
dimensions, materials, marketing plan, SWOT analysis, Gantt Chart, etc.
Also it shows every mail have sent or have received in Annex 6.

7.3. Companies

In this point it is explained an introduction of every company has been sought and interesting to develop Urban Node.

First of all it can see a list (table 5.3) of some companies searched. This table has four main company details. The list follows the next structure:

- Left column shows the company's name.
- The next one says the company's location as address and city.
- Third column expresses the company's number.
- Right column is written the email of the company.

Company	Location	Phone number	Email
Fundición Ros iluminación	Dr. Almera, 30 (Sabadell)	937263799	info@rosiluminacion.com
Alart - Punt Verd il·luminació S.L.	Sta. Anna 117, 1º (Cerdanyola del Vallés)	935805050	—
Benito Urban	Llevant 17, (St. Bartomeu del Grau)	938889730	info@benito.com
Ado S.A.	Acer, 37-43 Pol. Ind. (Badalona)	934560303	ado@adosa.es
GyC Solar	Avda. Hacienda Sant Antonio, Pol. Ind. (Sevilla)	954999939	fabrica@gycsolar.com / gyc@gycsolar.com
Abertis S.A.	Avda. del Parc Logistic, 12-20 (Barcelona)	932305000	abertis@abertis.com
Grupo Arelsa	Cra. Sabadell-Granollers, km 13,3 (Lliça de Vall)	938445280	arelsa@arelsa.com

Picture 25: Table of the list of the companies for the project

Selection process has been following two lines. The first one has been the location, it means that it is important to have the company near project members because one of the objectives of them is visit the company and develop Urban Node. So this is the main point about company profiles. The other one has been professional and historical trajectory about the company. Also the projects have made until nowadays by company are important.

Then it shows a few of information about every company. In explanations it sees the logo of company and his purpose nowadays like objectives of company, his work, products, technologies, etc.

Fundición Ros Iluminación is a leading company in the field of public lighting, with important works at National and International level. The long experience in the field has allowed him to have a wide range of products, both as luminaire supports, resulting in two distinct lines: Classic Line and Modern Line.

Always concern for environmental issues, their lights are constantly evolving for energy efficient lighting solutions, both with discharge lamps such as LED technology, responding to the current and future demand for energy savings.

Alart - Punt Verd Il·luminació is a company dedicated to the production and marketing for outdoor luminaries.

One of the most prominent and accredited by customers is the quality characteristics of the materials of manufacture of all our products in all the quality of the raw material is unquestionable, the prevalent use of stainless steel, aluminum and glass, materials high resistance to environmental etching. This is essential to offer, from the beginning of the manufacturing process, a guarantee of reliability and durability in the luminaries.

Benito Urban controls the entire production process, from product design, manufacture, distribution and sale. Offers 4 product lines including, Street Lighting, Street Furniture, Covers and Grills, Playground and Sports Equipment with over 6,000 references.

Urban Benito pays special attention to quality, design and innovation. In regard to design and product development, the company has registered more than 500 patents focusing on new ways to innovate their products, materials and designs in line with the latest trends, adapting their products to the needs and behavior of users.

Ado is a company specialized in urban facilities and public roads with the objective of improvement and maintenance of cities.

The team members is in constant research, developing and improving them products, adapting them to the needs and existing technologies.
They offer top quality and service with very competitive prices, offering a wide range of possibilities. Being manufacturers can adapt and customize their products according to customer needs.

GyC Solar designs and manufactures solar lamps for public lighting, contributing to the optimization of natural resources. GyC believe in the need to take priority as energy application photovoltaic solar energy as a solution to the demand for electricity for lighting our environment.

His business is in the manufacture sale and distribution marketing various solar PV applications for street and urban lighting in solar street lights and other applications that require light signaling solar powered .

Their great experience over the years supports us, and enables the lamps GyC are already present in the whole National Road illuminating, squares, residential areas, urban and natural parks, trails, sports facilities and municipal cemeteries.

Abertis telecom is positioned as the market leader in the segment of infrastructure and services terrestrial telecommunications operator in Spain and international reference in the field of satellite transmission, after becoming a member reference operator Hispasat (57.05%).

Abertis telecom facilitates the incorporation of new services in the TDT environment as emissions testing in HD. The company also contributes in the field of technological innovation to develop solutions aimed at setting up smart cities, called "Smart Cities".

Arelsa Group closely follows the market and it pleased to offer advanced solutions to future problems.

Building on its experience earned in over 20 years of urban remote management has developed a new family of products that facilitate the management of an actual Smart City, offering connectivity, synergy, intelligence and efficiency to all urban services.

His solution for the Smart City is a reality: tested both in laboratory and in the street, provide a complete, reliable, open, and fully customizable to each customer and product installation.

After explanations, it can tell most companies searched are manufacturers except Abertis that is an infrastructure company. Also some companies can do the infrastructure work, so both objectives can be done at same time.

7.4. Conclusions

This experience has shown how it is possible to design and implement the ideas in order to work with a company to carry out the project as in life itself.

Moreover, the implementation of such initiatives requires an appropriate institutional and organizational context. There should be a consistency between what the company requires and what lives on campus (students), level of experience, willingness to work and learn.

Finally say that the experience has also consistently shown that "the resistance of students" is usually a topic sometimes argued. Such resistance is inversely proportional to the enthusiasm of the company. It's very different to notify the company that something is done because it forces the university that explain to company the benefits that will be achieved with the implementation of the project "Urban Node".

8. From the Modeling to the Manufacturing

8.1 The 3D model

For every type of project, when Engineers are working on the research and the development of a new product or a new device, all the time, drawings are created, done by hand of thank to a modeling software.
Last year, the IDPS student in charge of the project made some drawing to have an idea of how could look like their Urban Node. For this they used Creo Parametric, Spanish software of 3D modeling and Solidworks, which is probably the most known software for 3D modeling.
Most of the drawings made last year were answering to our request and what we expected about the functions of the Urban Node.
The problem is that between last year and this year, those drawings were not easy to find out. After several week of research, asking to Neapolis or to the UPC, we conclude that the 3D drawings were missing and that we had to contact the last year project team to get them.

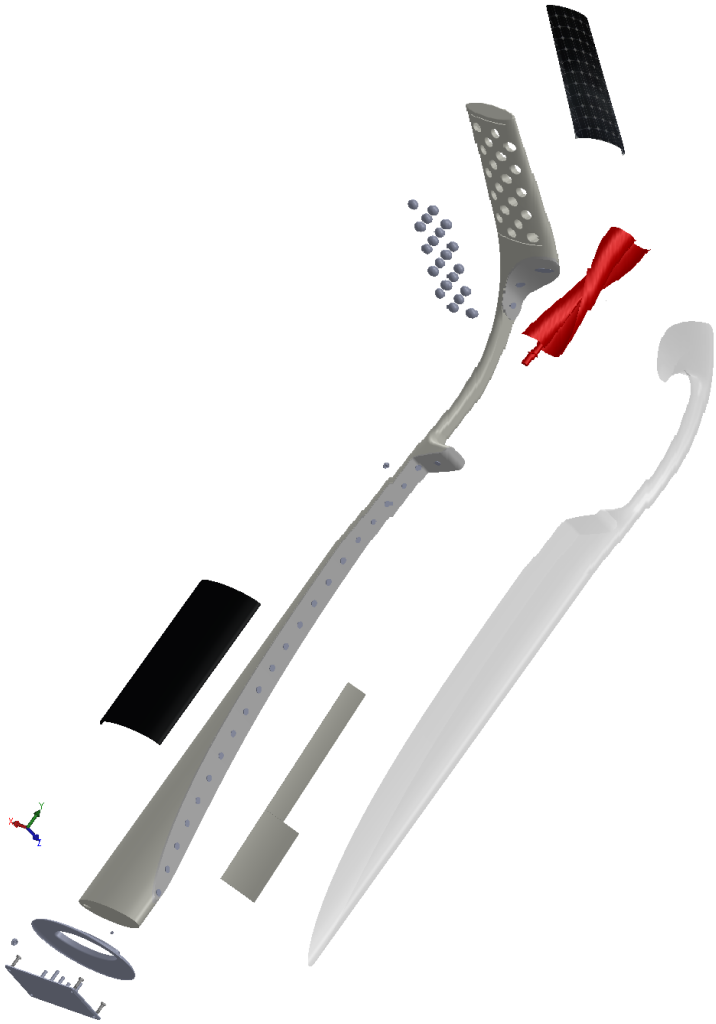
The task was laborious and not easy. Around Mid-April, we sent messages to the students explaining them the problem and one week after we received an answer. We succeeded to get some drawings but in fact only the base of the Urban Node. All the others elements were missing. We contacted another time the students of last year, around mid-May and another one answered telling us that she found everything.

When we received the files, we had to search what was the software used to read those drawings because the ".igs" is not an extension widely used for the 3D modeling. It is more an extension used to give a general view and aspect of every type of drawing, also called a rendering.

The fact also is that when we open the assembly file, we realized that the Wind turbine was missing. It is one of the main pieces that we redrew to complete the 3D model.

As we can see on the right, we realized an exploded view of the Urban Node. As we told at the beginning, the Urban Node needed to be designed and in the same time easy to produce, meaning without a lot of pieces.

Of course the main part of the Urban Node, the trunk, which will support the wind turbine and the solar panel is big, but this element will be separated in different part to facilitate the manufacturing process.
It will be the same for the transparent part of the right of the exploded view.



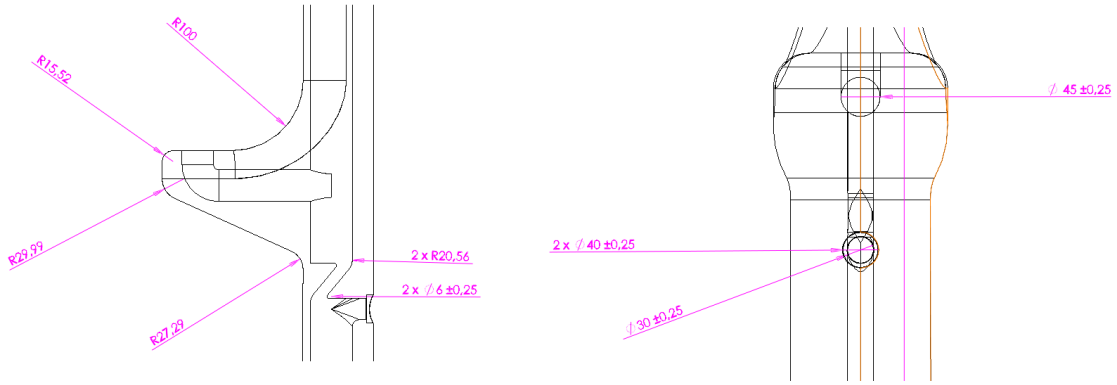
Picture 26: Exploded view of the Urban Node

8.2. The Technical drawings

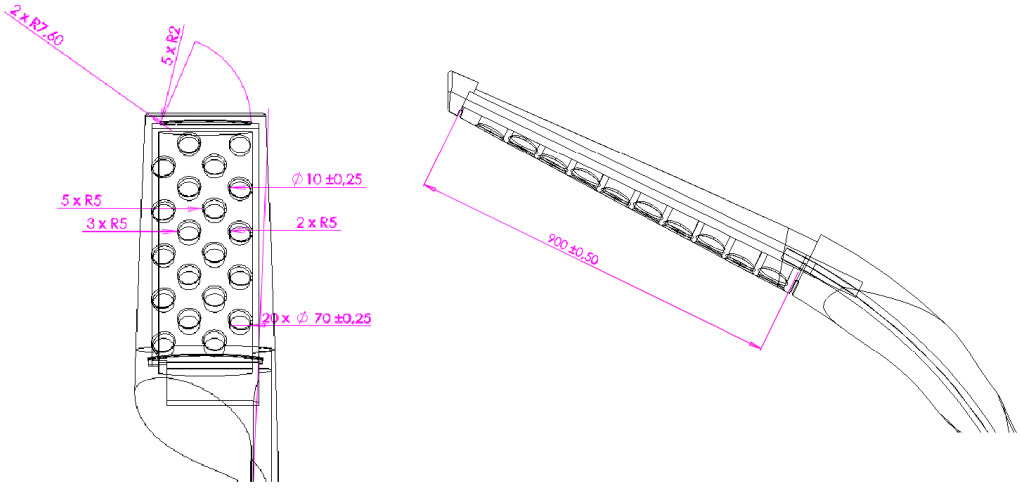
In the world of the Industry, every product and every object which are submitted to a manufacturing process have to be clearly defined by some plans, some technical drawings, which explain precisely the dimension and the size of every piece of the product.

For this, we made a lot of drawings, which could be used by the company Abertis for the manufacturing process in a close future. Indeed, thanks to a motivation letter and some e-mails exchanged, we succeeded to get a partnership with the company Abertis that will produce this Urban Node when all the technical drawings will be transmitted.

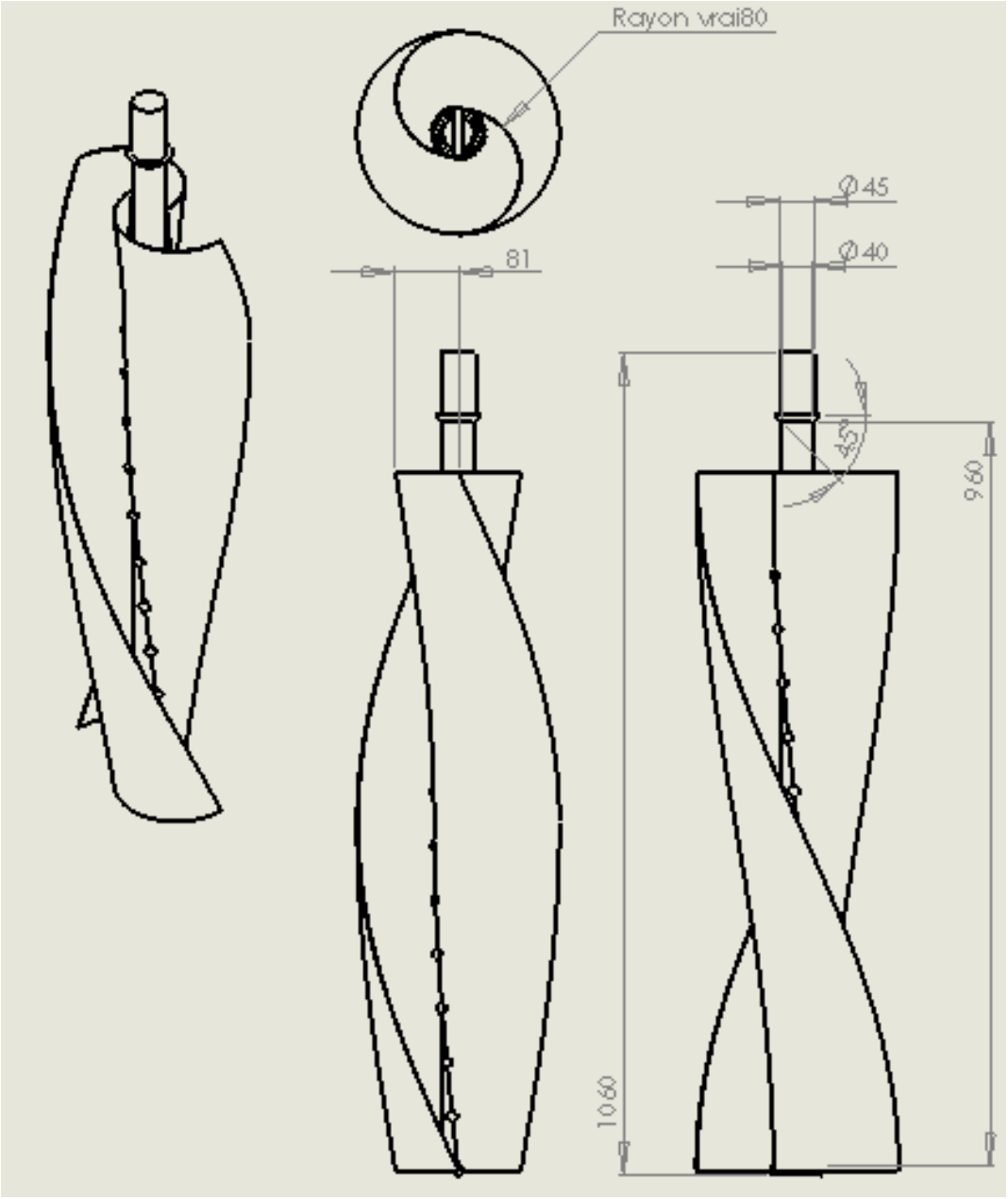
Here below are presented some of the technical drawings of this Urban Node. All the others can be found at the end of the report, in the annexes.



Picture 27: Main part of the Urban Node – the trunk



Picture 28: Light system composed of 20 LEDs



Picture 29: Wind turbine

The company will need all those technical drawings when the manufacture of the node will begin. A lot of companies nowadays are also equipped of systems called CAM (Computer-aided manufacturing). It is the use of computer software to control machine tools and related machinery in the manufacturing of work pieces. This means that the company Neapolis, owner of this innovative project, which will give the 3D molding to the company chose to manufacture this Urban Node.

9. Manufacturing Process

9.1 Introduction

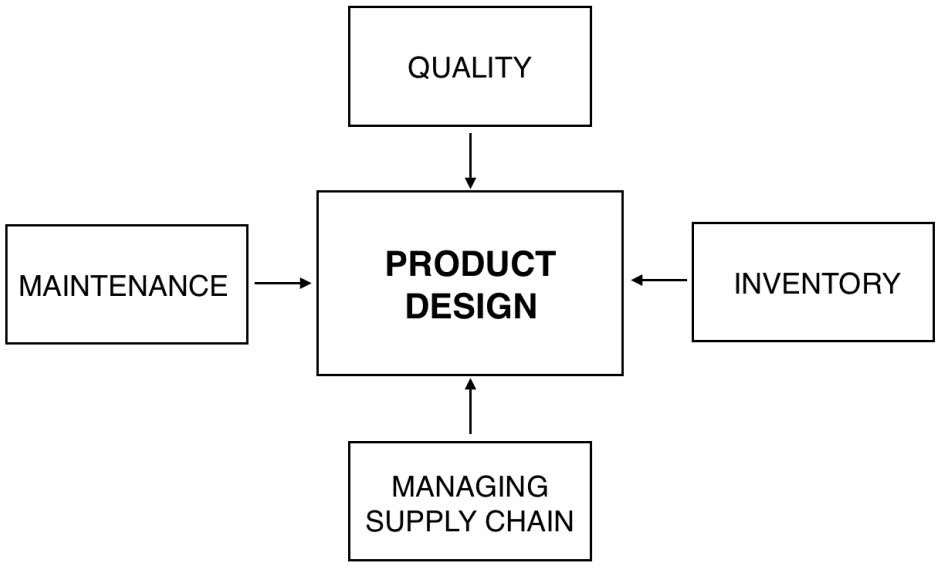
The Manufacturing process is described in different sets of operations as they are required for producing a product. These operations involve technological materials, humans and energy resources. Some other important elements that have to be considered in the manufacturing process are:

- Raw materials
- Manpower
- Work methodology
- Machines and tools
- Environment Issues
- Quality Test

The manufacturing process also has to have good management. This is because it' the part where the company will end up spending more money and it is also convenient to have the cost to a minimum ensuring that no mistakes are made and to try to get the Urban Node produced as fast as possible with good organization within the factory. This will result in good results for consumers because they are looking for an innovative product.

