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Interdisciplinary training within the education curricula for architects and engineers

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ABSTRACT: Up until the third decade of the 20th Century, architects relied mainly on the technical outcomes of civilisation when achieving internal environmental standards and used mainly technological solutions. Per Heilselberg says that before the introduction of sophisticated internal systems - internal comfort parameters were achieved through adequate shape of the building's form and detail. Currently, when the civilisation is confronted with the barrier of source scarcity, a shrinking level of not just fossil energy sources, but other sources as well, there is a need to remodel the curricula of design education and move from linear autonomous solutions into interdisciplinary ones, cooperating with external environmental parameters specific to each given location. This type of education is very rare and is difficult to achieve using contemporary education procedures. This article describes the outcomes and problematic issues found during interdisciplinary cooperation between architecture students and students representing other disciplines, during a semester design studio.

Keywords: Integrated design process, urban planning, architecture in sustainable development

INTRODUCTION

After decades of debate, climate change is now accepted as a fact. Analyses also predict that the changes in climate will become stronger and will develop faster. These will have a direct impact on spatial and urban planning, individual buildings and city inhabitants. Inhabitants of urbanised spaces should be aware that they will be the first to feel this impact [1].

This article focuses on the need to change educational programmes dealing with the building industry in both the design and construction phases. Designers have to be aware that a story is hidden behind the development of every urban tissue, street and square layout, density and volume of buildings, existing green areas and many other spatial and often cultural attitudes. Hence, even if cities are located in similar geographical zones, they may be characterised by entirely different vulnerable issues and, therefore, the design approach should be individual in each case [2].

The most commonly found phenomenon is the high percentage area of impermeable urbanised zones, which accumulate heat gains and create higher local temperatures. Urban areas are also subjected to sudden floods caused by unexpected downpours. All cities are dependent on external supplies, other cities and regions. Surrounding suburban and rural areas are the source of clean air, places for rainwater retention and a potential source of potable water, which soon might become one of the main *scarcities*.

From a few years back, the term *sustainable city* has become supported by the term *resilient city*, where resilience refers to possible proofing of the city zone in the face of future stresses arising from climate change. The possibility of a change can be developed through strong input from urban planners and architects, working as part of a team with technical specialists and other participants of the building investment process.

In view of the above, a standalone sustainable building (the most common perspective for many designers), appears to be only the threshold to a sequence of decisions, which should be undertaken already on a wider scale. Regardless of advanced research projects, which can be found in most European scientific centres, education curricula taught to future architects often prove that the idea that preservation of natural environment is more important than aesthetic creations or is more important than investors' short term income. One of the main arguments is that sustainable development, public participation and preservation of ecologic biotopes have nothing or very little in common with architecture.

This perspective also includes integrated design courses, which promote holistic methods of design and the use of innovative technology solutions in order to arrive at a level of an enhanced building form, function and space.

This educational approach is not consistent with the requirements and expectations of the younger generation, who fully understand that in contrast to existing education ideas, the integrated design process requires multidisciplinary cooperation between different designers and the key stakeholders, starting with the project's concept and ending with the building's completion or even further. The older generation of designers, who assume that an architect should always play a leading role in the design process and that all solutions should be subjected to the superior design idea, often find this attitude difficult to accept.

THE PROJECT

The author was first introduced to the integrated design process in 2002-2005 during the *International Project Sure Build*, which was prepared in a collaboration between Warsaw University of Technology (WUT), Warsaw, Poland, and the Norwegian University of Science and Technology, Trondheim, Norway. The main theme was preparation of *road maps* for sustainable modernisation of Polish education buildings. When initially organising the grant's structure, it was found that an architect was not required. The general opinion was that there was no need for this professional specialist since other technical consultants were involved. Life proved otherwise. The outcomes of this project were followed in the next international project STEP (2005-2011), concerned with the theme of international development project (IDP) for sustainable modernisation procedures of public buildings.

The author also had a chance to develop new ideas during participation in the *Intend - Integrated Energy Design Project* (2009) and later in the *IdesEdu Project* (2012-14), concerned with the development and harmonisation of sustainable development curricula in education programmes of professions dealing with design and construction business with special emphasis on cross-disciplinary and interdisciplinary issues.

Hence, the personal involvement gave the author an idea of starting a design pilot programme in the Faculty of Architecture at Warsaw University of Technology. The proposed programme existed between 2010 and 2014 as a two semester course and a diploma semester taught at a Master's degree level. During each of its three editions, it brought together a group of approximately 20 students from the Faculty of Architecture and the Faculty of Civil Engineering (WUT) to design a series of multidisciplinary sustainable concept buildings based on a draft programme from a real client.

The design process went further than the scope of conventional definitions, as it used data covering the synthesis of climatic parameters with a special focus on urban layout and characteristic parameters, use and well-being of inhabitants, building design and systems. This allowed each of the design groups to find interactions between climate, function and technical systems. This idea aimed to improve the current best design practices allowing creation of more comfortable, productive environment in a building and surrounding space [3].

While the interrelationship between the key issues involved is always crucial, in this case, the use of the term *interdisciplinary* was tailored to address the optimisation process of possible passive solutions to arrive at a high efficiency level.

Due to rather rigorous educational rules in the Faculty of Architecture at Warsaw University of Technology, an introduction of specialty courses was possible during design studios and as a facultative block of two seminars and two lectures. Students of the Faculty of Architecture were also given additional lectures in the Faculty of Civil Engineering, WUT, and the Faculty of Environmental Engineering, WUT, as well as by representatives of other disciplines and various building manufacturers.

