Solar gains in monumental protected structures (case study - a traditional structure in the town of Modra, Slovakia)

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ABSTRACT: Integration of sustainable inputs into culturally-significant, protected structures is quite a recent topic. Although it has not found any support in Slovakia yet, the whole western part of European space has demonstrated interest in it for several years. This topic brings some basic questions like: What is the main role of culture in the sustainability process? How can one define the intersection between new technologies (like solar technologies) and the historical environment? And, why is it important to talk about this topic during the educational preparation of future architects? This article will focus on finding a suitable method, which can identify potentials and limits of placing photovoltaic cells in protected structures. The main aim is to help architects to realise all connections. The main condition should be clear in every project: values of cultural heritage should be preserved as a first measure. A diploma project was chosen to demonstrate a new way of thinking, while caring for a monument, new technologies could be integrated as part of a creative architectural process.

INTRODUCTION

Cultural sustainability is a term, which was created by society after realising that its expansive lifestyle is no longer sustainable. Traditions of ascendents (who lived in harmony with their natural environment) have been ignored for a long time. This unpleasant effect was integrated not only into ethics and legislation, but also into the educational process. Monument care is only one discipline, which explores cultural identity from the point of view of the architectural educational process. Unfortunately, the current system does not care about solving environmental problems, because it is aimed mainly at the protection and restoration of cultural heritage. For this reason, there is a gap between monument preservation and sustainable architecture thanks to many architects perceiving this connection as being.

In the Slovak Republic, monument protection was integrated into its legislative programme thanks to differentiated protection, which classifies different types of historic objects according to their values. If the interest in cultural heritage protection is primary, its position against sustainable integrations will dominate. Authenticity and identity will become the limit for every new intervention, but not as an antipole to every new *…but as a part of the same - complex articulation of material space* [1]. From the point of view of monument restoration, it seems that it includes only the conservation of historic structures without any innovation.

In many cases, it can be true that the main role of architects is to recognise the *power* of new interventions. It is appropriate when the whole process of monument restoration follows a clear concept, which can accept different levels and forms of innovation. Because of that, a new experimental way of education, which is presented in this article, pays attention mainly to modelling scenarios (for example the Du-Mo method from the Netherlands shows a similar approach to this task [2]). Then, students (future owners, architects or some another professionals) can choose the variant and simultaneously take the role of coordinator of the transdisciplinary process which needs the main input: empathy.

The educational method outlined in this article was defined as an experiment. Its outcomes are a part of the ending grant project Architecture and Urban design 2020 - leading to zero energy standard, VEGA No. 1/0559/13 (Faculty of Architecture in Bratislava). This experiment will also be explored in future architectural and urban tasks. It was set to simulate an empathetic process of cultural and physical environment by creating scenarios. This setting is unique in the Slovak Republic. Only one conceptual approach in Slovakia pays attention to placing photovoltaic panels onto historic structures: the methodological guidelines about renewable energy sources and their setting - photovoltaic energy from the point of view of the monument fund protection (September 2013). It was published by the Monuments Board of the Slovak Republic and it is based on a differentiated protection system of monument structures. The document defines different limits for placing photovoltaic panels onto world cultural heritage areas, historic areas, monumental zones, protecting zones, national cultural heritage, archeological heritage and, globally, in protected areas of the monument fund [3]. It is focused at the possible visual vulnerability of sites, which can be devalued mainly from the holistic views

on the historic structure. It seems that the attitude of refusal to these implementations without examining the options available could be an inappropriate response. On the other hand, it is important to consider a wider context for setting these new technologies. These considerations should include the level of monument preservation, the function of an object, assumed energy efficiency, and the whole building operation, which could have an important influence both for the installation of these technologies and architectural development in monument areas [4].

The diploma project selected, endeavoured to verify the options presented by this experimental approach. The object of the old orphanage in the small Slovakian town of Modra was considered to be a suitable example [5]. It consists of three buildings (an old mill from the 18th Century, an orphanage building from 1913 and a school building from the 20th Century). The objects are situated in a nearby protected area of Modra.

