International Design Project Semester

the urban node

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Abstract **–** The urban node project originates from Neapolis, which is a government owned institution promoting technology and innovation in Vilanova i la Geltrú. The essential idea of the project is to reinvent the traditional light pole, to become a self-sufficient and sustainable urban element. This urban element should help to transform Vilanova i la Geltrú into a smart city. In the periphery around this core concept several other topics were investigated, such as the needs of the local residents, workers and tourists and how to address these needs through smart governance.

Keywords – ICT, sustainability, smart city, innovation, urban furniture, Vilanova i la Geltrú, Eco Design, State of art

I. INTRODUCTION

The project was conducted by a multinational and interdisciplinary team of engineers and designers.

- Aline Thomé Braganca is from Natal in Brasil, where she is studying product, service and graphic design at UFRN.
- Anja Sandberg is from Malmoe in Sweden, where she is studying mechanical engineering with industrial design at LTH.
- Erika Ramirez is from Ciudad de Mexico in Mexico, where she is studying industrial design at ITESM CCM
- Kasper Sørensen is from Copenhagen in Denmark, where he is studying mechanical engineering at DTU
- Marina Graells is from Barcelona in Spain, where she is studying mechanical engineering with industrial design at EPSEVG.

The aim of the project is to create a new urban element, called urban node, which was able to generate more energy than it spends and distribute wireless fidelity to the public. Two groups, EPS & IDPS, were working in parallel on the same project, with two different approaches. Strictly speaking, it was an engineering group and a design group, but both consisting of multidisciplinary teams, which helped the collaboration in between the teams.

The main focus of the EPS was to create a prototype that is able to combine hardware and software efficiently in order to comply with guidelines from IDPS. However, a more specific scope was chosen in order to minimize the workload.

The main focus of the IDPS was to define the frame of the urban node and its functions, as well as justifying these choices. Based on this, every choice was originated on needs of the city or the population.

The combination of engineering and design in two teams, one with a confined and pragmatic approach and another with an unconfined and idealistic approach proved to be a real life challenge in communication. However, both EPS and IDPS mastered this challenge, by aiding the other team with the unique skills at their disposal when it was needed.

II. RESEARCH

An integral part of this project was gathering knowledge from different fields, the most obvious two being design and engineering.

However, several other fields were investigated such as human factors, state of art, smart cities and general energy research. All of these topics have different relations to design and engineering and the challenge was to combine the collected information in a useful fashion in the urban node. So not only was information gathered, but also translated to be appropriate and easy to apply to the urban node.

The most evident example of this is the survey applied at an early stage of the project, which helped in choosing the scope of the project. It changed the project scope away from including electric car charges, and towards including a whole other area of town based upon the needs of the people interviewed.

III. DESIGN PROCESS

In the beginning the major focus regarding the design was placed upon the sustainability, modularity and standardization, which influenced the design. The results of these considerations can be found in the final design.

The modularity is very evident through the array of optional functions, the standardization is also easily seen through the functions, but can also be seen through the materials, which are the same for every urban node. The sustainability aspect of the project influenced the design, as a type of renewable should be physically included. At this stage of the project a model was selected and presented to the supervisors.

Later in the project, the focus turned towards a more contextual focus and on how to successfully integrate the urban node into its surroundings. A more organic shape was developed to accomplish this.

IV. FINAL SHAPE

The shape is a result of the considerations, which took place in the design process and can be found summarized in the functional analysis in the report.

A few general considerations were made while designing the urban node.

- Ergonomics
- User interface
- Eco-design
- Vandalism
- Future proof

In regards to ergonomics, a study of anthropometrics' was completed in order to justify the placement of the urban nodes interactive parts, such as the user interface. Eco-design was used to validate the sustainability aspect of the project and to prove this visually to the public. Vandalism is sought to be prevented by empowering the people through the feeling of ownership of the urban node. Finally, the design must be a suitable platform both now and in the future, so elements were borrowed from the local environment to establish a stronger connection between local residents and the urban node.

