Reflection

Scientific reflection

The relationship between research and design

This thesis is a design by research project. First of all, literature research upon photovoltaic technology and heritage buildings had to be explored in order to form a context of relevant information. Then, the combination of the two different previous subjects formed a new one which was based on literature research and reference case studies, since the subject is still underdeveloped. All these framed the criteria in which the evaluation of a photovoltaic application could be based on. Finally, the criteria structured the characteristics which the design should comply on and thus the different combinations was patterned in the matrix. The final proposal was an outcome of the matrix combinations and calculations regarding energy performance of photovoltaic modules. However, the proposed scenario was also a result of the building's own requirements, since the solar intervention should be relevant and harmonious with the building's urban environment.

The relationship between the graduation topic, master track, and master program

All in all, my graduation topic is a combination of many elements of my master track itself, Building Technology track. The two main factors are the Sustainable Design and the Façade Design, from my track, and Heritage Preservation, from Heritage department. The latter was vital to be explored since it was not a part of my track but was relevant with my thesis project. The needed information had to be collected in order to frame the guidelines in which this special building category has to obey at. Generally my master program is a combination of different sectors of the built environment, from the building construction to building renovation and preservation, but the common factor between all of them is sustainability. This is the element that changes the way of future thinking upon urban environment, and the one that could bring change for the future generations.

Research method and approach chosen in relation to the graduation studio methodical line of inquiry, reflecting thereby upon the scientific relevance of the work.

The methodology chosen for this research was based upon the methodical line of inquiry of the graduation studio. The chosen method for the purpose of this thesis is scientific-technical study and design research by using 2D and 3D computer software. The methodology aims to find ways for design flexibility and adaptability, but at the same time, implying to heritage buildings special requirements. The process was succeeded through computer models and drawings for replicate conditions as close to reality as possible. Therefore, the methodology used literature and design research to improve the aspects of the project and evaluate the results.

The relationship between the graduation project and the wider social, professional and scientific framework, touching upon the transferability of the project results

The impact of the project to the wider society is the possible ways for solar interventions on heritage cases, and especially the design behind the concept. The sustainable interventions for energy production on heritage cases is an important value that leads the design.

The design adaptability of the solar application is part of the zero energy buildings concept that has been promoted globally the last years. Therefore, the export of a methodical tool for solar application in heritage buildings has resulted in an efficient and adaptable design concept. The study concludes in efficient ways to deal with the solar intervention on heritage buildings as it proposes design variations and solutions to deal with the drawbacks of the project.

Since the case study chosen for testing the criteria of solar application on heritage buildings, is a neoclassical structure, the design concept could be applied by the same rules in a different manner in similar style cases in Europe and specially in Greece, since this style is spread in quite every heritage city center. However, that does not mean that in any other heritage case, this concept cannot be used, because the methodology behind the concept is going to follow the same path until the point when the process reaches the building's special requirements. As it have been seen from reference cases, the end result is different and depending on the design requirements of the style and the guidelines from special authorities, but the process of the decision making remains the same. The same study, thus, besides the design variation proposes essential elements that would be the key to apply solar modules in any existed building typology and style.

Additionally, the study achieves to improve and advance the façade design of solar application in an existing building, historic or not, thus contributing to the existing knowledge about the process and offers a tool to the design team to continue with the research in different plot cases.

The ethical issues and dilemmas that may have encountered in doing the research, elaborating the design and potential applications of the results in practice.

The ethical dilemmas behind the research was the same with all references found, that if it is worth investing on solar interventions on heritage buildings since, they are only a small portion of the built stock. In addition to that, the public acceptance and the allowance for the intervention from qualified authorities are big issues to the final result. That is because heritage cases have formed an urban environment that framed the identity of each city center and country, and it cannot be changed easily. But, by first renovation that building portion, to active better building performance, and by second, adding intervention elements for energy production, have many advantages for the building itself, the occupants and the overall urban environment. Specifically, the assessment value of the building rises since is remade viable and safe for the user to live inside and the whole process preserves the building for further deterioration. Furthermore, the overall heritage urban environment keeps its formal glory vivid for future generations which is a living proof of history itself.

Personal reflection

The topic of my graduation thesis first started as a response to the question how photovoltaic technology could be applied on heritage buildings, without compromising their architectural character. It is quite challenging for Architects to and Engineers to design photovoltaic modules which respond to heritage cases, since every style has its own character. My aim with this research is to provide all the tools for applying photovoltaic modules in heritage buildings. From the regulations and guidelines that have to be obeyed , to the different options and combinations depending each case and the end result. Most importantly, with this research, I aim to provide a tool and methodology which begins with a huge variety of options and restrictions, and leads the way to the decision making and the final proposal.

This research focuses on Climate Design and Façade Design, but with a high degree of specific heritage guidelines and aesthetics. In terms of Climate Design, the focus lays on sustainability since the aim of the proposed façade is to promote energy production in heritage buildings and lean the balance to an overall energy transition. The Façade Design was developed in combination with the Climate Design and was derived from energy performance results and heritage guidelines.

As any other research project, I started my study by undergoing some literature research which helped me define the research question and objectives. After the literature research, I was able to filter out the most influential façade design parameters which served as variables in the matrix process. Based on that, the different solutions were formed.

Heritage buildings involve a substantial amount of detail when it comes to interventions and changing the image of them. Each building has a different importance in a local environment and has to be treated differently quite each time. However, as it came out from the research upon reference case studies, there are some criteria that all cases should obey. The important is how well the new intervention is going to interact with the heritage case, the old with the new one. Together with the varies of products, which exist in the market, and those which are still in development, complicate the workflow and it's giving the chance to produce multiple scenarios and combinations.

One of the goals of this study was to evaluate the building's performance under conditions, which are close to reality as possible. Analyzing the solar radiation of the building and, based on the application possibilities that already exist, a first concept is forming on the possible positions that the modules could have on the building. After that, the matrix was formed. All the different criteria and parameters that had to be followed and the specific requirements of my case study, complicated the end result, since there are multiple outcomes with different energy performances. That said, two different energy scenarios were chosen, with two expressions each, one conservative and one progressive. From these scenarios, the most extreme cases were calculated as it comes to energy production and the balancing between the energy demand in each scenario.

The produced intervention was chosen because it is a combination of the scenarios mentioned above. The end result produces around 25 percent of the total energy demand while preserving the image of the heritage building as part of the local urban environment. The energy demand was based to the renovation assumption which is implied from the European Union's regulations and target for each country.

As an overall conclusion about the future interventions in heritage buildings, it is still questionable whether it is worthwhile to invest in these cases and even transform them into near-zero-energy buildings, which is the European Union's aim. However, the more research and development, the more solutions are going be produced and be more efficient and more suitable in every case. Even at this time, there are still many to be improved in terms of technology, but the key to each case is the customization of the products, which make them unique for each end-result.

All in all, new guidelines and regulations for heritage cases should be formed because of the energy transition target, if we want to include them inside the functioning grid. But first and foremost, in order to protect these building from deterioration, is to make them part of every-day life by renovate them and thus needing less energy that once used.