Additional curricula covered the implementation of the practical professional use of sustainable development solutions directly influencing urban scale planning, design of architectonic forms on the level of individual buildings, as well as within existing city contexts. It compiled knowledge which can be used at every level of the design and construction process. This approach also called for a wider implementation of knowledge concerned with the natural environment and its preservation. Two important areas were distinguished:

- the need to integrate the sustainable development of societies and urbanisation procedures, specifically within the design process, organisation and planning of the building investment process, as well as facility management and redevelopment of existing buildings;
- the need to introduce and implement a holistic multilevel understanding of the urban space, including harmonious interactions between manmade and natural environment within curricula of architectural education [4].

These two education themes formed the basis for a systematic development of knowledge pursued during the courses described. The scope covered the input of sustainable knowledge taught to the students during lectures and seminars within the curricula of legislation, economy and organisation of building investment process, as well as the management of the building process itself from the concept level, through construction, use, modernisation and the building's life cycle, and the possibility of re-using some of the structural and building elements for recycling.

The analysis proved that orientation and shape had a dramatic influence on a building's energy needs [5][6]. The students were asked to decide what their solutions would be when taking advantage of daylight and natural ventilation, and how that would have an impact on the orientation and shape of the final building's volume and detail. They were asked whether use patterns and the layout of the space offered any opportunities for determining the energy demands: natural light used in multiple spaces, and the possibility of reusing heat emitted in some areas of the building in other areas of the building. This was an interesting and widely pursued area, and one of the groups developed an option through which surplus heat energy was transported from a nearby metro station.

This particular project was prepared during a single semester integrated design scheme for the Copernicus Science Centre that wished to expand its present premises with a set of laboratories, fab-labs and other external amenities. It should be mentioned that the Copernicus Science Centre has operated at its present building site on the Vistula embankment since 2010. It comprises a set of scientifically oriented areas for children and people of various ages, as well as a conference centre and a small cafeteria. Its tasks are supported by the Samsung and BASF corporations, amongst others.

SEQUENCE

The students started off with a client meeting during which the client presented the idea as to the function and programme of the building. During a later seminar, it was dedicated to check the site and its urban context. The students worked in groups consisting of two architecture students and a civil engineering student - all Master's degree students at WUT. They met regularly with academic staff and every second week with consultants representing urban planners and environmental engineers. They also met once every two months with a client team to present and discuss their design. The students had many opportunities to develop their presentation skills as an effective means of communication. The project teams made stage submissions, within which there was a strong emphasis on drawing, sketching, storytelling and information graphics.

There were also two peer-assessed milestone presentations, at which the project teams presented their designs in front of academic staff, students and the client. The students were supported through a series of workshops on sustainable topics and useful skills, and had access to a wide range of academic and industrial expertise. Even though they were faced with the same site, programme and a set of climatic parameters, it was possible to distinguish three general design approaches.

Solution No 1

The students decided to strengthen the existing structure and remain within the perimeter of the existing gross floor area (GFA) of the ground parking lot. This resulted in a series of compact, cube-like volumes. Nevertheless, each of the proposals had individual aesthetic features.

Figure 1: The main façade of the existing Copernicus Science Centre and the newly designed building (students: K. Plawny and K. Kierznowska, Master's studies, Semester 1, 2014/2015, the Faculty of Architecture, WUT).

Solution No 2

The students decided to design new structural elements outside the perimeter of existing walls, but design the GFA within the underground parking lot. This resulted in rectangular buildings, often terraced with many green roof spaces.

Figure 2: The main façade of the existing Copernicus Science Centre and the newly designed building (students: A. Kozioł and M. Tomaszewska, Master's studies, Semester 1, 2014/2015, the Faculty of Architecture, WUT).

Solution No 3

The students decided to design a new structure altogether. This resulted in a choice of design whereby buildings were either totally submerged underground or under large volumes of terraced green roofs, which made the buildings seem like part of the landscape.

Figure 3: The main façade of the existing Copernicus Science Centre and the newly designed building (students: J. Michajlow, A. Szajda and A. Swiderska, Master's studies, Semester 1, 2014-2015, the Faculty of Architecture, WUT).

Most of proposed solutions actually were prepared within the client's budget. The compact solution had more floors and additional financing was required for the strengthening of the existing structure, whereas lower rectangular terraced buildings used less expensive structural solutions, but a more expensive green roof. The only project that was beyond the budget was to be 90% submerged. However, in return, a feasibility study showed that exploitation costs could be cheaper by 20% in comparison with more traditional solutions, as some of the heat gains from a local metro could be reused for heating purposes. Also, due to its *underground* solution, this complex appeared to have more stable internal parameters than any of the other proposals.

CONCLUSIONS

All projects (18 semester work) were presented during a public exhibition at the Copernicus Science Centre, which was also attended by representatives of Warsaw University of Technology. The client was very satisfied with the outcomes.

It should be stated that this type of design studio is particularly effective when teaching about the design of complex architectural projects, since students are working on real projects in an environment similar to that of an architecture design practice.

The students gained confidence in tackling large architectonic and engineering problems, with many unknowns, through applying skills and tools learnt in lectures and elsewhere to a real project. None of the projects, even though they were restricted by strict conditions, resulted in monotonous and non-inventive solutions, either on the urban or architectonic levels.

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BIOGRAPHY

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