The placement of the wind turbine was deliberately chosen not be placed on the highest point of the node, but rather on the side of it. This alternative placement was chosen in order to highlight the fact that the urban node is a new and innovative conceptual project, unlike the many hybrids between street lighting and energy generation, which share a common soulless design approach of smashing technology together.

The solar panels will act as a lid for the backside of the light fixtures, which will make the installation of both light and solar panel easy and straightforward.

It was important to achieve a smooth a streamlined design, which is the reasoning for the three materials. The rough and heavy look of the concrete will be complemented by the elegance of the polished steel and the lightness of the polycarbonate. Together the materials create an attractive design, which is evoking the curiosity of the users.

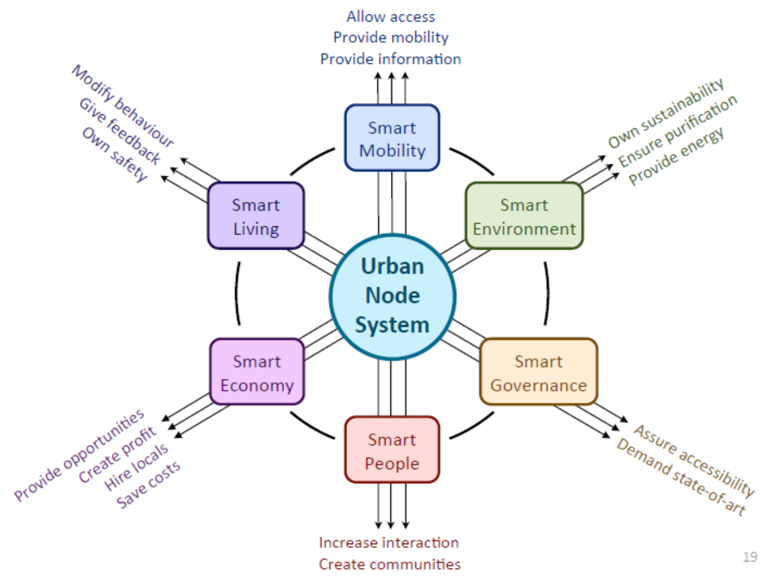
The colors of the urban node will be dominated by a bright white concrete, which is also the base for the artistic competition. The polycarbonate will be aimed to have the highest possible visual transparency. In between these two materials the shiny stainless steel will act as a smooth transition, marking the separation of opaque and transparent. Finally, a bright deep red is applied to the VAWT to make it stand out and promote the sustainable aspect of the node.

V. FUNCTIONS

The main function of the urban node were decided from the conclusions on the research regarding Vilanova i la Geltrú, demographics, state of the art, street furniture, smart cities and general principles for interacting.

The smart city model invented by the Centre of Regional Science at the Vienna University of Technology was adopted and modified to fit. Below the graph is showing a few of the more important needs that the urban node system should address.

All these needs were discovered through the research carried out and can be seen in full in the function analysis.