9.2. Strategic Operations and management decisions

The right decision about how to manage the strategic operations about the Urban Node are essential.



Picture 30: Product Design

9.2.1. Quality

The Urban Node is an attractive product to consumers. So for this reason it has to have an adequate level of quality. The quality can be seen through the selection of materials and several different functions. Another is the quality of the selection of machines.

9.2.2. Managing supply chain

First of all, company's employees have to do calculations and the planning of working time for not having assembly line stop. If the assembly line is stopped, the company will lose revenue because workers do not profit the time it takes to sell The Urban Node to consumers. Also the company will waste money if they do not have good management of supply chains because companys pay for having the assembly line activated. This means that company has the cost of energy and maintenance of the machines. So the management of the supply chain is essential in order to reach to a high level of production without wasting any revenue the.

9.2.3. Inventory

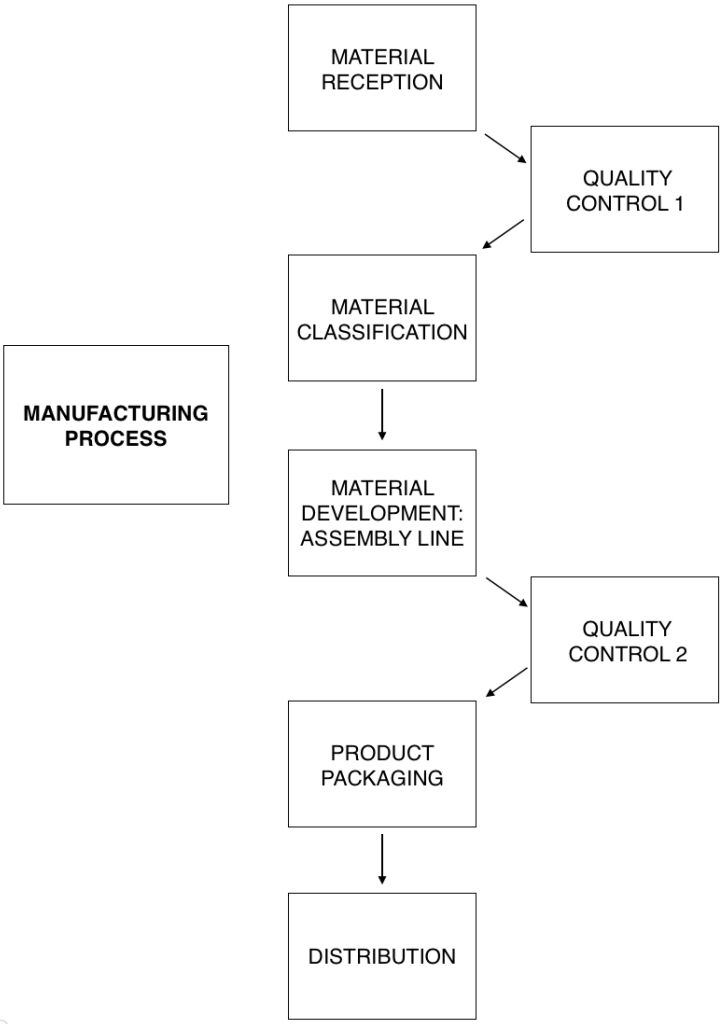
The inventory is one of the key elements of having a successful business, this means that the company has to have the enough raw materials in order to manufacture the product. Not to retain stock like materials, components, etc as they can be damaged and in effect the company will lose revenue.

9.2.4. Maintenance

Maintenance is everything (computers, calculation, machines, materials, etc) and is as important as mounting and producing every step of assembly line. Therefore the maintenance of machines have to be frequent. If they are not frequent , the production will be a chaos because in one step of chain or at the end of production, workers can see that Urban Node will only have the minimum quality that consumers wish and they will have to restart again and the company would lose time and money. So it is important the maintenance of every equipment. With these main points about how to manage every decision of manufacturing process, Urban Node will place to be a product design to a real prototype and a product. So to design a product, it is necessary to add these points. These points are the base for manages a product. It can be called a brainstorming. Also it is important to have good thinkers and designers in the company because this point of the project is the key to have successful.

9.3. Manufacturing Process

Manufacturing process is divided by 6 steps. The steps are the following: material reception, material classification, quality control, material preparation, product packaging and distribution.



Picture 31: Manufacturing Processes

9.3.1. Material reception

Material reception is the first step of Urban Node. Company has to choose the right raw materials for developing Urban Node. So when the material has chosen, it will be sent to company to start Urban Node.

9.3.2. Quality control

Quality control point have the purpose of checking the materials and electronics components of Urban Node to see that everything works right. In point 5 of Manufacturing Process will be more detailed.

9.3.3. Material classification

The second step is called material classification because when raw materials or components have arrived to company, the workers have to separate the materials through the position of assembly line that them will be used.

9.3.4. Material development: Assembly line

This point consists to develop Urban Node in the assembly line following the right order for having a qualitative product. The material preparation will be more detailed in point 4 of Manufacturing Process.

9.3.5. Product packaging

Product packaging is the step that shows about Urban Node that it has been manufactured following the steps of assembly line good. The packaging of Urban Node has to have very safety because it contains elements fragile and these can be broken easy.

Picture 32: Product Packaging

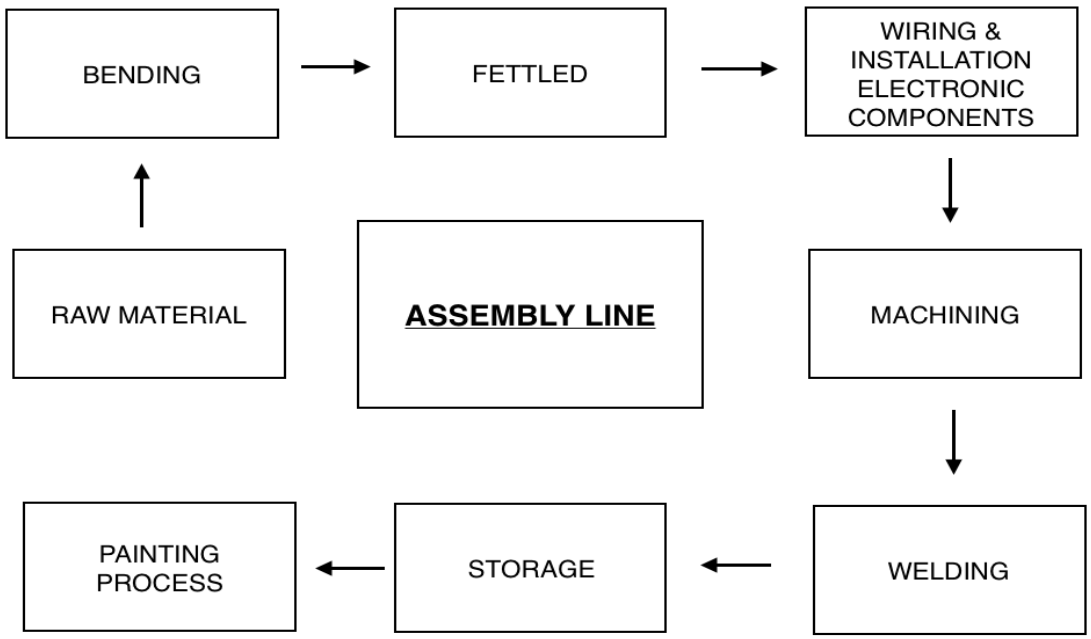
9.3.6. Distribution

The last step of Manufacturing Process is the distribution of Urban Node. It means that the work has done it successfully and well. So for doing properly this point, the company has to do a great work and communication (marketing plan) to distribute to consumers.

Picture 33: Distribution

9.4 Characteristics of production process: Assembly line

In this point it will be explained the characteristics of production of Urban Node. Like it was mentioned in previous point, this step consist to explain the order of assembly line that materials follow in it. The order of steps are: bending, fettled, wiring and installation of electronic components, machining, welding, storage, painting process, polymerization chamber.



Picture 34: Assembly Line

9.4.1. Bending

Bending is a manufacturing process that produces a V-shape, U-shape (The case of Urban Node). Commonly used equipment includes box and pan brakes, brake presses, and other specialized machine presses.

The process that steel or plastic about Urban Node follows is: in press brake forming, a work piece is positioned over the die block and the die block presses the sheet to form a shape. The formed bend radius is dependent upon the dies used, the material properties, and the material thickness.

Material sheet thickness varies from 0.79 to 12.7 mm in with length from 150 mm to 6 m. Ductile materials are best suited for the pressing like aluminum, mild steel and new plastic materials. But Urban Node will be split in different parts around 3 m.

The big advantage of bending is a cost effective process when used for low to medium quantities, because it does not require significant amounts of tooling.

9.4.2. Casting

Casting is the first step of assembly line where raw materials are casted for putting the liquid material into molds that it will be the following step. Urban Node uses casting by arena that it is the common process because the arena is a cheap material to gain.

Picture 35: Casting

9.4.3. Moulding

Mold is a piece inside hollow where it is useful for doing solids pieces for developing Urban Node. Inside has to drop the liquid material. When this material is solidified, it acquires the shape of the mould. There are different kinds of molds: rigid and flexible. For Urban Node, it will be used flexible mold because has one big advantage in front of the rigid mold. This kind of mold flexible has the extraction of the solid smoother with better results for the piece. So in this step is made the structure of Urban Node with moulding technique.

Picture 36: Moulding

9.4.4. Fettled

Fettled step is used with the purpose to remove the portion of left material that it is accumulated on the edge or surface of one part of the structure. Usually it happens after withdraw the solid inside of the mold.

Picture 37: Fettled

9.4.5. Wiring and installation of electronic components

The fourth step is wiring and installs all electronic components of Urban Node. This part of assembly line requires a lot of knowledge in electronics field. Every part of Urban Node's structure will join, but before this, it is necessary to connect every electronic component and put inside the wires. If workers want to do it when the structure is one piece, it will be impossible to do it.

Picture 38: Wiring

9.4.6. Machining

Machining is the step that the material is removed by abrasion for shaping the piece. With this technique, the product does not require other operations, so it gets the final version of the piece. The company has chosen this technique because the precision that it will have and surface finish can be very good but it might spend more time than other techniques less precise.

Picture 39: Machines

9.4.7. Welding

Welding is a very important point for developing Urban Node because workers have every part of structure of Urban Node ready to join. So the purpose of welding is to join the parts/pieces of Urban Node through the fusion of materials. Welding has a key role in the assembly line. It is the most expensive step in the assembly line because workers have to be very careful or the Urban Node would have to restart again at first step mentioned previously.

Picture 40: Welding

9.4.8. Storage

Storage is a part of logistic of factory, the warehouse, where specifically store the Urban Node in one piece with previous steps would have done well and guard the product until workers need it to follow developing Urban Node.

Picture 41: Storage

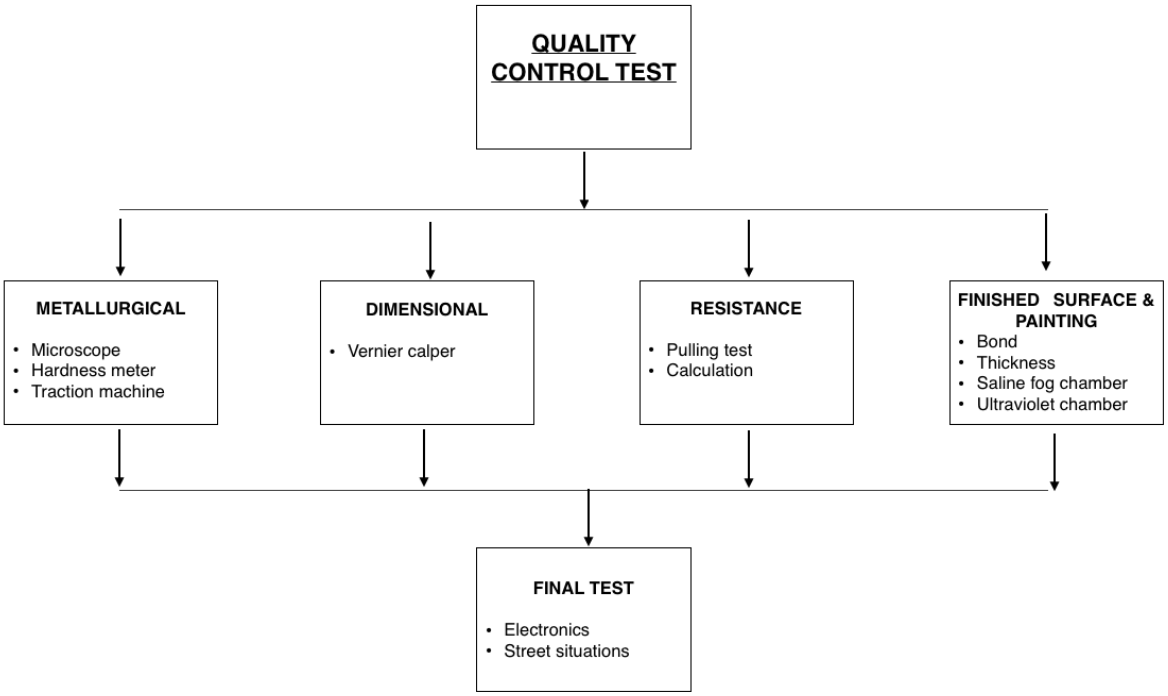
9.4.9. Painting Process

The purpose of painting process is to give a coating to Urban Node. The main function of it can be decorative, anticorrosive or both. The company uses guns to paint the product.
After Urban Node has painted, the product will go to dry chamber that it oscillate between 20ºC and 80ºC maximum.

Picture 42: Painting Process

9.5. Quality Control Test

Quality control is the most important step previous to start developing Urban Node because with only one small mistake of the material or component used becomes to failed product for his functions and Urban Node will have to restart again all the steps and company would lose money and time. Also it is useful for seeing if final version of Urban Node works right with all functions and every component do not lose his properties. So it will be ready for packaging and to send for consumers. The quality controls supports are the following: metallurgical, dimensional, resistance, finished surface and painting.



Picture 43: Quality Control Tests

9.5.1. Metallurgical

Metallurgical step has the objective to check the properties about every material used. For checking these properties the workers use three machines. These machines are: Microscope, hardness meter and traction machine.

The microscope is an instrument that it allows to look small things like objects, chemical things, etc. Hardness meter is a machine that it is useful for determining the hardness on surface quickly. And traction machine to measure both tensile and compressive forces.

Picture 44: Metallurgical

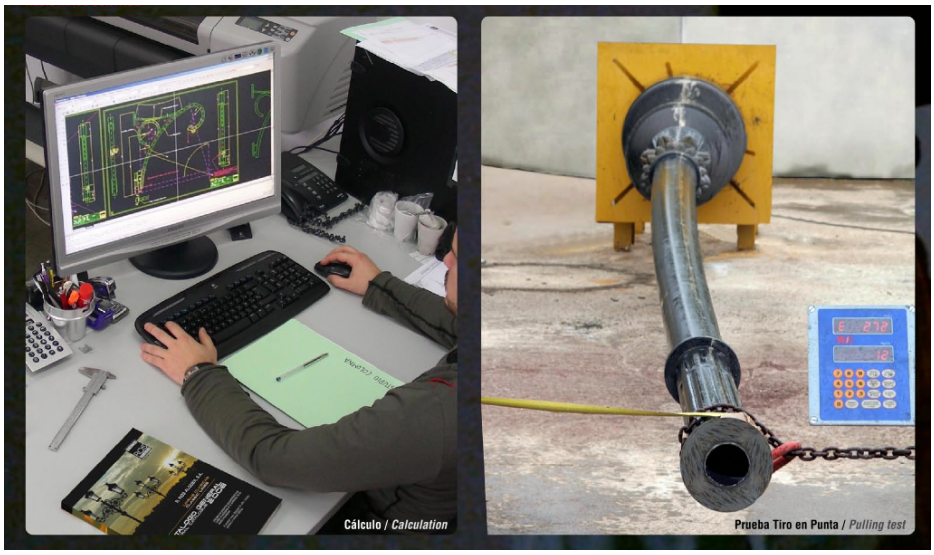
9.5.2. Dimensional

Dimensional controls are the quality control that it confirms that Urban Node satisfies the dimensions of the product such as the company said to consumers. The dimensions have a little bit of error of range too. The tool used for satisfying the requirements of consumers is a veneer caliper.

Picture 45: Dimensional

9.5.3. Resistance

Resistance test has the objective of verifying the calculations previously calculated and also it uses pulling test again similar to metallurgical test but this time for measuring the resistance only.



Picture 46: Resistance

9.5.4. Finished surface and painting

For finished surface, workers check bond and thickness. For measuring these things, they use vernier calipers again. And also in this quality step, workers check saline and finished painting of Urban Node. For doing this test, they use fog chamber and ultraviolet chamber. This quality control is very special and delicate.

Picture 47: Finished surface and painting

To conclude the quality control about Urban Node, workers put Urban Node in every situation that the product might find in the streets. Also they test all functions of Urban Node, especially electronic components because these kinds of objects usually have fail.

10. Cost Benefit Analysis

As the project went on, there was a very important need for cost benefit analysis. Actually whenever there is a project that is meant to put a product on the market, it has to be done at some point. There are many reasons why it is part of project requirements and they will be developed later in this part. Once these matters would have been explained, the cost benefit analysis will be presented. First the scope and hypothesis of the analysis will be explained. Since there are many variables to take into account, it is very important to specify this kind of information. Furthermore, the different expenses and incomes will be developed. Finally, a study with the different return on investment depending on the models and hypothesis used will be presented.

It is important to understand that this part of the report is composed of assumptions and hypothesis at some points in order to make this analysis feasible.

10.1. A Need For A Cost Benefit Analysis

As important as technical drawings, manufacturing processes and strength analysis can be, cost benefit analysis is one of the most important of all since it is the main lever that can be used to persuade a client to get involved in the project and invest money.

First it is indispensible to know the expenses of the product. Now that most of the steps of the project are completed, it was possible to search and define the associated costs and to evaluate the necessary investments.

Secondly, a study on the incomes was required. The different features of the urban node are designed to give innovative properties to the node but it was also a way to get money from those features. For instance, there are 5 main income sources: energy sold to the grid thanks to wind turbine and solar panels, advertising using the interactive screen, selling the data gathered by sensors, get money with the users payments and finally the money for the sale of the urban node.

Finally, once the expenses and the incomes are clearly established it is possible to propose different models and to study the influence of some parameters on the time needed to get a return on investment.

10.2. The Expenses

There are some different origins for the expenses such as the machine costs, raw materials, the urban node electronic parts, the salaries of workers, logistic cost, quality, etc. In this part, the costs will be detailed and explained in order to give a clear overview of the matter.