Searching for Solution Concept - Creating Scenarios

Students were presented with three basic scenarios: authentic, adaptive and innovative scenarios, which differed according to the *power/pressure* for sustainable implementations and their own philosophy. They made some new assumptions for different solutions depending on their acceptance or refusal. The authentic scenario is aimed at renovating the most precious parts of protected structures and the implementation of contrasts in terms of new forms, materials and technologies that are not allowed. It conserves the homogeneity of the structure. The innovative scenario accepts the heterogeneity of the current condition of a structure and allows for placing new technologies into objects of historic value. The adaptive scenario is a compromise between these two options. This article offers a detailed description of the diploma project's method (part A) and preliminary outcomes for the VEGA project (part B).

DESCRIPTION OF THE CURRENT SITUATION OF THE BUILDING'S SITE - PART A

The scenarios were created for urban and architectural dimensions. The option of the final scenario was conditioned by the opinion about monument preservation. The urban dimension of the site is characterised by the traditional structure of a provincial town, in which the original building of the mill is surrounded by the mill race. The historic structure has been partially disturbed by new apartment houses. At the beginning of the 20th Century, the mill was adapted to become an orphanage. Then, in the second part of the 20th Century, its solitariness was lost due to the erection of new structures around the mill.

The architectural dimension is characterised by an object; namely, a mill from the 18th Century with a mill race (construction - massive stone walls, small windows openings, low highs of interior spaces, sloping roofs, etc), which was changed into an orphanage at the beginning of the 20th Century (construction - thin brick walls, big windows openings, high light height of interior spaces, etc). The orphanage building is shown in Figure 1.

Figure 1: Historic photograph of the orphanage, in front: ancient living part of the mill (source: Petronela Pagáčová).

This situation was seriously disturbed by lodging houses built in the second half of the 20th Century (concrete prefabricates, big window openings, narrow ceilings, etc). It was important to examine the process of placing new technologies on the orphanage roof, the mill and the surrounding buildings, because of the potential of the orphanage building to become a national cultural heritage.

Problems and Finding their Solutions

In the urban dimension, the issue is mainly about eliminating much of the heterogeneity of the urban concept with the vision of returning the solitariness of the orphanage building and, at the same time, finding options for solar gains. According to this student, three possible scenarios of renovation were created, which came from three developmental milestones of the building site.

The first is an authentic scenario that supposes the recovery of a historic urban context from 1913, when the surroundings were created only from traditional structures. This scenario also dismisses any implementation of photovoltaic cells and solar panels, because of the need to retain the atmosphere of the whole context (even if these new technologies were placed only into the inner courtyards). The second adaptive scenario is to keep the existing surroundings in the context, but assumes the setting of photovoltaic and solar panels on the top of the buildings, so the existing surrounding buildings would stay untouched. The last scenario - the innovative model, supposes an application of new technologies into all proper objects of the whole urban context (Figure 2).

In the architectural dimension of design, it is important to consider the value of interiors and constructions of the orphanage building when choosing a suitable function of the object and finding an adequate design of the said new implementations. In this scale, all three scenarios of the building concept were designed. The first (authentic model) was aimed at dismantling all the relatively new-built objects surrounding the orphanage. It supports the vision of the orphanage building returning to being a solitary building. The adaptive scenario partly accepts the existing new buildings surrounding the orphanage and the innovative model works with the current situation without major demolitions of the new buildings.