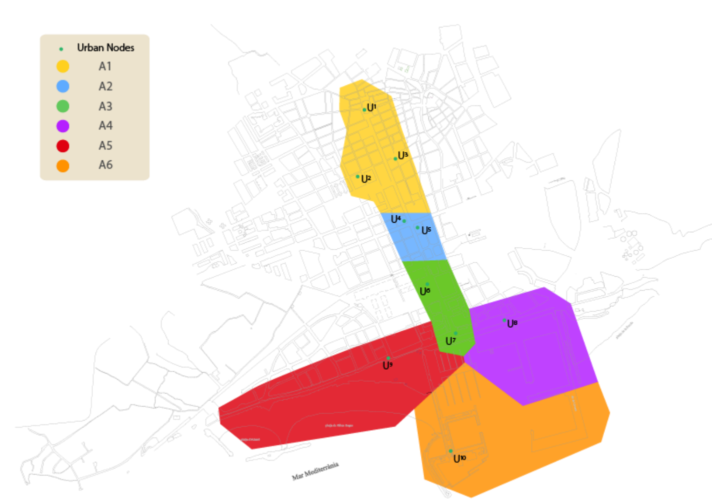


Wind power is great solution at the beach promenade, where an average airflow of 6 m/s is common [1]. In the city with a lower average airflow it is obviously less efficient; however it is still efficient enough to operate. The low start up speed of vertical axis wind turbines, allows for energy generation even at wind speeds below 2 m/s. A savonius design is chosen as the best overall option.

Solar power is an emerging and promising technology. With mono crystalline technology now reaching 20% efficiency at a still decreasing cost, it is impossible to neglect the possibilities of the photovoltaic effect. The combination of wind and solar is chosen to get a more constant energy income.

IV. PLACEMENT

Through qualitative research such as surveys and several field studies, a number of locations were selected due to their strategic important location.



Each area was investigated for existing street furniture and general feel of the environment. This was done in order to use the modularity of the urban node functions to only apply the required function to the required places.

It was found that some functions were relevant to apply everywhere and others only in a few or even only a single location.

V. MATERIALS

The material selection part of the project was conducted in Granta Designs software Cambridge Engineering Selector. In order to comply with the projects sustainable intentions, the materials to be used in the urban node and the processes they may be exposed to can be explained as simple objectives and constraints. These general requirements are:

Objectives

- Minimize price
- Minimize CO_2 footprint
- Minimize embodied energy

Constraints

- Non-toxic
- Excellent in marine environment
- Recyclable
- Possibility to down cycle
- Local manufacture

The types of materials of the urban node were determined in the design phase, to be a structural material, a transparent and a transition material. This classification allowed setting out further specification for each material type. To demonstrate the process, a walkthrough of selecting the structural material is shown below.

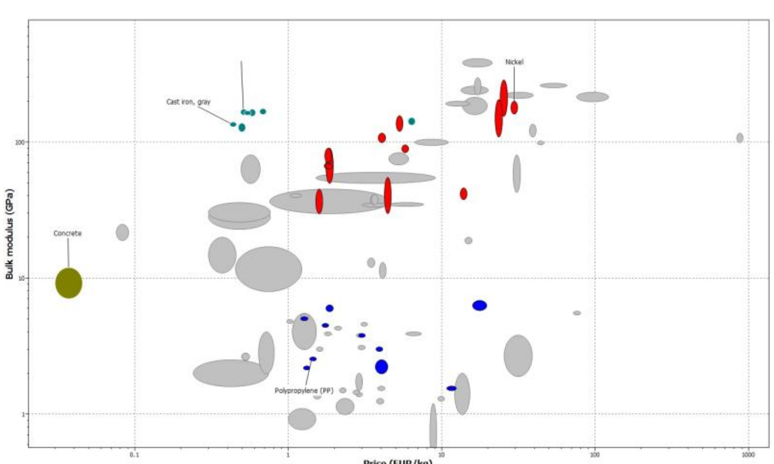
The structural material was chosen by setting the objectives to be

- Increase compressive strength
- Reduce density
- Increase bulk modulus

Constraints:

- Fracture toughness
- Opaque

After screening with the both the general and specific constraints a graph was developed considering both the general objectives and the specific objectives.