10.2.1. Machines costs

Once the manufacturing processes were defined, it was possible to evaluate the different prices of the machines necessary to build urban nodes. There are 8 machines in total for a global cost of 11,650€. In the following table, there is a summary of the machines and their cost. The selling prices were different depending on the different websites we searched on and therefore we took the highest value to do a worst-case scenario. As it is possible to see on the table, the most expensive machines are the ones that will be used for making the steel structure of the node.

Machine	Cost	Selling price
Microscope	200 – 300 €	300,00 €
Hardness meter	1000 – 2000 €	2 000,00 €
Traction machine	1000 – 1500 €	1 500,00 €
Calculation (software)	400 €	400,00 €
Pulling test	500 – 3000 €	3 000,00 €
Paint	400 €	400,00 €
Ultraviolet chamber	3000 – 5000 €	5 000,00 €
Dial/digital caliper	40 – 50 €	50,00 €
	Total	**11 650,00 €**

10.2.2. Raw materials & Parts

Previously in the project, the materials needed for the construction of the urban node were studied and validated by a strength analysis that would guaranty the safety of users. Therefore there is a need for raw materials. The main expenses for the raw materials were the steel blades and the plastic needed for the transparent part. The following table gives the quantity needed for one urban node and the daily price when we did the research. Regarding the plastic quantity, 2,5 means 2,5 plates since it is the easiest way to manufacture the transparent part. The surface needed is 5 m2 and the plates are 2 by 1 m.

Raw material	Quantity	Cost per tonne	Total
Steel	200	1 300,00 €	260,00 €
Plastic	2,5	130,00 €	325,00 €
Total:			585,00 €

With the raw materials come also the parts of the urban node. Most these are mostly electronics parts that are necessary for the interactive screen and the sensors. The figures found by the previous project were used since it was their expertise area and that supervisors checked it when they did the aspects. The next table presents their cost and the quantity needed for one urban node.

Parts	Units	Cost	Total
I-beam 20x20x4	1	25,00 €	25,00 €
M20 skrews	1	35,00 €	35,00 €
M20 nuts	1	25,00 €	25,00 €
Washers	1	35,00 €	35,00 €
Arduino	2	25,00 €	50,00 €
Raspberry pie	1	35,00 €	35,00 €
Cat-5 cables	10	80,00 €	800,00 €
Multitouch kit	1	200,00 €	200,00 €
LCD screen	1	600,00 €	600,00 €
Speakers	1	125,00 €	125,00 €
Aux cables	10	2,00 €	20,00 €
Mini USB	4	5,00 €	20,00 €
VAWT	1	600,00 €	600,00 €
Solar panel	1	300,00 €	300,00 €

Total	2 870,00 €

10.2.3. Workers Salaries

Regarding the workers salaries, we manage to evaluate what were the types of workers needed for the manufacturing processes, for the logistic and for the quality control. The expenses are the most important ones for two main reasons. First in term of value, they are the highest ones of the expenses therefore they have to be taken care of very carefully. Secondly, it was very difficult to estimate what was the required time for manufacturing the nodes. Since the salaries are monthly salaries the total amount of expenses can vary a lot. So we choose to use the necessary manufacturing time as a variable to will be studied for the return on investment phase. We made it change between 1 and 10 months for 10 urban nodes. The next table shows the monthly salary of the workers and the number of them needed. We decide to split in to 3 different categories this expense.

→ The next three tables present those figures.

- Production workers

Process	Worker nº	Salary/worker	Total
Construction moulds	2	1 500 €	3 000 €
Casting	2	1 500 €	3 000 €
Fettled	1	1 500 €	1 500 €
Machining	1	1 500 €	1 500 €
Welding	2	1 500 €	3 000 €
Storage	2	1 200 €	2 400 €
Painting	1	1 500 €	1 500 €
Polymerization chamber	1	1 300 €	1 300 €
Packing	2	1 200 €	2 400 €
Total			19 600 €

- Logistics workers

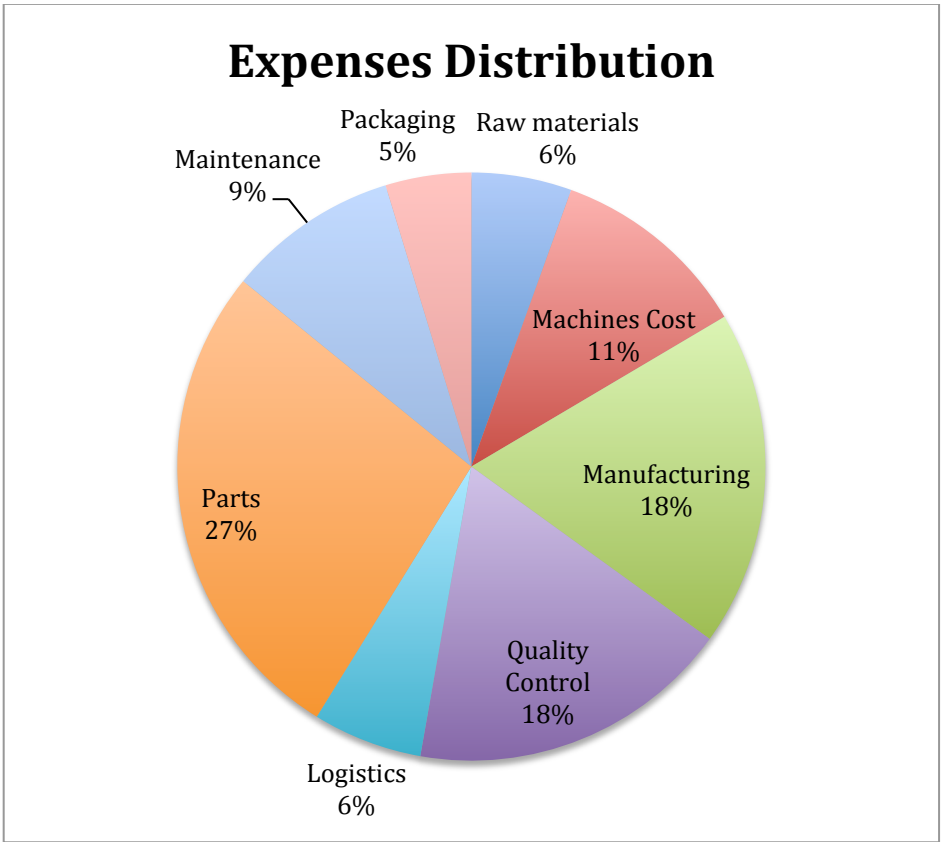
Function	Worker nº	Salary/worker	Total
Warehouse worker	2	1 300 €	2 600 €
Materials transport	1	2 000 €	2 000 €
Driver truck	1	1 800,00 €	1 800 €
Total			6 400 €

- Quality control workers

Quality control	Worker nº	Salary/worker	Total
Metallurgical control	1	1 500 €	1 500 €
Dimensional control	3	1 300 €	3 900 €
Resistance control	2	1 500 €	3 000 €
Finished control/painting	2	1 500 €	3 000 €
Assembly	5	1 500 €	7 500 €
Total			18 900 €

10.2.4 The expenses distribution

Now that all the expenses were defined we could have the distribution of them. A distribution chart allows having a clear view of the most important ones and permits having a lever of action on some the expenses. The next pie chart presents it. It considers the manufacturing of 10 urban nodes for a manufacturing time of 1 month.



Picture 48: Expenses Distribution

As it is possible to see on this chart, the expenses linked to the salaries of the manufacturing workers is the most important with quality control after the cost of parts. But when we considered 2 months for the manufacturing time the manufacturing and quality are worth more than 50% of the expenses distribution.

10.3 The Incomes

The main objective of the project was to design an innovative urban element. Therefore it was decided to include features to the node and those different features are the origins of the necessary incomes to put on the market. There are five main incomes and the selling price of the urban node:

- Selling of the energy produced
- Using the interactive screen for advertising
- Giving the opportunity to telecom companies to put a 4G antenna
- Getting money from the users payments
- Selling the Data gathered from the sensors

In this part we are going to go through these 5 categories and then a analysis of the distribution pie chart will be made.

10.3.1. The Energy & Users payments Incomes

The previous EPS project group calculated the incomes earned by the solar panels and the wind turbine. They also calculated the earning from the user payments. Therefore we are not going to develop those points in this report.

10.3.2. Advertising and 4G Antenna

Regarding the earnings that we could gain with advertising thanks to the interactive screen were hard to evaluate. As a matter of fact, advertising on the kind of support is not very developed yet. A study of the other advertising supports was then made to allow the team to design different models. The idea is to use the different existing references on TV advertising, website advertising, advertising display and dynamic digital signage.

We were able to find some information on French and Spanish websites that give the average cost for advertising on different support. The following tables show these figures.

Advertising Display	Number	Week	Location	Cost
Grand format	50	1	Nantes	10 000,00 €
Grand format	150	1	Marseille	35 000,00 €
Petit format	300	1	Paris	140 000,00 €
Petit format	2500	1	France (without Paris)	185 000,00 €

Internet Website	Type	Audience	Nbr CPM	Cost	Cost per CPM
Format standard	Portal website	15 and +	4 000,00	7 000,00 €	1,75 €
Format standard	Portal website	15 and +	8 000,00	14 000,00 €	1,75 €
Format standard	Portal website	15 and +	12 000,00	21 000,00 €	1,75 €
Format standard	Portal website	15 and +	16 000,00	28 000,00 €	1,75 €

TV	Length	Time	Nbr CPM	Cost	Cost per CPM
Local Channel	15"	Anytime	300,00	2 000,00 €	6,67 €
National Broadcast Channel	30"	18:00	1 350,00	12 000,00 €	8,89 €
National Broadcast Channel	30"	19:30	3 000,00	30 000,00 €	10,00 €
National Broadcast Channel	30"	20:40	5 000,00	85 000,00 €	17,00 €

Dynamic Digital Signage

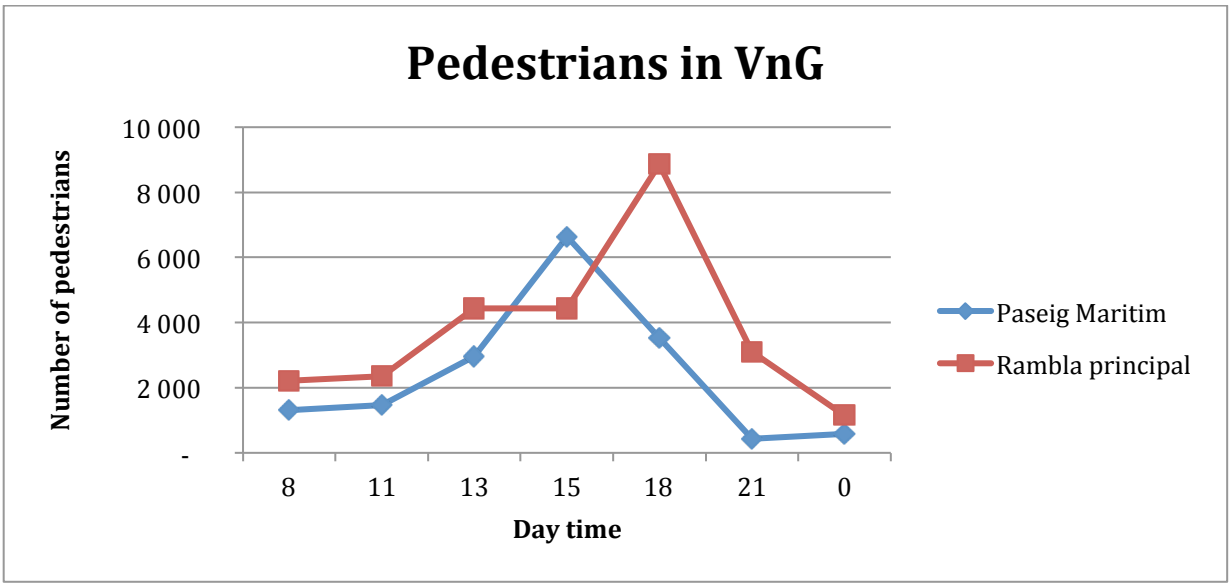
Nbr de semaines	5"	10"	Total price for 5"	Total price for 10"
1	150,00 €	290,00 €	150,00 €	290,00 €
2	145,00 €	280,00 €	290,00 €	560,00 €
3	140,00 €	270,00 €	420,00 €	810,00 €
4	135,00 €	260,00 €	540,00 €	1 040,00 €
8	125,00 €	240,00 €	1 000,00 €	1 920,00 €
12	115,00 €	220,00 €	1 380,00 €	2 640,00 €
24	105,00 €	200,00 €	2 520,00 €	4 800,00 €
52	95,00 €	180,00 €	4 940,00 €	9 360,00 €

While we were conducting this study, we learnt a marketing concept used for advertising. This concept is called CPM meaning Cost per Mille (Mille means thousand in French). Therefore we looked into it to learn what this concept was about and what were the implications for us. The website Marketing terms gives us a good definition of it.

"The CPM model refers to advertising bought on the basis of impression. This is in contrast to the various types of pay-for-performance advertising, whereby payment is only triggered by a mutually agreed upon activity (i.e. click-through, registration, sale).

The total price paid in a CPM deal is calculated by multiplying the CPM rate by the number of CPM units. For example, one million impressions at $10 CPM equals a $10,000 total price."

Given this piece of information we had to study the pedestrian flow in Rambla and on the beach were we want to implement our urban elements. Since it was impossible to stay all day long counting every person passing the street we did it couple times at some precise hour of the day and then we used a ratio for the rest of the day. Of course the analysis lacks precision but it was mostly done to get an approximate idea of the importance of the flow so that we could match one model with the CPM cost that were showed on the previous tables. The difference between summer and winter should also have been considered but we decided that for this analysis we did need that much precision. The next chart illustrates how busy the Rambla and the beach are during the day.



Picture 49: Pedestrians in Vng

Thanks to these estimations we were able to realize projections for each models. Those models will be used to calculate the return on investment.

Concerning the 4G antennas, the market is not developed yet and therefore we could not find any information in the state of the art. The only information we could get was about the classic telecom antenna. We decided to take similar figures for renting the antenna of the urban node. The average price is 10 000€ per year for 10 urban nodes.

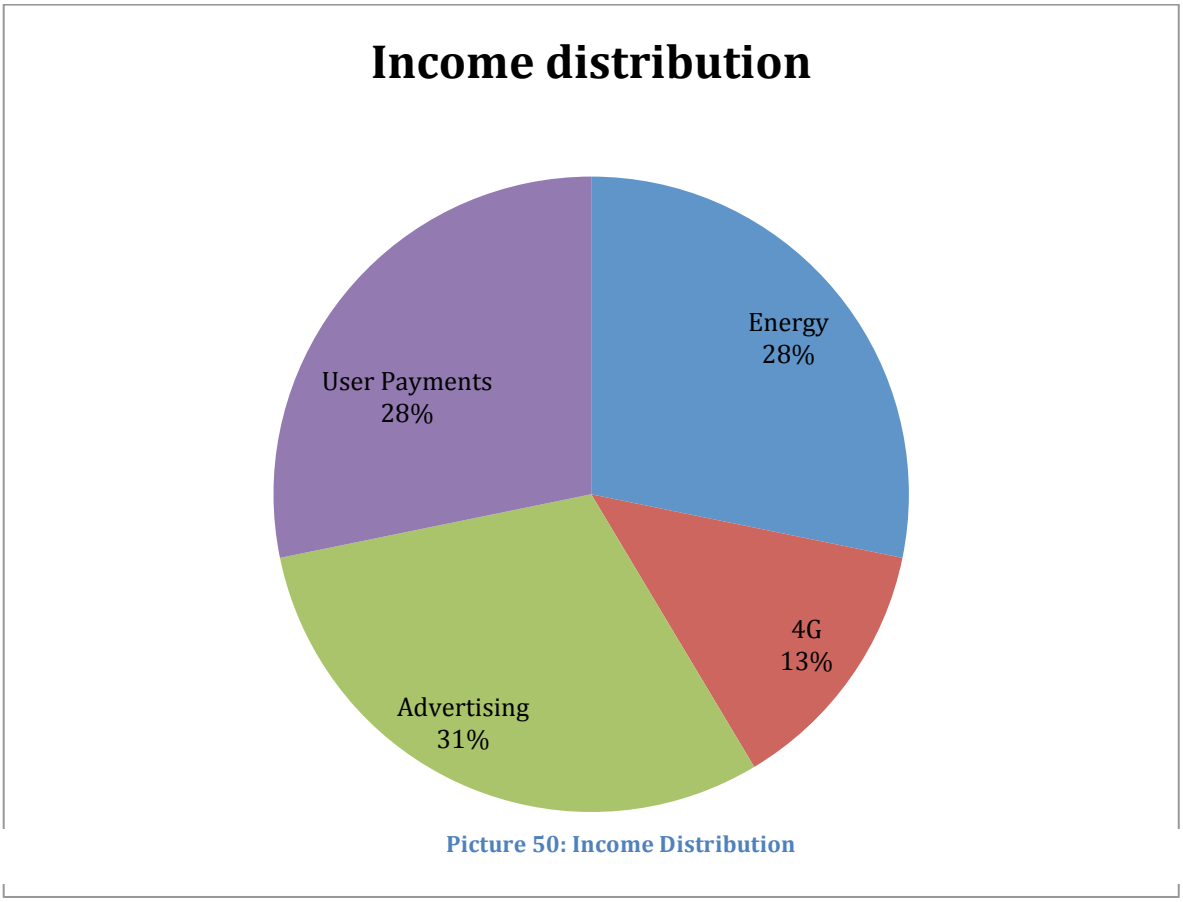
10.3.3. Big data and data minding

Another features of our product are the sensors. Thanks to them an enormous amount of data will be gathered. Nowadays major companies are looking for personal data that they get on

social networks but we are getting to a new era and they want to combine them with impersonal data such as temperature, humidity, etc. The idea is to find links between those to kind of data to predict consumers and more generally human behaviors. It is very import for marketing services for example. Unfortunately the sell of such information does not really exist yet and we were not able to make any evaluation of the possible income from this feature of the urban node.

10.3.4 The Incomes Distribution

As we explained the variable aspect concerning the incomes is the advertising model we want to use. For the distribution we choose to take the CPM model because it seems to be the most relevant one. The next pie chart shows the distribution.