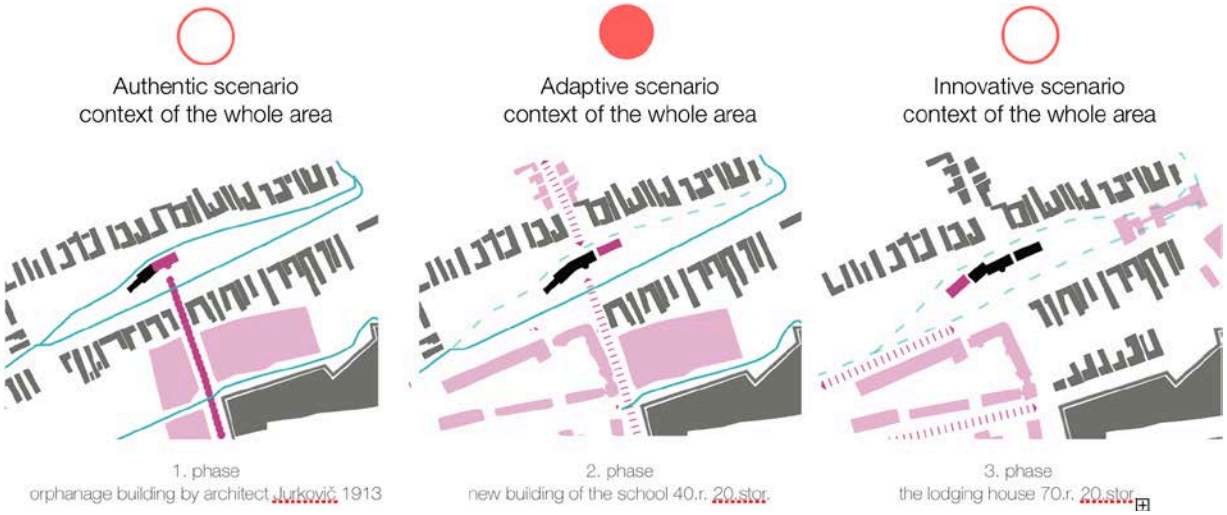

Figure 2: Three scenarios of urban dimension of the orphanage were inspired by the building phases of its setting: phase 1 - authentic scenario; phase 2 - adaptive scenario; phase 3 - innovative scenario (author: Zuzana Koniarová).

Solar technologies could be applied on different scales according to the degree of acceptance of new objects surrounding the orphanage building. In the end, the student chose the innovative scenario in the urban dimension (it focuses on the surrounding context of the orphanage) combined with an authentic scenario of its architectural dimension (aimed at the orphanage building preservation). It means that the modern buildings were accepted in the traditional context as was the setting of solar technologies on the roofs of the inner courtyards. Every disruptive object near the orphanage building was removed, so new technologies that support the orphanage building with renewable energy were located on the roofs of the surrounding buildings. Suitable places would be on the top of all new apartment buildings and, eventually, on the roofs of smaller objects. This concept tries to connect to the idea of *smart grids* in a sustainable town, but nowadays, it is not a sufficient argument, because of many factors, such as owners' relationships, and so on.

Architectural Dimension

It is also possible to apply a similar approach of the three scenarios in order to evaluate interior spaces of the orphanage building and the old mill. The interior spaces, which could not be touched by serious intervention (e.g. interior insulation) were clearly marked according to the type of construction and the protection level of interiors - mainly in the new part of the orphanage.

On the other hand, the desolated rooms of the old mill offered an opportunity to apply interior insulation, and because of that, better interior temperatures of all surfaces allowed functions with a higher demand for temperature to be set there. The architectural concept also included a new addition to the old mill in a passive standard. Considering materials and technologies, it is an innovation from the point of view of shaping it as a partial renovation of the old part of the mill. After temperature schemes were done, it was possible to design functions for every room and also to design the

new interventions mentioned earlier (Figure 3). However, the definition of potentials became the limit for the architectural thinking and, at the same time, it had no influence on the architectural form, which was dependant on the abilities of the architect. So, the question remais: is energy efficiency in a cultural environment limiting or inspiring?

Figure 3: Longitudinal section of orphanage, the old mill, and a new built cafeteria (author: Zuzana Koniarová).

SOLAR ANALYSES - VASARI PROGRAMME - PART B

It was necessary to analyse the chosen area in order to find the best places for installing photovoltaic panels. This solar radiation analysis was done using the Vasari program (Figure 4).