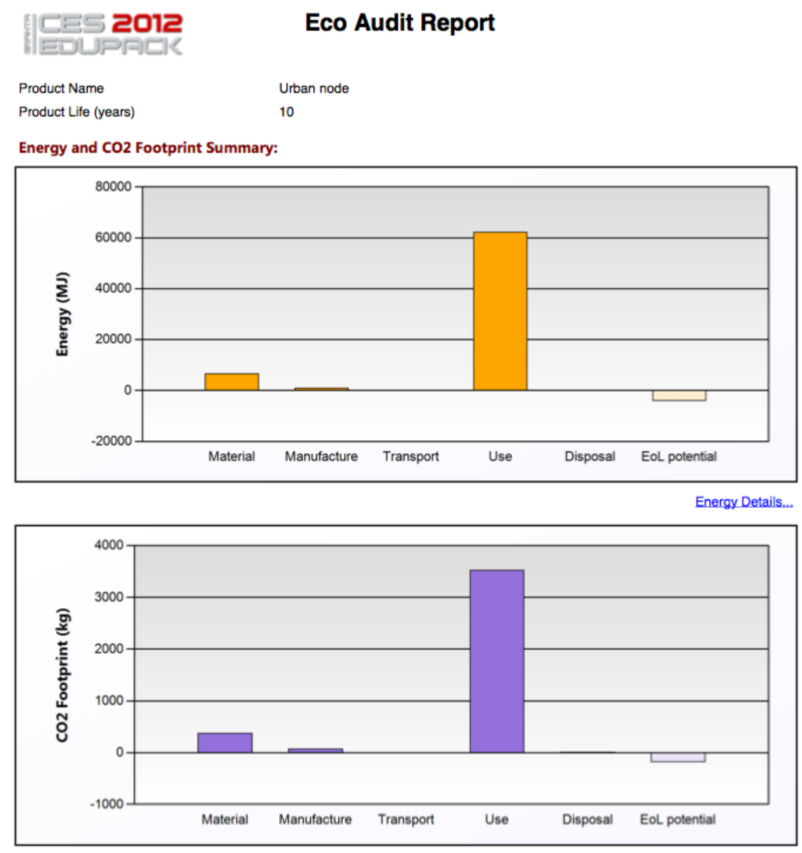


As seen on the picture concrete (read: brown circle) is here the most optimal solution in regards to price and bulk modulus.

Unfortunately, concrete is also very brittle when carrying tensile loads, a problem that must be counteracted with reinforcement in order to make the design proposal feasible.

The same approach was applied to the other materials, which were found to be polycarbonate and stainless steel.

Finally, an Eco-audit was performed using these three materials in order to show the total carbon footprint of the urban node exterior.