Picture 50: Income Distribution

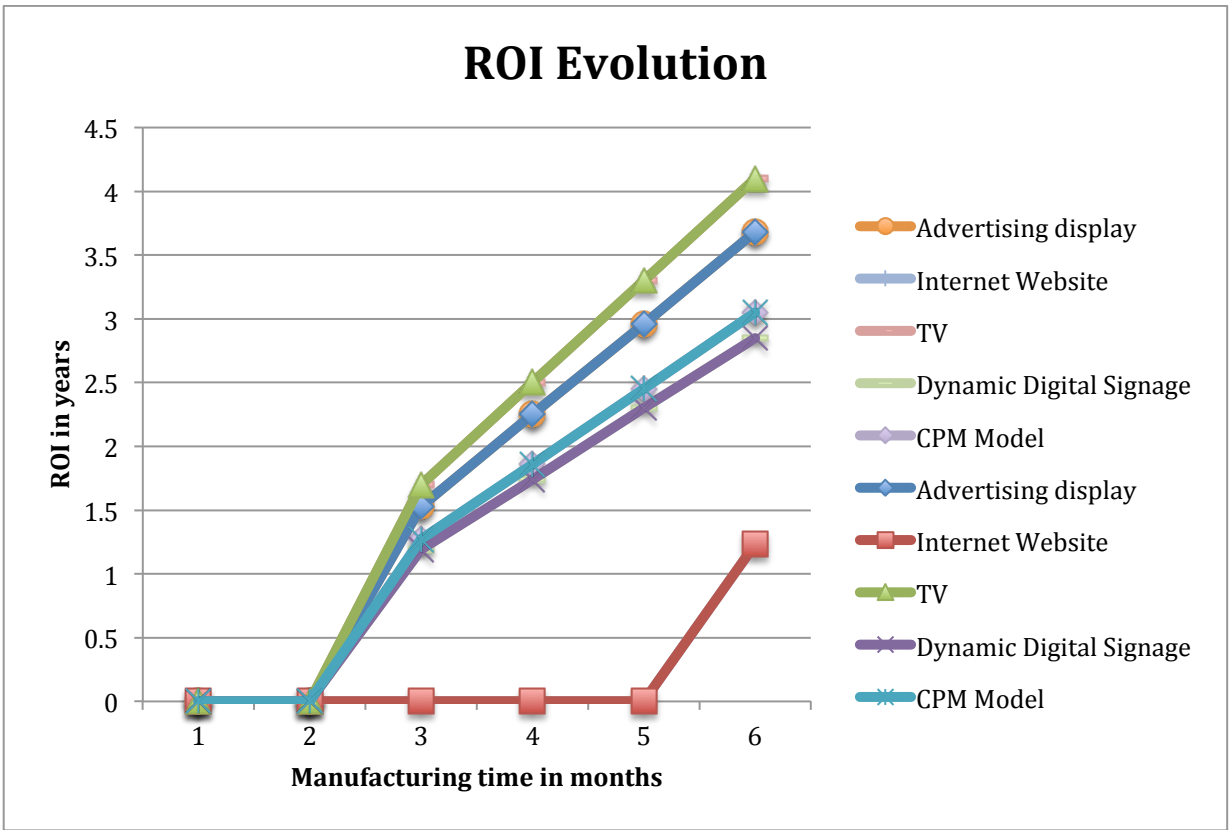
We can see that the income from advertising is the most important revenue. And it can be even more important if another advertising model is considered.

10.4 Expenses and Incomes Balance and ROI

Finally it is necessary to compare the expenses and the incomes to see if you get a return on investment in an acceptable time. But as it was mentioned previously some hypothesis were made to realize this analysis and two variables were chosen. For the expenses part, the manufacturing time was considered as a variable that could go from 1 to 6 months to manufacture 10 urban nodes. On the other hand for the incomes, we did several models for the advertising earning, advertising display, TV, website, dynamic digital signage and CPM model. The next table presents the balance considering 4 months for the manufacturing time and the CPM model for the advertising earnings.

	Expenses	Incomes	
Raw materials	5 850,00 €	100 000,00 €	**Selling price**
Machines Cost	11 650,00 €	21 350,00 €	**Energy**
Manufacturing	78 400 €	10 000,00 €	**4G**
Quality Control	75 600 €	22 985,80 €	**Advertising**
Logistics	25 600 €	21 350,00 €	**User Payments**
Parts	28 700,00 €		**Data**
Maintenance	10 000,00 €		
Packaging	5 000,00 €		
Total	**240 800,00 €**	**175 685,80 €**	

Then it was necessary to calculate the ROI (return on investment). Of course the selling price could be taken into account only once, the incomes for year 2, 3 and above were only coming from energy, 4G antenna, Advertising, user payments and data that we could not evaluate. So we realized a chart that shows the evolution of the ROI depending on the different settings of the variables. The next diagram presents it with the different advertising models and the manufacturing time as variables.



Picture 51: ROI Evolution

The results of this study is that even if there are still some unseen matters and some points of the analysis is not very precise, the urban node is an interesting product. It will be strong arguments to try to sell the concept to a co

11. Marketing Plan

11.1 Introduction

The following plan aims to provide a detailed outline as to how the Urban Node will be launched into the market place. Without a strong marketing plan, the product will fail to reach its full potential and the project will ultimately result in failure. Extensive research has been carried out to ensure the plan has depth and covers all the necessary areas for a successful launch to market. The following plan will act as a formatted strategy that will identify the steps that must be completed to successfully launch the Urban Node into the marketplace and contribute to the achievement of the objectives set.

11.2 The Vision

The vision of this project is the evolution of a previous project of the Urban Node. Developing the product defining materials, dimension, contacting manufacturers and helping it reach closer to entering the market. The design needs to be unique and offer features that no other design has before. This will allow it to be a new product on the market and straight away reducing any problems regarding competitors.

11.3 The Background

This is a continuation of the work of previous project groups the brief was first tackled my two groups, IDPS and EPS during the Erasmus Semester Last Year in 2013. The IDPS group directed their main objective to; The Ergonomics using Anthropometrics to ensure the ergonomics of the product would be sufficient enough to suit as many, if not all of the possible users. Then using the Ergonomics to decide the Aesthetics, Focusing on materials, shape and size. The EPS directed their main objective to the Function of the Node. Focusing on the electronical aspects and how it will function centering their designs and ideas to the inside of the Node.

11.4 Marketing Mix – People

The team consists of six members with five different nationalities;

- Céser– Grenoble, France – Industrial Engineering
- Antoine – Reims, France – Packaging Design
- Weronika– Lodz, Poland – Architectural Engineering
- Calley-Ann Nixon – London, England – Product Design
- Dieter– Antwerp, Belgium – Civil Engineering
- Gerard– Barcelona, Spain – Mechanical Engineering

With members of the team coming from different design backgrounds, it is hoped that together their skills and expertise can be combined to meet the project objectives. The team is working in collaboration with Neapolis, an agency in the field of technology situated in Villanova, Spain. Neapolis is represented by Josep Farre and Felix Ruiz Gorrindo. The team has also received ongoing support from their university (UPC) mentor, Pau Marti.

11.5 Marketing Mix – Product

The Urban Node's primary function is to provide public lighting through the use of LED's and will be powered using solar panels and wind turbines. However there are more features that distinguish the product from its competitors. It has been specifically designed to encourage user interaction; the main enabler for this is an electronic touch screen. A number of potential features for the Urban Node were considered and are listed below:

• Free WiFi	• Phone charger
• Bike rentals	• Electric vehicle charge point
• Car shares	• Video vigilance
• Encouragement of physical Exercise	• Vehicle speed control
• Touch screen	• Time
• Parking facility information	• Weather

A questionnaire was produced and a sample of the general public of Vilanova was used to understand their preferences towards and identify three essential features. The results concluded that the top three were; Free wifi, Phone charger and the display of Time and Weather. This has given insight to what the public wants, further research will be needed to understand what councils want from the Urban Node. Once this has been carried out a final definitive decision can be made on which features will be taken forward.

11.6 The Objectives

- To produce an Urban Node that is specifically design for user interaction.
- For the Node to have additional features such a lighting and sensors.
- For the Node to produce energy using Solar Panels and Wind Turbines as well as them being a social and educational benefit.
- To encourage the development of smart cities by the implementation of a smart design.

11.7 The USP (The unique selling point/proposition)

THE ABILITY TO INTERACT WITH ITS USERS THROUGH THE USE OF TECHNOLOGY

In recent years there has been a growing demand for innovative modern technology as smart cities continue to grow, with the aim to interact with their populations with design implementations. Therefore our USP of 'The ability to interact with its users through the use of technology' will ensure there is a demand for the Urban Node. It will provide the product with an obvious distinction from its competitors and consequently provide reason to consider the product.

11.8 The Target Market/Users

This section describes the target consumers. It defines all of their demographic profiles for example age, occupation and lifestyle. It then defines their physcographic profile for example, their wants, their needs and how they can relate to the product and the service. The Urban Node has ten main preferences of its users. They include; Adults, Families, Children, Retired people, Tourists, Wheel chair users, People with walking disabilities or balance problems, visually or hearing impairment, learning disabilities and homeless people. This is a large number of target users that could potentially encounter an experience with the urban node at some point in the

products life time period portraying that this product has a mass market. This information clearly identifies all target users allowing pinpointing advertisement to 'speaking the language' of prospective consumers and to produce a user centered design (UCD). As previously discussed smart cities are continuing to grow with the desire to expand. This portrays that consumers although currently happy with existing products on the market are always enthusiastic about more innovative and efficient designs.

11.9 The Marketing Mix – Price

With the products market position being at the top end, it will carry a premium pricing strategy. Although the premium price runs the risk of making the product unaffordable to some, the growing demand for this type of technology with the development of smart cities means it will still have a demand. The exact price of the Urban Node is yet to be calculated but to do cost analysis will need to be carried out on the following; materials, manufacturing, transportation and labor. Once this analysis has been completed a profit analysis can be completed and a suitable price decided upon.

11.10 The Market Position

This product will be classed as a high end product, positioning it in the top band of it competitors. This is due to the complexity and the function of the design, its USP and because it is also a UCD. It also does not have any real competitors at the moment as no other design can offer the exact same qualities and function as the Urban Node.

11.11 Competitors

After secondary research it was clear that identified competitors are companies and designers that are developing the standard street light into a more evolutionary design. There are implementations of wind turbines and solar panel petals. However, the Urban Node remains unique as it is the only design on the market that can offer the above with the combination of lighting and sensors and of course it's USP of user interaction. This portrays that the Node rate of success is high.

11.12 Marketing Mix – Promotion Strategy and marketing materials

The first stage of the promotion strategy will be the implementation of a working prototype in Villanova town center with representative offering help and information on how to use the product. This would allow users to interact and engage with the product in a visual and tactile experience. It would also help to see whether or not the products aesthetics fit with its environment. Users will be asked to complete a short survey having used the product, which will provide the team with valuable feedback from the target market. This feedback will then be acted upon in order to ensure the product is suitable in meeting the needs of the consumer before is fully launched. This could involve adaptations and improvements made to certain aspects or even the elimination of features all together. By taking into account the views of objective parties this means that we can work on any concerning features. For example, the aesthetics, ergonomics and function.

The second stage of the promotion strategy will be the creation and distribution of marketing materials during the launch of the product. Following in the theme of innovation and smart cities we will look to make the most of online advertising. A website will essential as this now common practice with all businesses, this will explain who we are, what we do, what our product is, how

it works, how to order one, where we are situated and how to contact us. In order to direct people to the website we will look to take advantage of social media. In recent years it has proved a very effective way to market mass-market products with an ability to reach a large amount of people quickly at a low price. It is likely we will enlist the help of a dedicated marketing agency in building a social media campaign. Traditional marketing mediums such as posters and leaflets are likely to be used in support of this however our focus will be online marketing.

11.13 Distribution Plan

The Urban Node will be manufactured in three different with a simple assembly process. The product will be distributed in these three separate parts and then assembled once delivered to the final location. This makes it easier to distribute, reducing the size of the product. Distribution channels such as trains, lorries and ferries that are required for industrial use only will be used as the product will still be large and heavy even though it will not be fully assembled. The product once at its chosen location can then be assembled and constructed accordingly.

12. Eco-Audit

One of the main objectives of this project is to continue work on a sustainable element of small architecture: Urban Node. Some materials used in project are recyclable or reused. Additionally it products its own energy. The sustainable analysis made with the Eco Audit software allows to study the environmental impact of used products. As it is explained on the website, "The user inputs information about product composition, usage, and transportation. This is combined with eco property data on the materials and processes used to make the product to estimate energy usage and CO2 output at each stage in the product life cycle."

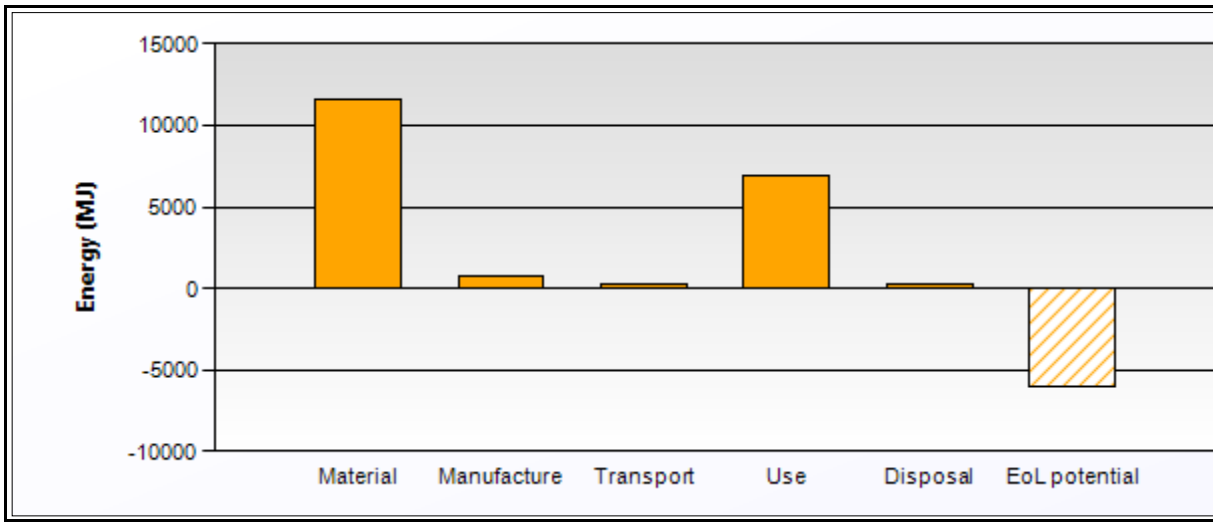
The analysis considered all the component of the product, the processes, the transport of the product to where it will be placed and the energy that it will use. The main objective when a new product is created is to decrease its harmful impact. At the end of the product life, the product can be used in a way that will not affect environment. Most of the component of the Urban Node are downcycled or even entirely recycled.

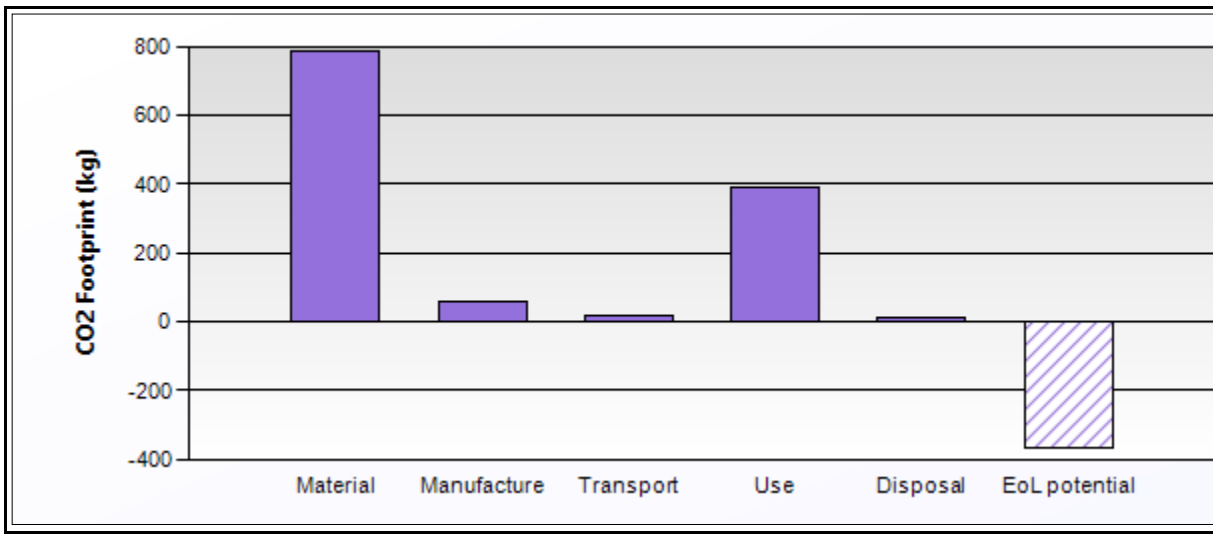
Processes used after life of the product:

- ✓ Remanufacture: The process of returning a used product to at least its original performance with a warranty that is equivalent or better than that of the newly manufactured product.
- ✓ Reuse: a product or its components are put back into use for the same purpose at EoL
  Downcycle: process of converting waste materials or useless products into new materials or products of lesser quality and reduced functionality.
- ✓ Repair: a faulty or broken product or component back to a usable
- ✓ Recycle: The processing of waste materials for their original purpose or for other purposes, excluding energy recovery.
- ✓ Compost: The process of converting organic matter to create a soil additive which improves soil structure and provides nutrients for plants. This may be undertaken domestically or at a municipal site.
- ✓ Incinerate: The process of combustion of organic waste materials to generate electric power.
- ✓ Landfill: The process of disposing of waste by burial.