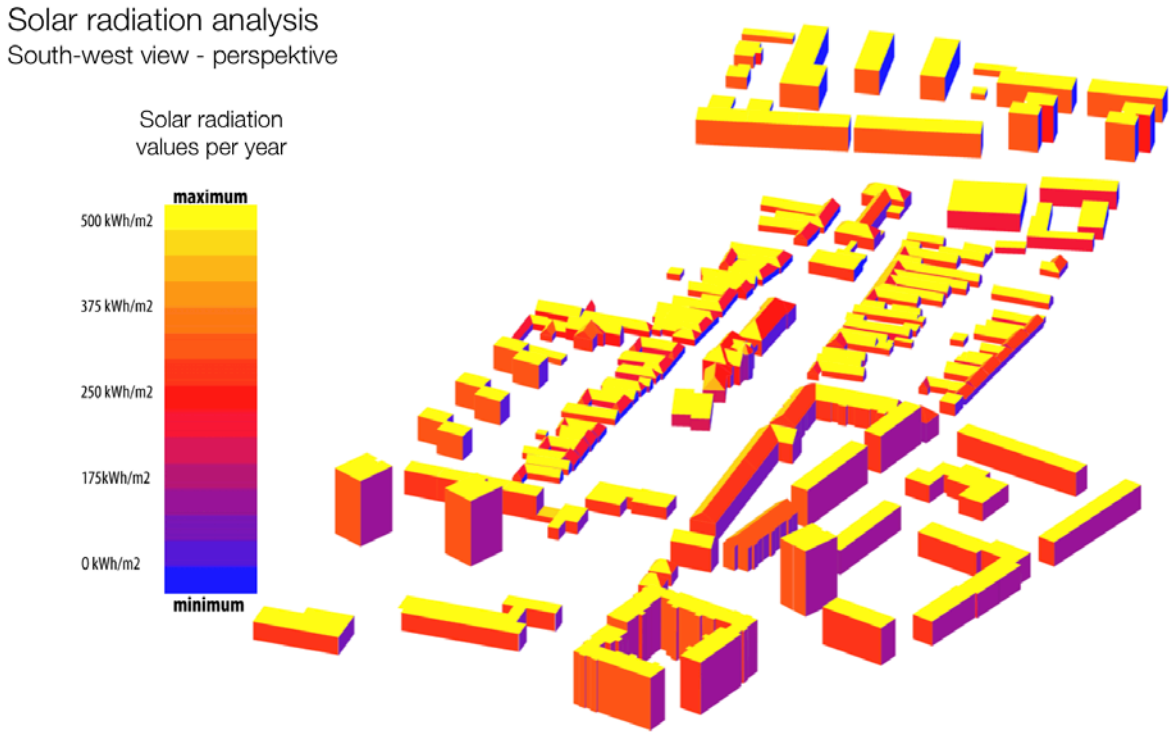

Figure 4: Analysis of solar radiation (author: Zuzana Koniarová).

The orientation of the surrounding objects was ideal from the point of view of the south-north orientation of the roofs, so solar panels could be set in the inner courtyards of the longitudinal objects. On the other hand, the orientation of the orphanage building and the old mill (which was influenced by the creek and mill race) was not suitable from this point of view. After the final evaluation, the total value of solar radiation was 243 kWh/m^2. Based on this analysis, the roofs with the best values of solar radiation were marked on the map. After that, the roofs, which were a part of protected visual vulnerability were excluded. As one could have expected, the best values were measured on the roof in the courtyards. The roof of the orphanage building had no extraordinary values and what was more, it was absolutely inappropriate from the point of view of visual vulnerability to install solar panels there (Figure 5).

The problem of visual vulnerability and excessive contrast between new technologies and traditional buildings is still an unpleasant theme. It is present mainly in the preservation of landmarks. While the design of photovoltaic panels and solar collectors will have this kind of design, its settings in historic areas should be limited. It should not be so strict in the case of changing the design closer to tradition (for example, solar tiles used in England) and so the important limit should be only the energy efficiency of the object.