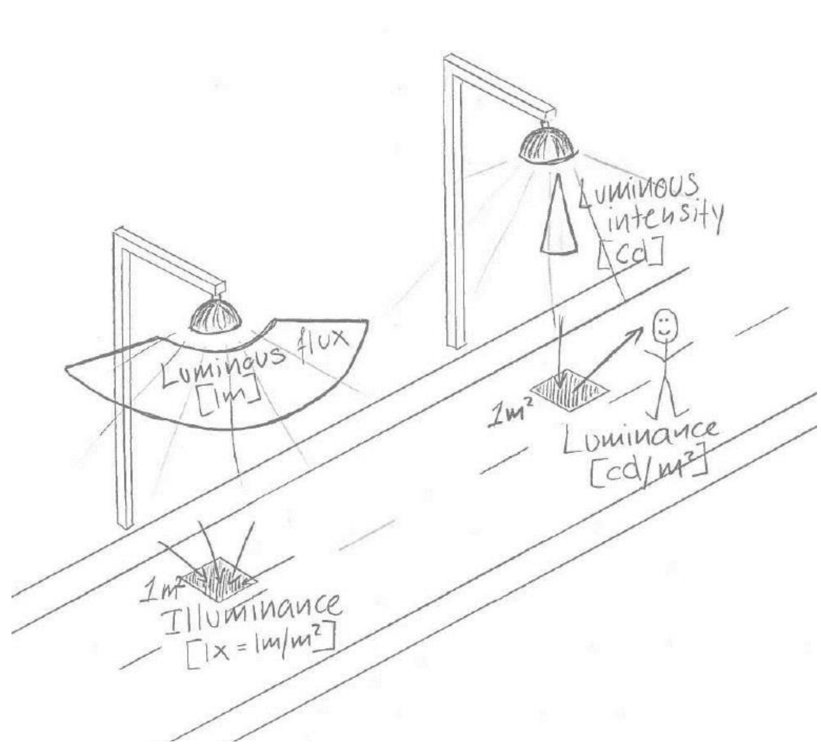


According to the Eco Audit, the biggest energy consumption and CO2 footprint index would be in the using stage, but this data considers that the energy used is regular grid energy. As the urban node will generate its own energy through renewables, the given usage data can be disconsidered. The impact of the material can also be compensated by the EoL (end of life) potential. So, when this data is put together the impact is almost neutralized, what makes the total impact of the urban node be minimal.

VI. ILLUMINATION

In general the urban nodes will only complement to the existing street lighting, however, to prove its diligence as street light the marina was chosen to showcase the urban nodes potential.

Luminaires calculations are ensuring that the high efficiency LED lights also are delivering a high quality solution. The calculation can be found in the report and all prove the usefulness of the LED in several aspects. The basics for the calculation are found on the illustration shown below.



Luminous flux, illuminance, luminous intensity and luminance are all taken into consideration and used as properties for investigating the quality of the light. Briefly, summarized it is found that the LED lighting in the position intended will supply sufficient lighting on the street while not polluting the skies with excessive lighting.

VII. INTERNAL STRUCTURE

The structural part of the urban node, which will be molded concrete, will have an internal structure specifically designed to meet the requirements from the EPS team. Therefore the internal structure will have a detailed shape, fitting electronics and also facilitating installation, ventilation and maintenance.

The structural material will be molded as a solid body, with holes for

- Modular boxes
- Grid-tie inverter for solar panel
- Grid-tie inverter for wind turbine
- Wind turbine
- Solar panel
- LED-light
- Cables
- Airflow
- Installation (to ground)
- Installation (of rack system

In this way, the installation of the node can be done in factory and delivered as a one-piece installation on a truck. This is desirable due to better assembly and working environments in the factory, compared to in the streets.

To cool down all the electronic parts in the urban node, and make sure that the thermal sensor gives the correct data, there will be two main airflows in the structure. One from the bottom leading the air through the GTIs and the boxes and then up and out through the tunnel. The other one will give an airflow cooling down the solar panel and the LED-lights in the top.
Both airflows are designed to not let either water or dust into the system. The lower airflow will have two ports with holes; these holes have an angle to prevent particles to pass. The upper airflow has its intakes underneath the lamp, which also prevents particles to pass.

VIII. CONCLUSION

The urban node system as it is proposed will be fulfilling the initial requirements of project, which is to create a new urban element with functionalities such:

- Produce energy
- Data platform
- Touchscreen

Furthermore it is designed with the parameters of the project brief, so that it is:

- Ergonomic
- Ecologic
- Simple maintenance
- Secure
- Attractive

Regarding feasibility, everything specified is state of the art, but not at a conceptual stage. This means that everything proposed already exist in one form or another, and it simply needs to be translated onto the urban node platform. This will require a significant effort when taking the project to the next level, but it is achievable for students to do.

In conclusion, the urban node will be an urban element, which will promote Vilanova I La Geltru as a smarter and more innovative city, attracting more tourist and business while giving the local residents a great addition to their local environment.

The urban node proposed by the IDPS team is its own in many ways. The features it suggests do exist in other products, but the combination of features and their placement in public is truly unique. Charging your phone is absolutely not revolutionary, but becoming empowered with the opportunity to do so in public is. The urban node addresses some unmet needs of society, and might just become as unimaginable to live without as your phone.

Although the pilot project is intended for Vilanova I la Geltru, the full scale of the project is to extend to other cities if the project proves successful.

IX. Acknowledgments

Inspiration has been drawn from many other projects and project partners.

Companies
Clearchannel
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Projects
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Dong

X. REFERENCES

[1] : Vilanova I La Geltru wind data 1995-2010