Product Name	Product
Product Life (years)	15

12.1. Energy and CO2 Footprint Summary:





Phase	Energy (MJ)	Energy (%)	CO2 (kg)	CO2 (%)
Material	1.16e+04	58.9	789	62.2
Manufacture	797	4.0	59.7	4.7
Transport	221	1.1	15.7	1.2
Use	6.88e+03	34.9	390	30.8
Disposal	208	1.1	14.5	1.1
Total (for first life)	**1.97e+04**	**100**	**1.27e+03**	**100**
End of life potential	-6.05e+03		-369	

12.2. Energy Analysis

	Energy (MJ)/year
Equivalent annual environmental burden (averaged over 15 year product life):	1.3e+03

Detailed breakdown of individual life phases

12.2.1. Material:

Component	Material	Recycled content* (%)	Part mass (kg)	Qty.	Total mass	Energy (MJ)	%
Body	Medium carbon steel	Virgin (0%)	2e+02	1	2e+02	5.3e+03	45.5
Light covering	Polyethylene terephthalate (PET)	Virgin (0%)	18	1	18	1.5e+03	13.2
Mother board	Polylactide (PLA)	Virgin (0%)	0.4	1	0.4	21	0.2
Box	Polylactide (PLA)	Virgin (0%)	0.1	16	1.6	82	0.7
Ardunio	Small (hand held) electronic devices	Virgin (0%)	0.057	1	0.057	1.6e+02	1.4
Raspberry	Small (hand held) electronic devices	Virgin (0%)	0.045	1	0.045	1.3e+02	1.1
USB cable	Cable	Virgin (0%)	0.012	2	0.024	2.2	0.0
Power cables	Cable	Virgin (0%)	0.48	1	0.48	44	0.4
Modules cables	Cable	Virgin (0%)	0.25	1	0.25	23	0.2
Temperature sensor	Transistors	Virgin (0%)	0.001	1	0.001	2.9	0.0
Light sensor	Resistors	Virgin (0%)	0.001	1	0.001	1	0.0
LEDs	Semiconductor diodes, LEDs	Virgin (0%)	0.001	100	0.1	3e+02	2.6
PCB Sensor board	Polylactide (PLA)	Virgin (0%)	0.004	10	0.04	2.1	0.0
Transistor	Transistors	Virgin (0%)	0.001	10	0.01	29	0.2
Capacitor	Transistors	Virgin (0%)	0.001	10	0.01	29	0.2
GTI wind	Power supply unit	Virgin (0%)	4	1	4	1.8e+03	15.7
GTI solar	Power supply unit	Virgin (0%)	1.3	1	1.3	5.9e+02	5.1
Touch screen	LCD panel (liquid crystal display)	Virgin (0%)	4.5	1	4.5	1.1e+03	9.4
Barometric pressure sensor	Resistors	Virgin (0%)	0.002	1	0.002	2	0.0
Infrared sensor	Resistors	Virgin (0%)	0.006	1	0.006	6.1	0.1
Decibel sensor	Resistors	Virgin (0%)	0.17	1	0.17	1.7e+02	1.5
Foundation	Concrete	Virgin (0%)	2.5e+02	1	2.5e+02	2.8e+02	2.4
Total				**164**	**4.8e+02**	**1.2e+04**	**100**

*Typical: Includes 'recycle fraction in current supply'

12.2.2.Manufacture:

Component	Process	Amount processed	Energy (MJ)	%
Body	Rough rolling, forging	2e+02 kg	6.5e+02	82.1
Light covering	Polymer extrusion	18 kg	1.1e+02	13.8
Mother board	Polymer molding	0.4 kg	6.5	0.8
Box	Polymer molding	1.6 kg	26	3.2
PCB Sensor board	Polymer molding	0.04 kg	0.65	0.1
Total			**8e+02**	**100**

12.2.3. Transport:

Breakdown by transport stage Total product mass = 4.8e+02 kg

Stage name	Transport type	Distance (km)	Energy (MJ)	%
Vilanova i la Geltru	32 tonne truck	1e+02	22	10.0
Shipping	Sea freight	2.5e+03	1.9e+02	86.6
Factory > Port	Sea freight	1e+02	7.7	3.5
Total		**2.7e+03**	**2.2e+02**	**100**

Breakdown by components

Component	Component mass (kg)	Energy (MJ)	%
Body	2e+02	92	41.8
Light covering	18	8.3	3.8
Mother board	0.4	0.18	0.1
Box	1.6	0.74	0.3
Ardunio	0.057	0.026	0.0
Raspberry	0.045	0.021	0.0
USB cable	0.024	0.011	0.0
Power cables	0.48	0.22	0.1
Modules cables	0.25	0.12	0.1
Temperature sensor	0.001	0.00046	0.0
Light sensor	0.001	0.00046	0.0
LEDs	0.1	0.046	0.0
PCB Sensor board	0.04	0.018	0.0
Transistor	0.01	0.0046	0.0
Capacitor	0.01	0.0046	0.0
GTI wind	4	1.8	0.8
GTI solar	1.3	0.6	0.3
Touch screen	4.5	2.1	0.9
Barometric pressure sensor	0.002	0.00092	0.0
Infrared sensor	0.006	0.0028	0.0
Decibel sensor	0.17	0.079	0.0

Foundation	2.5e+02	1.1e+02	51.7
Total	**4.8e+02**	**2.2e+02**	**100**

12.2.4. Use:

Static mode

Energy input and output type	Electric to thermal
Use location	Spain
Power rating (W)	15
Usage (hours per day)	12
Usage (days per year)	3.7e+02
Product life (years)	15

Relative contribution of static and mobile modes

Mode	**Energy (MJ)**	**%**
Static	6.9e+03	100.0
Mobile	0	
Total	**6.9e+03**	**100**

12.2.5. Disposal:

Component	**End of life option**	**Energy (MJ)**	**%**
Body	Recycle	1.4e+02	67.4
Light covering	Recycle	13	6.1
Mother board	Recycle	0.28	0.1
Box	Recycle	1.1	0.5
Ardunio	Down cycle	0.029	0.0
Raspberry	Down cycle	0.023	0.0
USB cable	Down cycle	0.012	0.0
Power cables	Down cycle	0.24	0.1
Modules cables	Down cycle	0.13	0.1
Temperature sensor	Down cycle	0.0005	0.0
Light sensor	Down cycle	0.0005	0.0
LEDs	Down cycle	0.05	0.0
PCB Sensor board	Recycle	0.028	0.0
Transistor	Down cycle	0.005	0.0
Capacitor	Down cycle	0.005	0.0
GTI wind	Down cycle	2	1.0
GTI solar	Down cycle	0.65	0.3
Touch screen	Re-manufacture	0.9	0.4

Barometric pressure sensor	Down cycle	0.001	0.0
Infrared sensor	Down cycle	0.003	0.0
Decibel sensor	Down cycle	0.085	0.0
Foundation	Reuse	50	23.8
Total		**2.1e+02**	**100**

12.2.6. EoL potential:

Component	End of life option	Energy (MJ)	%
Body	Recycle	-3.8e+03	63.2
Light covering	Recycle	-8.3e+02	13.8
Mother board	Recycle	-6	0.1
Box	Recycle	-24	0.4
Ardunio	Down cycle	0	0.0
Raspberry	Down cycle	0	0.0
USB cable	Down cycle	0	0.0
Power cables	Down cycle	0	0.0
Modules cables	Down cycle	0	0.0
Temperature sensor	Down cycle	0	0.0
Light sensor	Down cycle	0	0.0
LEDs	Down cycle	0	0.0
PCB Sensor board	Recycle	-0.6	0.0
Transistor	Down cycle	0	0.0
Capacitor	Down cycle	0	0.0
GTI wind	Down cycle	0	0.0
GTI solar	Down cycle	0	0.0
Touch screen	Re-manufacture	-1.1e+03	17.8
Barometric pressure sensor	Down cycle	0	0.0
Infrared sensor	Down cycle	0	0.0
Decibel sensor	Down cycle	0	0.0
Foundation	Reuse	-2.8e+02	4.7
Total		**-6e+03**	**100**

Eco Audit Report

12.3. CO2 Footprint Analysis

	CO2 (kg)/year
Equivalent annual environmental burden (averaged over 15 year product life):	84.6

Detailed breakdown of individual life phases

12.3.1. Material:

Component	Material	Recycled content* (%)	Part mass (kg)	Qty.	Total mass	CO2 footprint (kg)	%
Body	Medium carbon steel	Virgin (0%)	2e+02	1	2e+02	3.6e+02	45.8
Light covering	Polyethylene terephthalate (PET)	Virgin (0%)	18	1	18	71	9.0
Mother board	Polylactide (PLA)	Virgin (0%)	0.4	1	0.4	1.4	0.2
Box	Polylactide (PLA)	Virgin (0%)	0.1	16	1.6	5.8	0.7
Ardunio	Small (hand held) electronic devices	Virgin (0%)	0.057	1	0.057	12	1.5
Raspberry	Small (hand held) electronic devices	Virgin (0%)	0.045	1	0.045	9.5	1.2
USB cable	Cable	Virgin (0%)	0.012	2	0.024	0.16	0.0
Power cables	Cable	Virgin (0%)	0.48	1	0.48	3.3	0.4
Modules cables	Cable	Virgin (0%)	0.25	1	0.25	1.7	0.2
Temperature sensor	Transistors	Virgin (0%)	0.001	1	0.001	0.14	0.0
Light sensor	Resistors	Virgin (0%)	0.001	1	0.001	0.056	0.0
LEDs	Semiconductor diodes, LEDs	Virgin (0%)	0.001	100	0.1	22	2.8
PCB Sensor board	Polylactide (PLA)	Virgin (0%)	0.004	10	0.04	0.14	0.0
Transistor	Transistors	Virgin (0%)	0.001	10	0.01	1.4	0.2
Capacitor	Transistors	Virgin (0%)	0.001	10	0.01	1.4	0.2
GTI wind	Power supply unit	Virgin (0%)	4	1	4	1.4e+02	17.3
GTI solar	Power supply unit	Virgin (0%)	1.3	1	1.3	44	5.6
Touch screen	LCD panel (liquid crystal display)	Virgin (0%)	4.5	1	4.5	82	10.4
Barometric pressure sensor	Resistors	Virgin (0%)	0.002	1	0.002	0.11	0.0
Infrared sensor	Resistors	Virgin (0%)	0.006	1	0.006	0.34	0.0
Decibel sensor	Resistors	Virgin (0%)	0.17	1	0.17	9.5	1.2
Foundation	Concrete	Virgin (0%)	2.5e+02	1	2.5e+02	23	3.0
Total				**164**	**4.8e+02**	**7.9e+02**	**100**

*Typical: Includes 'recycle fraction in current supply'

12.3.2. Manufacture:

Component	Process	Amount processed	CO2 footprint (kg)	%
Body	Rough rolling, forging	2e+02 Kg	49	82.1
Light covering	Polymer extrusion	18 Kg	8.2	13.8
Mother board	Polymer molding	0.4 Kg	0.48	0.8
Box	Polymer molding	1.6 Kg	1.9	3.2
PCB Sensor board	Polymer molding	0.04 Kg	0.048	0.1
Total			**60**	**100**

12.3.3. Transport:

Breakdown by transport stage Total product mass = 4.8e+02 kg

Stage name	Transport type	Distance (km)	CO2 footprint (kg)	%
Vilanova i la Geltru	32 tonne truck	1e+02	1.6	10.0
Shipping	Sea freight	2.5e+03	14	86.6
Factory > Port	Sea freight	1e+02	0.54	3.5
Total		**2.7e+03**	**16**	**100**

Breakdown by components

Component	Component mass (kg)	CO2 footprint (kg)	%
Body	2e+02	6.6	41.8
Light covering	18	0.59	3.8
Mother board	0.4	0.013	0.1
Box	1.6	0.052	0.3
Ardunio	0.057	0.0019	0.0
Raspberry	0.045	0.0015	0.0
USB cable	0.024	0.00079	0.0
Power cables	0.48	0.016	0.1
Modules cables	0.25	0.0082	0.1
Temperature sensor	0.001	3.3e-05	0.0
Light sensor	0.001	3.3e-05	0.0
LEDs	0.1	0.0033	0.0
PCB Sensor board	0.04	0.0013	0.0
Transistor	0.01	0.00033	0.0
Capacitor	0.01	0.00033	0.0
GTI wind	4	0.13	0.8
GTI solar	1.3	0.043	0.3
Touch screen	4.5	0.15	0.9
Barometric pressure sensor	0.002	6.6e-05	0.0

Infrared sensor	0.006	0.0002	0.0
Decibel sensor	0.17	0.0056	0.0
Foundation	2.5e+02	8.1	51.7
Total	**4.8e+02**	**16**	**100**

12.3.4. Use:

Static mode

Energy input and output type	Electric to thermal
Use location	Spain
Power rating (W)	15
Usage (hours per day)	12
Usage (days per year)	3.7e+02
Product life (years)	15

Relative contribution of static and mobile modes

Mode	**CO2 footprint (kg)**	**%**
Static	3.9e+02	100.0
Mobile	0	
Total	**3.9e+02**	**100**

12.3.5. Disposal:

Component	**End of life option**	**CO2 footprint (kg)**	**%**
Body	Recycle	9.8	67.4
Light covering	Recycle	0.88	6.1
Mother board	Recycle	0.02	0.1
Box	Recycle	0.078	0.5
Ardunio	Down cycle	0.002	0.0
Raspberry	Down cycle	0.0016	0.0
USB cable	Down cycle	0.00084	0.0
Power cables	Down cycle	0.017	0.1
Modules cables	Down cycle	0.0088	0.1
Temperature sensor	Down cycle	3.5e-05	0.0
Light sensor	Down cycle	3.5e-05	0.0
LEDs	Down cycle	0.0035	0.0
PCB Sensor board	Recycle	0.002	0.0
Transistor	Down cycle	0.00035	0.0
Capacitor	Down cycle	0.00035	0.0
GTI wind	Down cycle	0.14	1.0

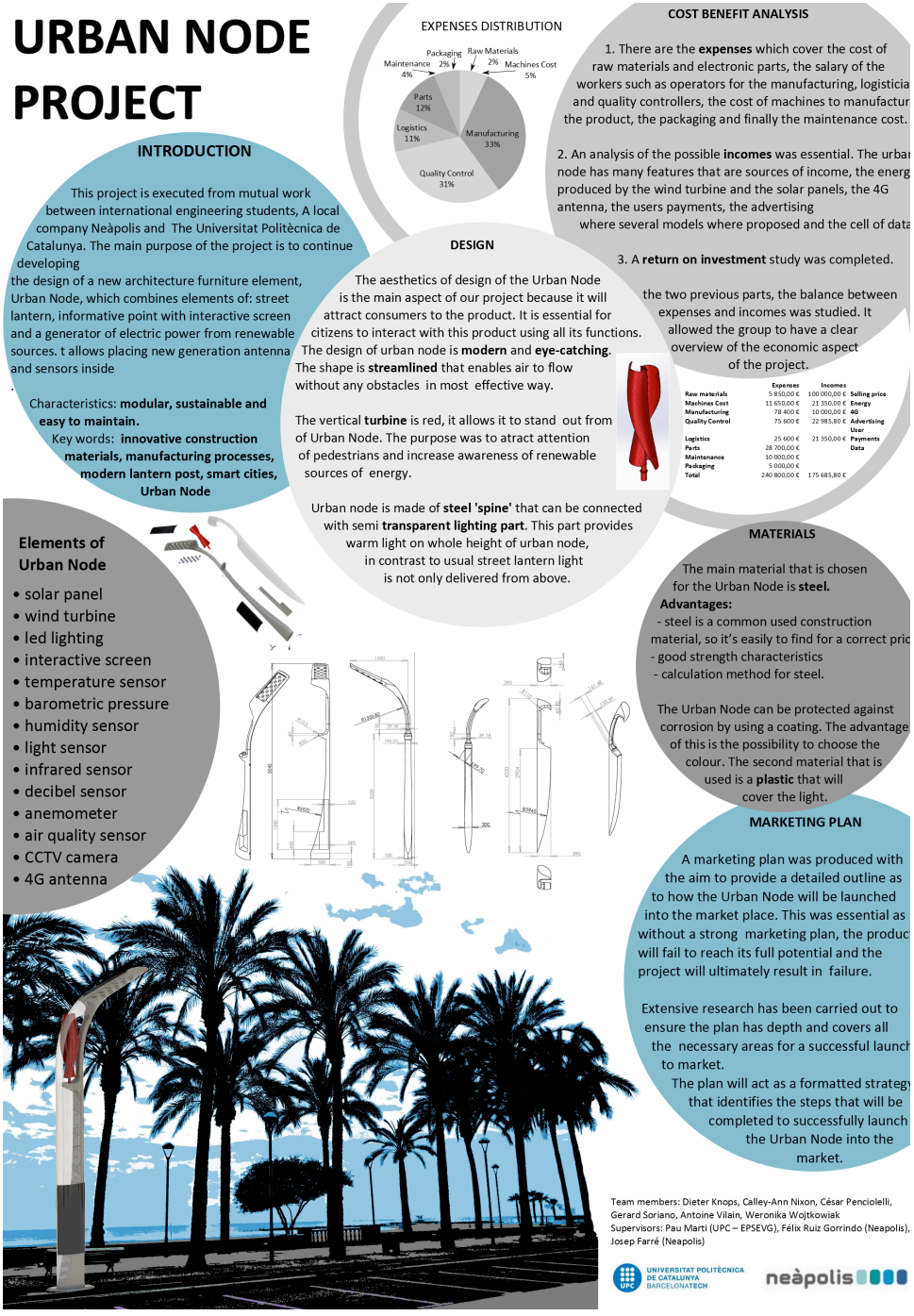
GTI solar	Down cycle	0.046	0.3
Touch screen	Re-manufacture	0.063	0.4
Barometric pressure sensor	Down cycle	7e-05	0.0
Infrared sensor	Down cycle	0.00021	0.0
Decibel sensor	Down cycle	0.006	0.0
Foundation	Reuse	3.5	23.8
Total		**15**	**100**

12.3.6. EoL potential:

Component	**End of life option**	**CO2 footprint (kg)**	**%**
Body	Recycle	-2.5e+02	66.9
Light covering	Recycle	-16	4.4
Mother board	Recycle	-0.29	0.1
Box	Recycle	-1.2	0.3
Ardunio	Down cycle	0	0.0
Raspberry	Down cycle	0	0.0
USB cable	Down cycle	0	0.0
Power cables	Down cycle	0	0.0
Modules cables	Down cycle	0	0.0
Temperature sensor	Down cycle	0	0.0
Light sensor	Down cycle	0	0.0
LEDs	Down cycle	0	0.0
PCB Sensor board	Recycle	-0.029	0.0
Transistor	Down cycle	0	0.0
Capacitor	Down cycle	0	0.0
GTI wind	Down cycle	0	0.0
GTI solar	Down cycle	0	0.0
Touch screen	Re-manufacture	-81	22.0
Barometric pressure sensor	Down cycle	0	0.0
Infrared sensor	Down cycle	0	0.0
Decibel sensor	Down cycle	0	0.0
Foundation	Reuse	-23	6.4
Total		**-3.7e+02**	**100**

13. Urban Node Poster

Part of assignment for this project was to prepare poster in format A1 (594×841mm). It was decided to use it in portrait. As a background we used view on the palm trees, beach and bull sculpture seen from afar. Picture was taken at The Passeig Ribes Roges, characteristic place in Vilanova, where in future Urban Node hopefully will stand. To keep viewer focused on urban node picture was edited to look more geometrical and Urban Node is on the first plan. Information's placed on poster are crucial for our project and we wanted to present them in most clear way. Asymmetric placing of frames makes it not boring and eye-catching. Expectantly this poster will be excellent promotion for our Project, EPS programme an Urban Node itself.

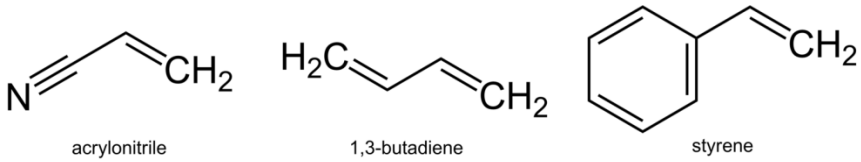


14. Urban Node Prototype – 3D Printing

As in every project of Research and Development, the realization of a prototype is necessary to test our product and to how it look like in real scale or in a smaller scale. Thanks to Neapolis and its 3D Printing department, we managed to develop a model in a scale 1:10.

A 3D printing or additive manufacturing (AM) is a process of making a three-dimensional solid object of virtually any shape from a digital model. 3D printing is achieved using an additive process, where successive layers of material are laid down in different shapes under computer control. 3D printing is thus distinct from traditional machining techniques, which rely on the removal of material by methods such as cutting or drilling (subtractive processes).
Generally, the material used for this system is a thermoplastic polymer. The property of this polymer is that it becomes pliable or moldable above a specific temperature and returns to a solid state upon cooling.