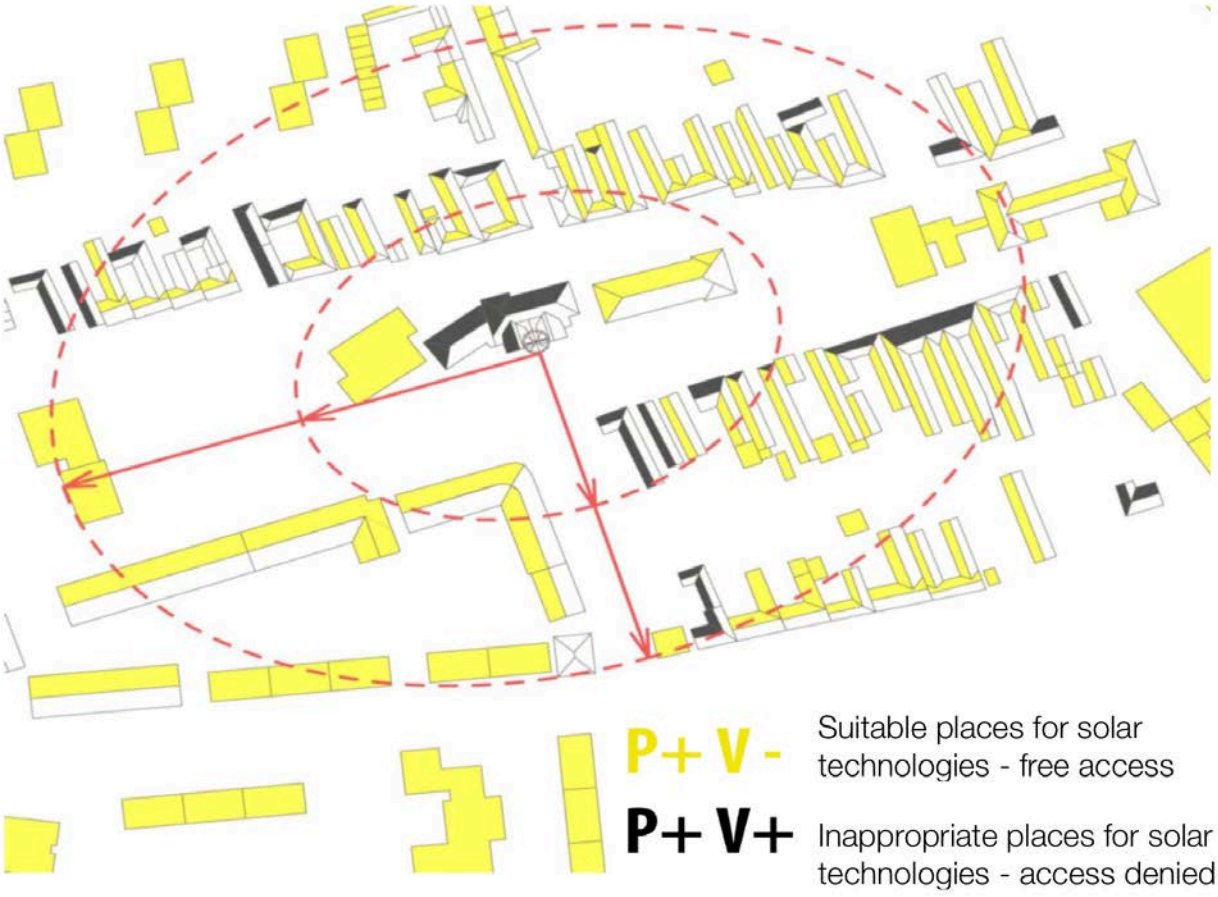

Figure 5: Analysis of proper settings of photovoltaic panels on the roofs of provincial objects (author: Zuzana Koniarová).

CONCLUSIONS

It is important to understand that cultural heritage is mainly about the preservation of timeless values, which without the proper relationship with new technologies, could be endangered to the point, where society will be solving the energy effectiveness of ruins in the future. For this reason, it is important to lead future architects into exploring their own source of empathy and understanding. It is impossible to reach success during designing in historic structures without empathy. A compassionate architect will probably be the most important player in the preservation of monuments.

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REFRENCES

1. Melková, P., *Prožívat architekturu*. Řevnice: Arbor Vitae, 15 (2013) (in Slovak).
2. Troi, A. and Lollini, R. Interdisciplinary Research: FP7 Project: 3ENCULT - Efficient Energy for EU Cultural Heritage (2014), 26 January 2014, www.eurac.edu/en/research/institutes/renewableenergy/Publications2/Documents/EURAC_RenEne_Dubrovnic2011_Troi-Lollini.pdf
3. Metodická Inštrukcia pre Umiestňovanie OZE - Fotovoltická Energia z Hľadiska Ochrany Pamiatkového Fondu. 16 March 2015, RE: Fotovoltika metodika (in Slovak).
4. Coplák, J. and Rakšányi, P., *Plánovanie Ekologických Sídlisk*. Bratislava: ROAD, 26 -27 (2009) (in Slovak).
5. Koniarová, Z., Revitalizácia Modranského Sirotinca. Bratislava: Fakulta Architektúry STU (2014) (in Slovak).