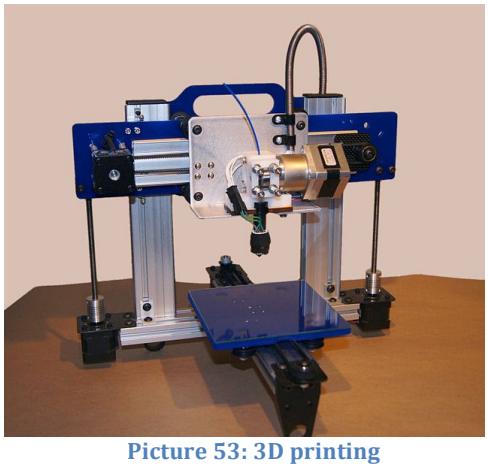
At Neapolis, the plastic used is the ABS (Acrylonitrile butadiene styrene). It is a material stiff, light and able to be molded. The chemical formula and the properties are represented below.



acrylonitrile 1,3-butadiene styrene

Glass Transition Temperature	Temperature use	Resistance	Liquid resistance
105 °C (221 °F)	−20 and 80 °C (−4 and 176 °F)	Impact resistant Toughness Stability under light load	Aqueous acidsl Akalis Hydrochloric and phosphoric acids Alcohols and mineral oils

Picture 52: Chemical Formula



Picture 53: 3D printing

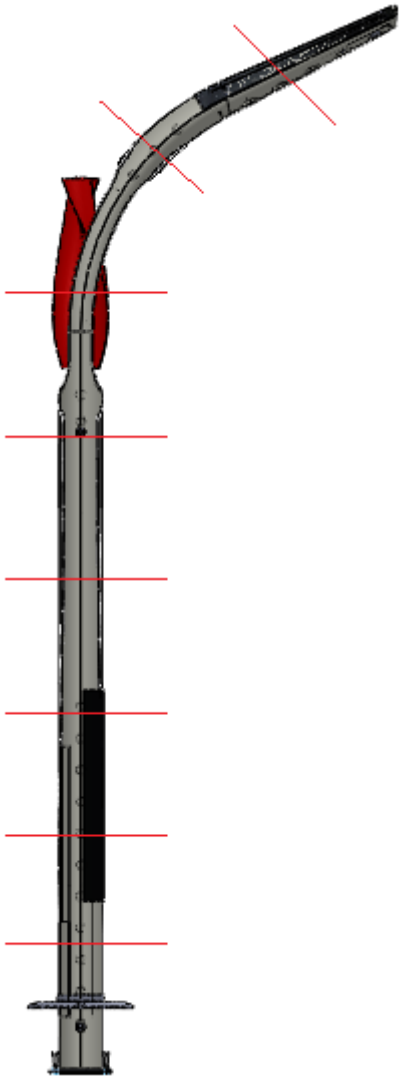
All those properties allow our prototype to be resistance against the external conditions and resist in the time.

The process basically consist in reading the design from 3D printable file (STL file) and lays down successive layers of liquid, powder, paper or sheet material to build the model from a series of cross sections. These layers, which correspond to the virtual cross sections from the CAD model, are joined or automatically fused to create the final shape.

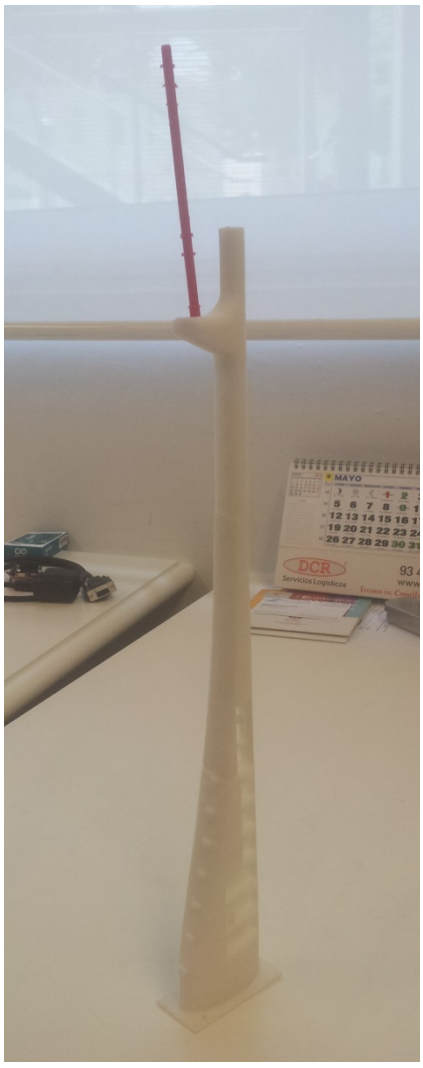
Applying this method, we cut our 3D model in 10 sections because the size of that printer was small. Indeed, Neapolis's printer can only print objects of 13x13x13cm.The picture at the right shows the different colored plastic reel. The 3 colors used for our prototype are blue, for the main part (column) of the node, red for the wind turbine and white for the modular plastic part of the urban node.

Picture 52: Colours

As you can see on the picture below, the Urban Node has cut in 9 parts and the 10th is the wind turbine. We wanted to make a functional prototype with the wind turbine turning, which is why the piece is made of only one element.



Picture 53: Wind turbine cut for 3D printing



Picture 54 : Picture of the pieces of the Node printed

At least, the prototype was made in one week. Then we assembled the different parts sticking them with glue. You can see below and in annexes the final representation of the Urban Node printed.

At least, the prototype was made in one week. Then we assembled the different parts sticking them with glue. You can see below and in annexes the final representation of the Urban Node printed.

Conclusion

The Urban Node is an innovative, evolutionary project. This is because the project was first launched last year in 2013, with the students from the IPDS and EPS groups, which had the focus to design and develop the Urban Node concept. Their task was to create a futurist node, which could couple several renewable energies such as the sun power and the wind power. This node had also to be an information point with a touchscreen which could provide information about the city, the weather, the time and things interesting to do in Vilanova I la Gueltru, as a virtual tourism office.

This semester we had main objectives to develop this Urban Node to scale, as a multi-functional, sustainable and aesthetically pleasing element of small architecture. We are planning to incorporate inside Urban Node following elements: solar panel, new generation antenna for WI-FI distribution, wind turbine, interactive screen, CCTV Camera, sensors (temperature sensor, barometric pressure, humidity sensor, light sensor, infrared sensor, decibel sensor, speed and direction of wind sensor, air quality sensor). Also, we had to define the dimensions of this node, the materials that will then be applied to our results for a strength analysis in order to judge exactly what will be needed to launch the production of this Urban Node, in collaboration with a chosen company.

The project has progressed immensely. We have succeeded to define that the Urban Node composed of two parts, which will be easier for the production and also for the material definition. The materials have been defined, we realized that using simple materials, as steel alloy would be cheaper and more efficient for the weather resistance, particularly against the corrosion effect caused by the salt of the sea, more present in the atmosphere of Vilanova. We have also carried out in depth research that indicates that using steel would not create interference, especially for the WI-FI waves.

With regards to the Gantt chart, the project met some difficulties, particularly for the strength analysis. We also had difficulties with the access of technical drawings and CAD modeling files, which were apparently. We sent several emails to the last year project members that gave us a solution to our problem. We then succeeded to retrieve the CAD from the group. Not being in possession of the software required for the file reading, we couldn't progress on this point until later on in the semester. However, once we had retrieved the files, thanks to sold works we were able to define the changes we had made.

The Urban Node project is a large-scale project, which requires the common investment of all the different members of the team to produce a considerable amount of work. Although the Node is a lot closer to entering the market that it previously was there is still a lot of work needed in regards to the electrical part. The next EPS groups would ideally complete this next year. Who should focus on the electrical part including all the sensors.

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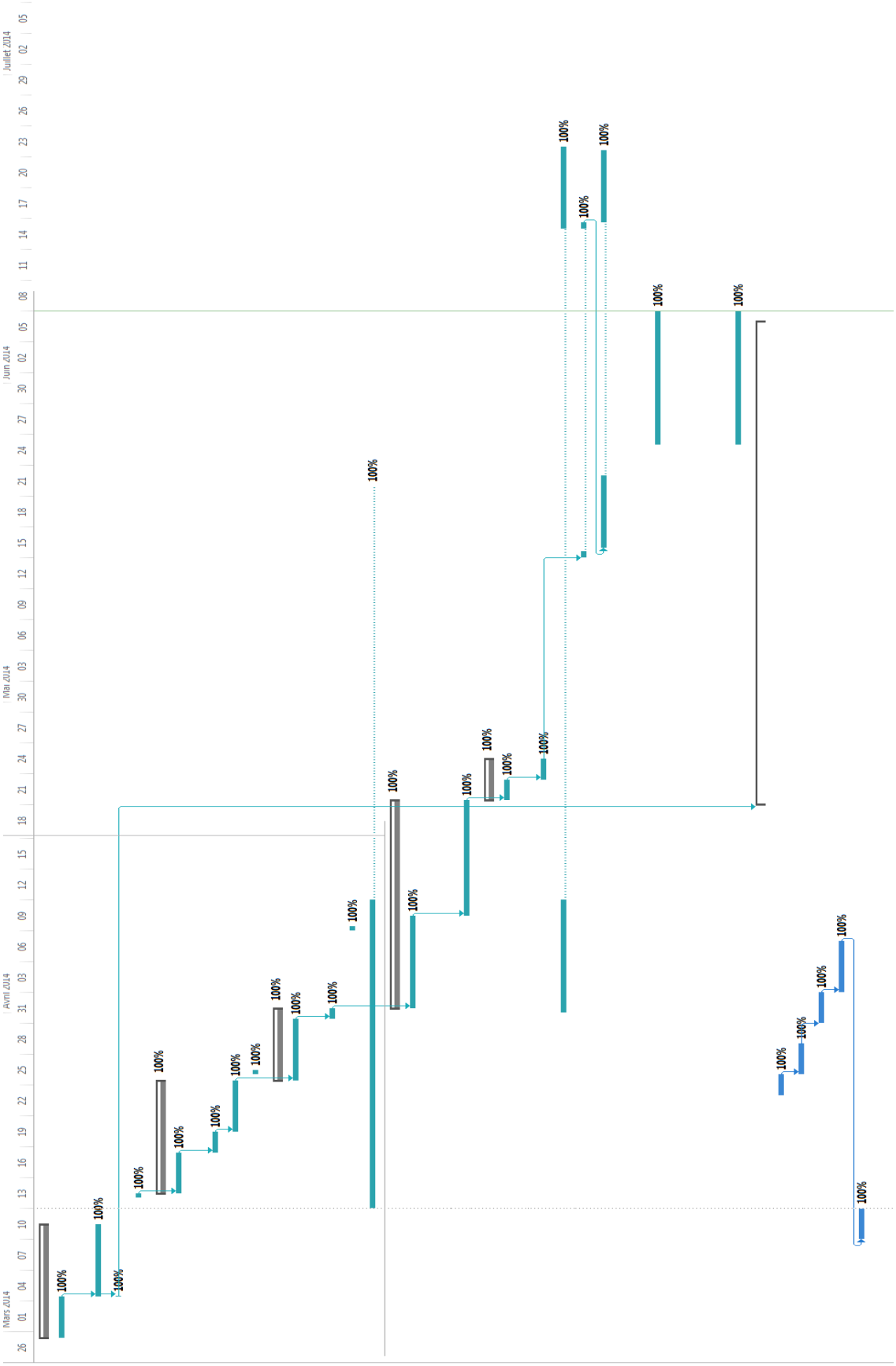
Annexes

Annex 1: Drawing of the Urban Node from previous project

Annex 2: Gantt chart of the project

	Nom de la tâche	Durée	Début	Fin	Préc
1	**1st meeting**	**7 jours**	**Ven 28/02/14**	**Mar 11/03/14**	
2	WBS - Work Breakdown Structure	2 jours	Ven 28/02/14	Mar 04/03/14	
3	Gantt Chart	5 jours	Mar 04/03/14	Mar 11/03/14	2
4	SWOT Analysis	1 hr	Mar 04/03/14	Mar 04/03/14	2
5	2nd meeting	1 hr	Ven 14/03/14	Ven 14/03/14	
6	**Define Dimensions**	**7 jours**	**Ven 14/03/14**	**Mar 25/03/14**	
7	Dimensions from 3d model - Design/Shape Aspect	2 jours	Ven 14/03/14	Mar 18/03/14	5
8	Dividing to moduls	2 jours	Mar 18/03/14	Jeu 20/03/14	7
9	Dimension of each moduls	3 jours	Jeu 20/03/14	Mar 25/03/14	8
10	3rd meeting	1 hr	Mer 26/03/14	Mer 26/03/14	
11	**Define Materials**	**5 jours**	**Mar 25/03/14**	**Mar 01/04/14**	
12	Research and choice of materials	4 jours	Mar 25/03/14	Lun 31/03/14	9
13	Choosing finishing layer	1 jour	Lun 31/03/14	Mar 01/04/14	12
14	4th meeting	1 hr	Mer 09/04/14	Mer 09/04/14	
15	Find Technical Drawings	22 jours	Jeu 13/03/14	Mer 21/05/14	
16	**Strenght Analysis**	**14 jours**	**Mar 01/04/14**	**Lun 21/04/14**	
17	Research for calculation method (in function of materials)	7 jours	Mar 01/04/14	Jeu 10/04/14	13
18	Calculation	7 jours	Jeu 10/04/14	Lun 21/04/14	17
19	**Foundation**	**4 jours**	**Lun 21/04/14**	**Ven 25/04/14**	
20	Research for calculation method	2 jours	Lun 21/04/14	Mer 23/04/14	18
21	Calculation	2 jours	Mer 23/04/14	Ven 25/04/14	20
22	Write the Midterm Report	15 jours	Mar 01/04/14	Lun 23/06/14	
23	Proposition of the specifications	1 jour	Jeu 15/05/14	Lun 16/06/14	21
24	Waiting time - Answer from the company about the specifications	10 jours	Ven 16/05/14	Lun 23/06/14	23
25	Write the Final Project Report	11 jours	Lun 26/05/14	Sam 07/06/14	
26	**Process Production**	**30 jours**	**Lun 30/06/14**	**Ven 08/08/14**	
29	**Quality control**	**9 jours**	**Lun 11/08/14**	**Jeu 21/08/14**	
41	**Delivering product**	**5 jours**	**Lun 25/08/14**	**Ven 29/08/14**	
45	Cost Benefit Analysis	11 jours	Lun 26/05/14	Sam 07/06/14	30
46	**Marketing Plan**	**35 jours**	**Lun 21/04/14**	**Ven 06/06/14**	**4**
47	Analysis of the market	2 jours	Lun 24/03/14	Mar 25/03/14	
48	Analysis of the competitors	3 jours	Mer 26/03/14	Ven 28/03/14	47
49	Porter analysis	3 jours	Lun 31/03/14	Mer 02/04/14	48
50	Commercializing campaign	3 jours	Jeu 03/04/14	Lun 07/04/14	49
51	Selling aspects	3 jours	Lun 10/03/14	Mer 12/03/14	50

Annex 2bis: Gantt Chart Diagram

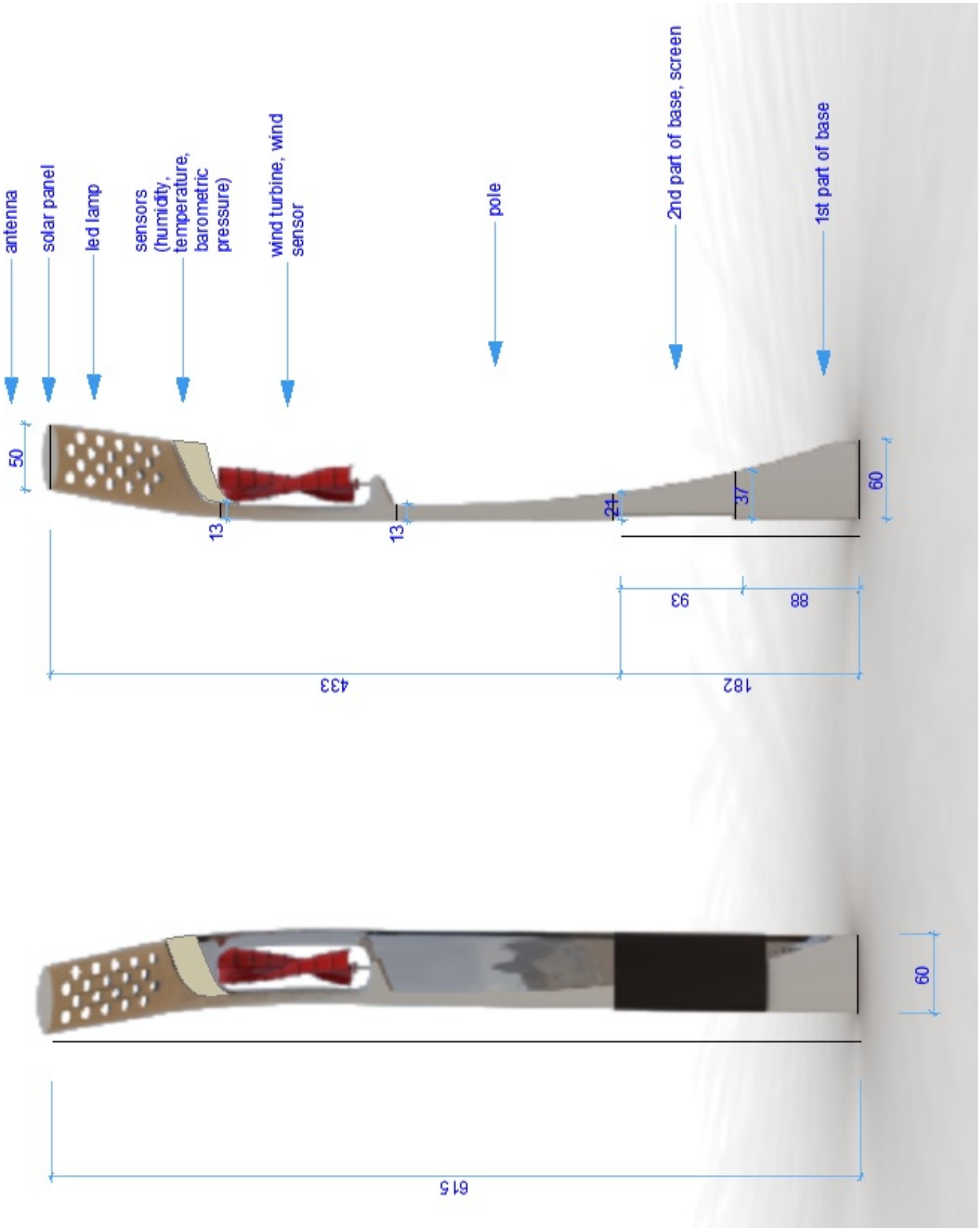


Annex 3: Communication Plan

What	Who/Target	Purpose	When/Frequency	Type/Method(s)
Initiation - Briefing	All stakeholders* Supervisors	Gather information from the previous year project for Initiation Plan. - Explanations of the project by the Supervisors.	07/02/14	Meeting and briefing
Distribute Project Initiation Plan	All stakeholders*	Distribute Plan to alert stakeholders of project scope. - Read the EPS and IDPS project of last year.	Before the first meeting: 28/02/14	Electronic document. Reports in PDF, by mail. Sent by our supervisors. PPM Templates: Project scope
Communication system	All stakeholders*	IT platform to communicate and share documents in real-time between all the members of the team	At the beginning: 10/02/14	Facebook group.
Project Kick Off	All stakeholders*	Communicate plans and stakeholder roles/responsibilities. Encourage communication among stakeholders.	Project Start Date: 28/02/14	Meeting - Work Breakdown Structure - Responsibility Matrix
Status Reports	All stakeholders and Project Office	Update stakeholders on progress of the project.	Every two weeks.	Documents posted of Facebook group. PPM Template: Status Report
Team Meetings	Entire Project Team.	To review detailed plans (tasks, assignments, and action items).	Every week between the members of the team. Every week with the supervisors.	Meeting at School (EPSEVG – team members) Meeting at Neapolis (with Supervisors) PPM Template: Minute meeting form – New one every week.
Project imperatives	Supervisors and Project team.	Work through issues and change requests here according to the imperatives.	Every week.	Meeting at Neapolis
PO (project office) Audit/Review	Supervisors and Project team.	Review status reports, issues, and risks. To identify and communicate potential risks and issues that may affect the schedule, budget, or deliverables.	Every week.	Meeting at Neapolis Project Office will produce report using their template.
Post Project Review & Post Project Presentation	Supervisors and Project team.	Identify improvement plans, lessons learned, what worked and what could have gone better. - Review accomplishments. - Do a training presentation.	Before the mid-term defense: 25/04/14 And also in June, before the Final Project Defense (9-13 June)	Presentation at Neapolis.
Mid-term Report	Project team.	Write the Project Mid-term report.	End of major phase of the project: Mid-term report - 28/04/14	Report of the project. PDF or Word document. Send it to the Supervisors.
Mid-term Defense	Supervisors, Project team, Teachers, Studies and students.	Presentation of the project.	28/04/14	Presentation at School (EPSEVG)
Quarterly Project Review	Supervisors and Project team.	Review overall health of the project and highlight areas that need action.	1 or 2 times after Mid-term report.	Meeting
Initiation of Manufacturing Process	Different companies	Redaction of the letter to find a company which will accept to begin the production.	07/04/14	Letter and Specifications of the Urban Node.
Presentations to Special Interest Groups: → Company	Project team, AMG (Academic Managers Group), Company.	Presentation of our project to the company which will manufacture the Urban Node. Communicate with other interested parties of changes that could be introduced.	Mid-May	Presentation/Demonstration to the company which will approve our project.
Periodic Demos and Target Presentations	Specific Focus Groups or End Users. AMG (Academic Managers Group), Students, Power Users.	To gain input from special groups and keep them abreast of the Project's status. Evolution of the Urban Node manufacture.	Once product has enough to "show". As you complete critical phases or make major enhancements. → Planned for June	Presentation/Discussion with the Company.
Submission of Final Report	Project Team	Submission to the supervisor of the Final Report.	09/06/14	Report of the project. PDF or Word document.
Final Project Defense	Supervisors, Project team, Teachers, Company, Studies and students.	Presentation of the whole Project.	16/06/14	Presentation/Demonstration at Neapolis

- Stakeholders: "...any person or group who has a vested interest in the success of the project, i.e. either provides services to the project, or receives services from the project.
- Key stakeholder: "A person whose support is critical to the project – if the support of a key stakeholder were to be withdrawn, the project would fail."

Annex 4: Drawing of the Urban Node with dimensions and elements



Annex 5: Letter to companies

Urban Node

635537348 urbannode@hotmail.com EPSEVG

26th March 2014

company's email
company's name
company's adress
company's location

Dear *company*,
We are a group of students from Polytechnic University of Catalonia (EPSEVG). We are carrying out a project on a modern organic lamp post. We are interested in visiting your company in order to learn the process of production and the products performance as real as possible. We have many aspirations for this product (materials, dimensions, calculations, ideas...). The next step would be to see which techniques are most appropriate and efficient for our product. Thus, in turn we would like to share our ideas with you.

We would hope than you a later date, you would consider building a prototype (1:1).

We look favorably upon your reply and hopefully this will include an acceptance to visit the company.

To conclude, we look forward to this anticipated visit and in sharing our objectives and goals for this project.

Thank you very much for your time.

Sincerely,
Urban Node Team

Annex 6: Solar Panel Information

Things to consider

Kind Solar Panel
- Mono-crystalline
- Poly-crystalline

Working Voltage & Cells number
- 36 cells (12V)
- 72 cells (24V)
- 60 cells

Output Power

Irradiance: 1000 W/m2, to compare different panels sizes.

Irradiance is a measure of the sun's power available at the surface of the earth and it peaks at about 1000 watts per square meter. With typical crystalline solar cell efficiencies around 14-16%, that means we can expect to generate about 140-160W per square meter of solar cells placed in full sun. Insolation is a measure of the available energy from the sun and is expressed in terms of "full sun hours" (i.e. 4 full sun hours = 4 hours of sunlight at an irradiance level of 1000 watts per square meter).

Tolerance

Output power can vary a little bit

Efficiency
- Power can in 1 square meter on solar panel with 1000 W/m2
- Usually goes from 11% to 16%
- f.e. Solar panel (245 W) has 15% of efficiency, so every 1000 W/m2 produces 150 W

Electrical characteristics with temperature in nominal operation

Thermal characteristics

NOCT

Street Light consume (only led's)
- Around 50W per lamp (from 35W to 50W)
- Working around 10 hours/day
- Results = 0.5 KW/day

  Then we must add other functions of urban node that spend more energy

Photovoltaic panel adjustable tilt angle
- Fix support: Max. Performance when is at 90º with Sun (3-4 hours/day)
- Articulated support: Profit 100 % sun power but high maintenance.

Bird protection (avoid depositions on panel)

Prices Solar Panel

f.e. 140W: 140W x 4 = 560W (full sun) = 0.560 KW/day.

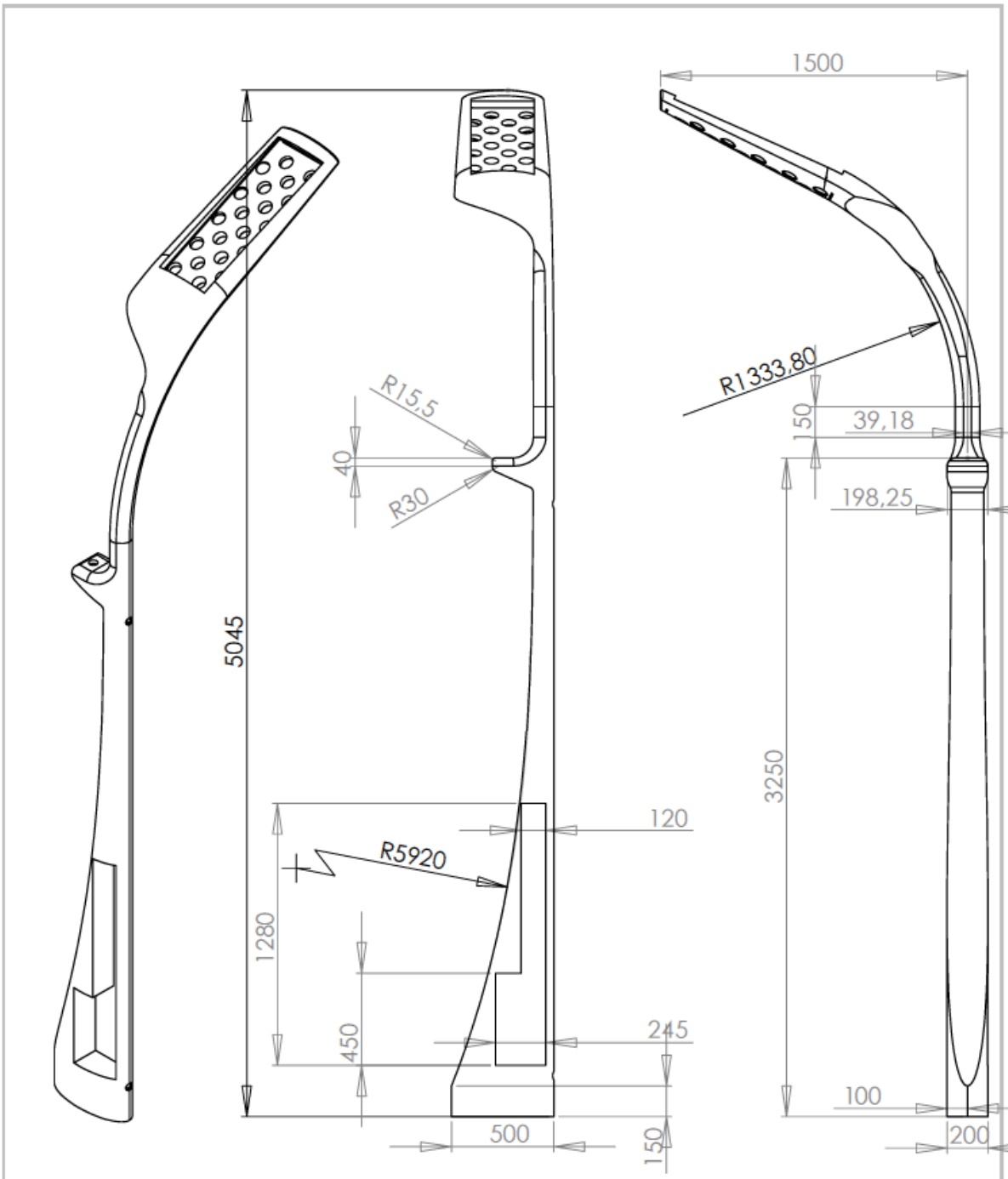
We can say that can be possible to get positive energy.

But the problem is the size of solar panels because it is difficult to find ones that have the dimensions about urban node surfaces on the top.

Urban Node surface top

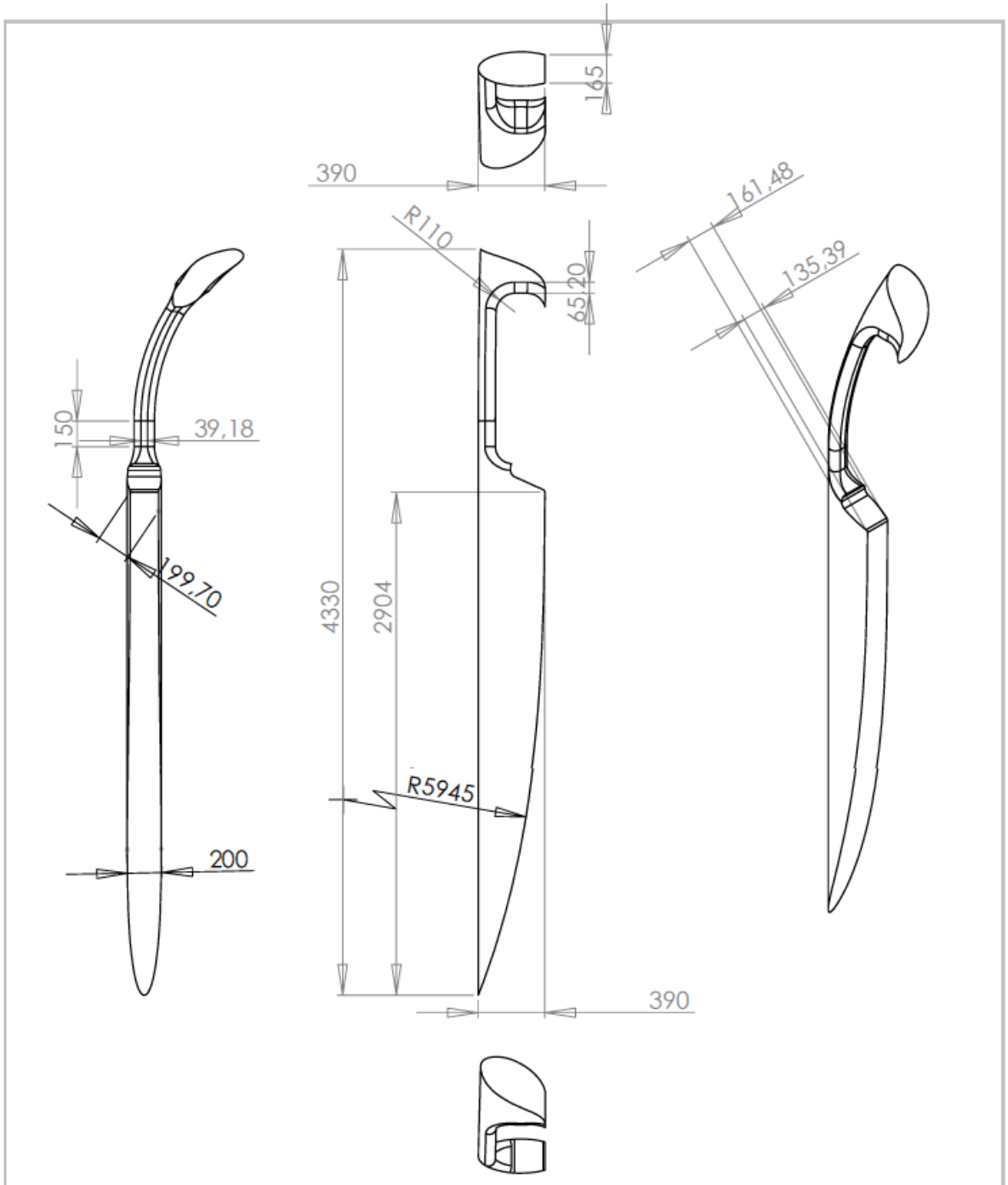
We have more or less 0.2m2 surface on top.

Annex 7: Base Urban Node



SAUF INDICATION CONTRAIRE: LES COTES SONT EN MILLIMETRES ETAT DE SURFACE: TOLERANCES: LINEAIRES: ANGULAIRES:	FINITION:		CASSER LES ANGLES VIFS	NE PAS CHANGER L'ECHELLE	REVISION		
	NOM	SIGNATURE	DATE			TITRE:	
AUTEUR						Base UrbanNode	
VERIF.							
APPR.							
FAB.							
QUAL.				MATERIAUX:		No. DE PLAN	A4
				MASSE:		ECHELLE:1:50	FEUILLE 1 SUR 1

Annex 8: Transparent Part Urban Node



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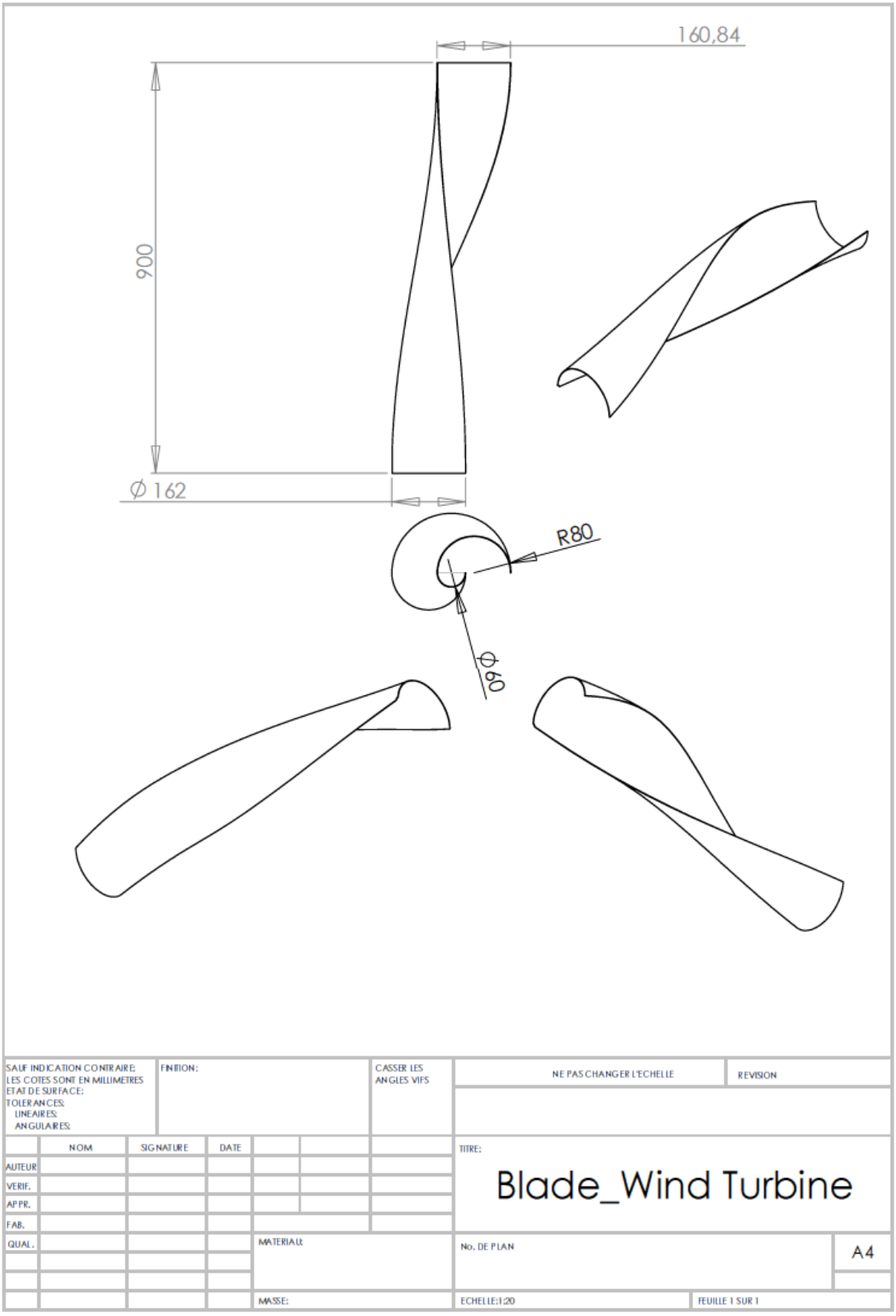
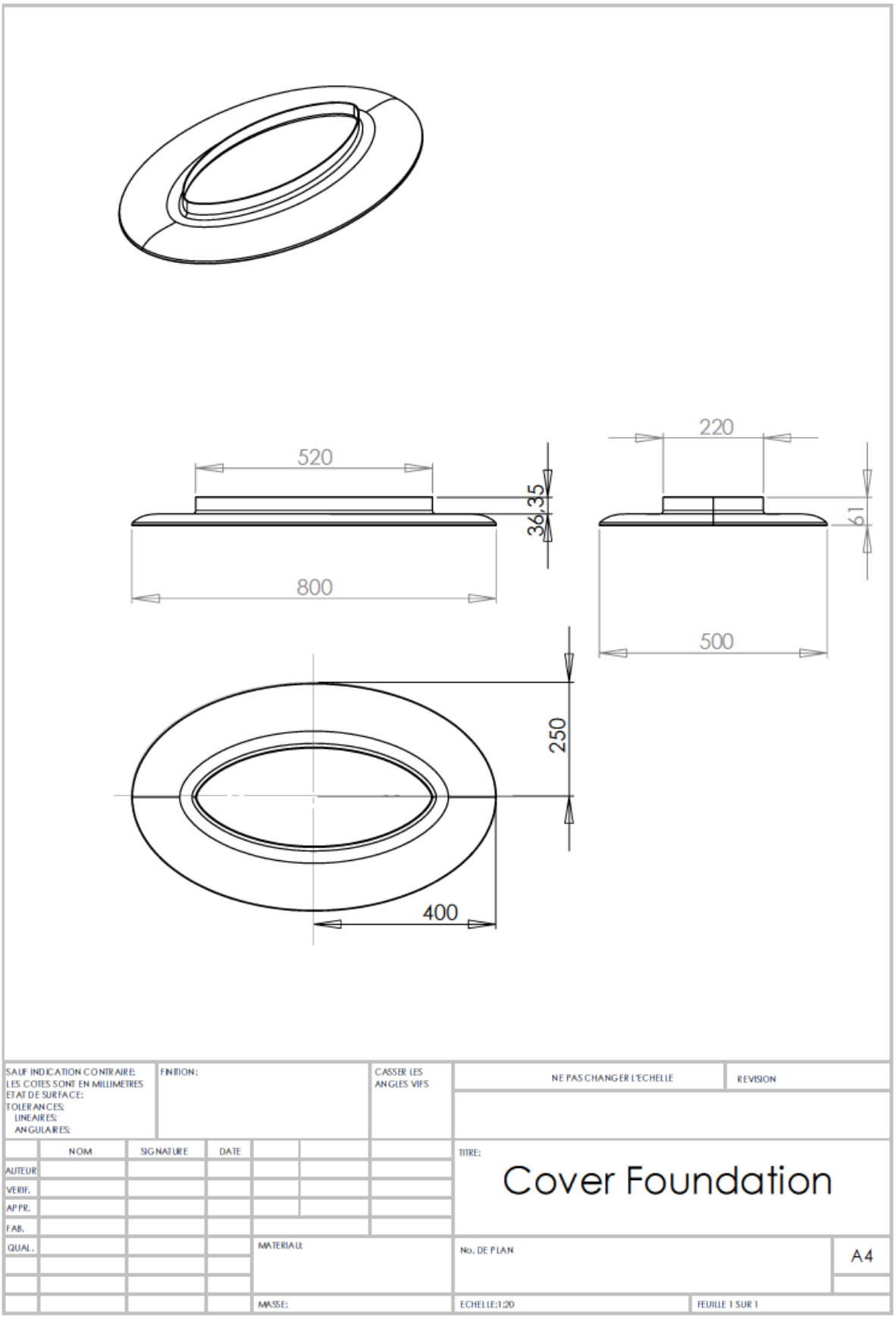
AUTEUR							
VERIF.							
APPR.							
FAB.							
QUAL.				MATERIAUX		No. DE PLAN	A4
				MASSE:		ECHELLE: 1:50	FEUILLE 1 SUR 1

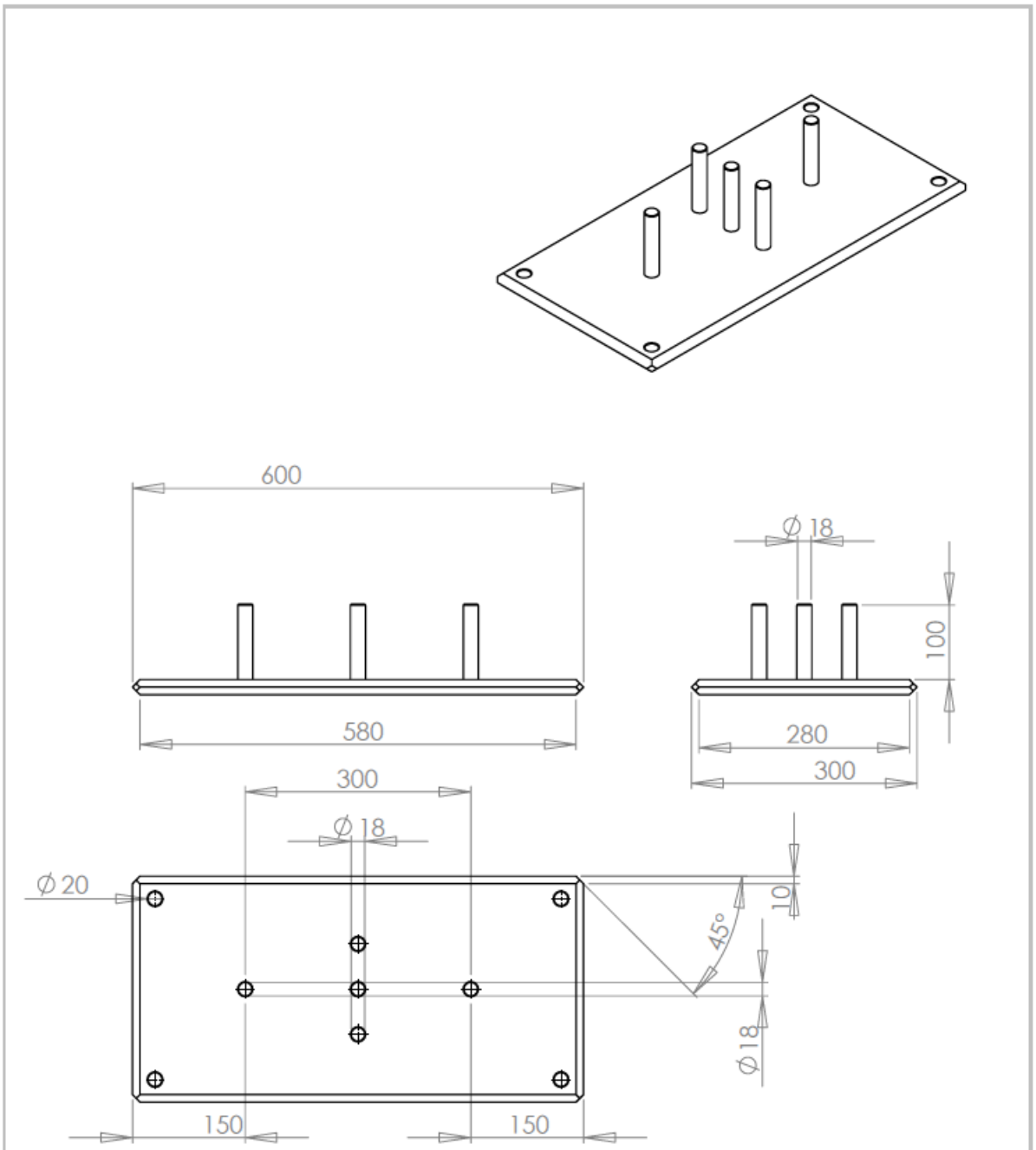
Annex 9: Blade – Wind Turbine



Annex 10: Cover Foundation



Annex 11: Foundation



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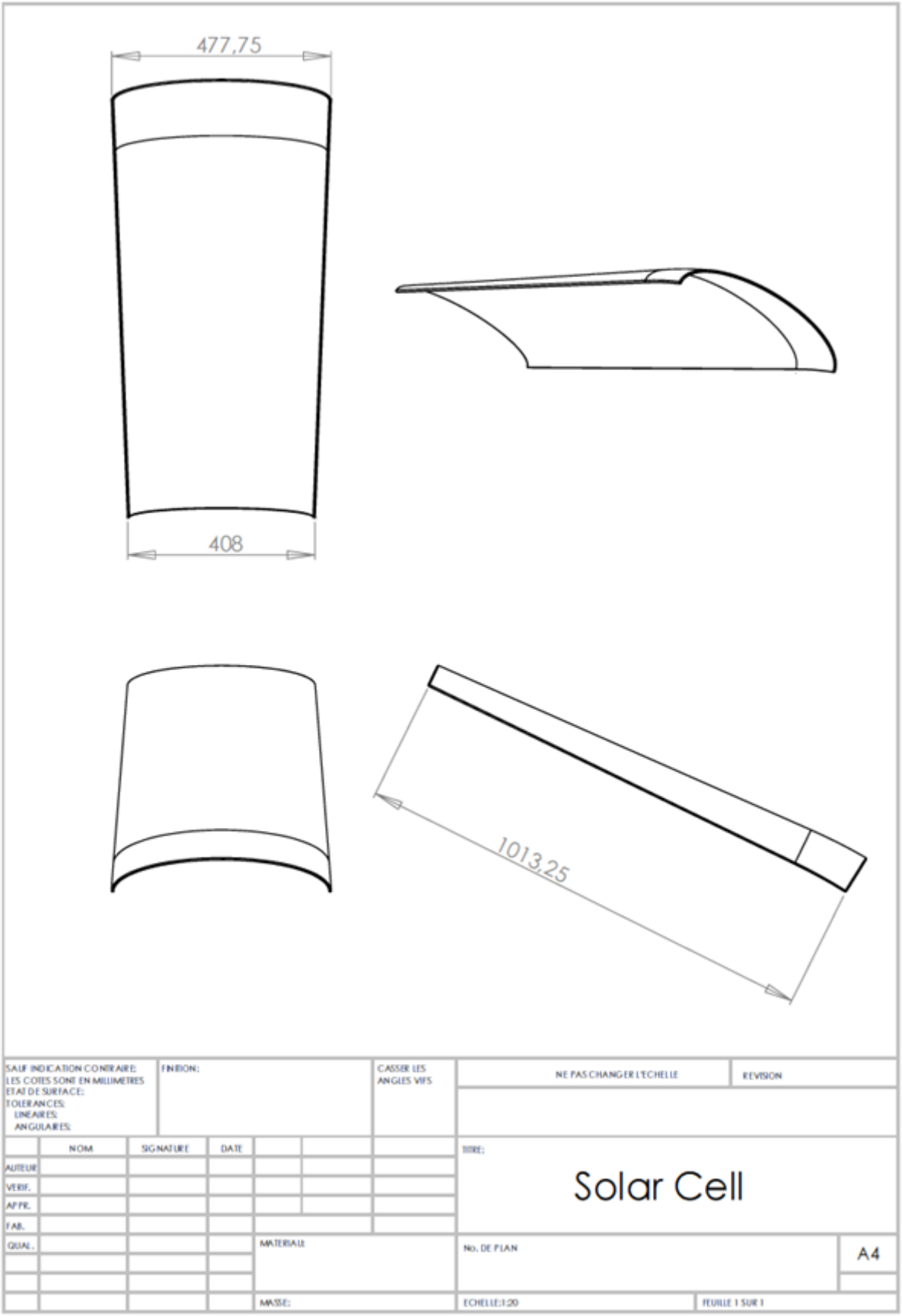
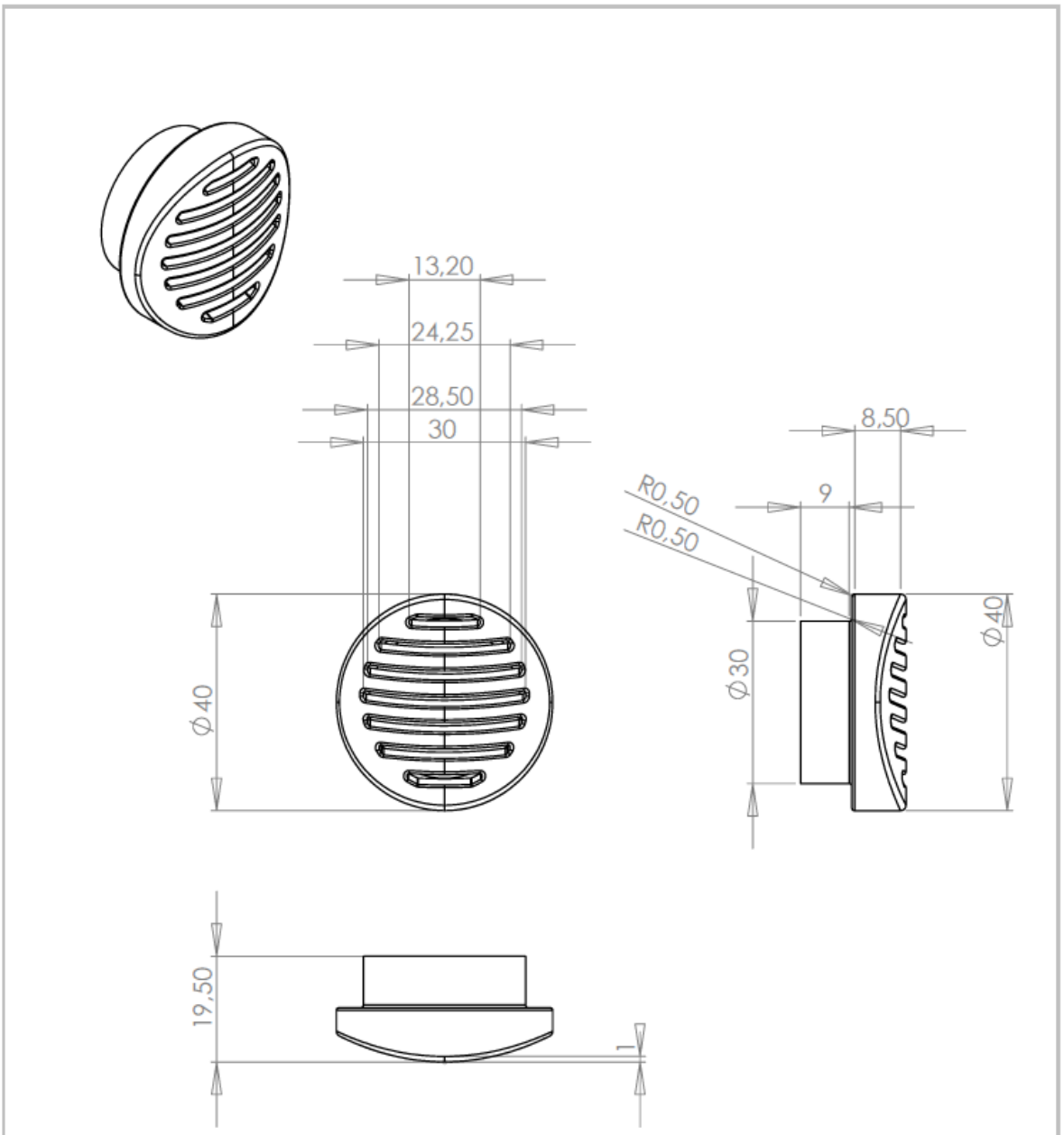
	NOM	SIGNATURE	DATE	TITRE:		
AUTEUR				FOUNDATION		
VERIF.						
APPR.						
FAB.						
QUAL.				MATERIAUX	No. DE PLAN	A4
				MASSE:	ECHELLE:1:10	FEUILLE 1 SUR 1

Annex 12: Solar Cell



Annex 13: Ventil



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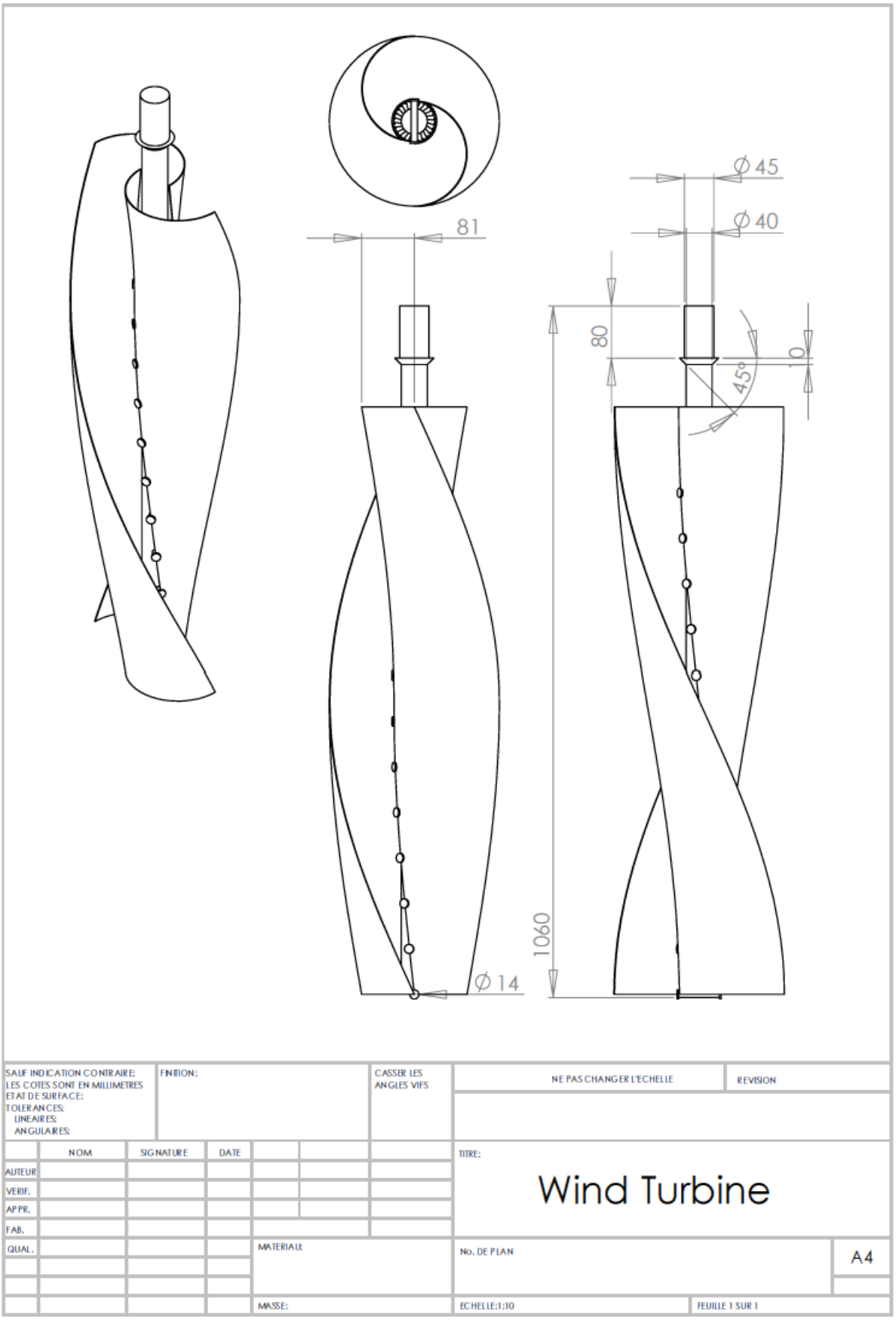
	NOM	SIGNATURE	DATE			TITRE:	
AUTEUR						VENTIL	
VERIF.							
APPR.							
FAB.							
QUAL.				MATERIAUX		No. DE PLAN	A4
				MASSE:		ECHELLE:1:1	FEUILLE 1 SUR 1

Annex 14: Wind Turbine



Annex 15: Final Render