Energy as an issue in architectural diploma designs

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ABSTRACT: Diploma projects in faculties of architecture have often been considered to be the last opportunity for students to express their spatial idealistic thoughts. The long-established methods of cooperation between students and their academic supervisors were based on gradual smoothing and bringing to realistic forms the most fantastic spatial ideas. The functional, structural, spatial and aesthetic preliminary ideas would finally appear as well-studied and usually attractive urban complexes or buildings. However, since the end of the 20th Century, some other aspects have been of growing importance. They have to be considered, and seriously taken into account in architectural discussions and practice. Among many related issues, energy in buildings is now a basic component of the sustainability paradigm in architectural design. In this situation, the methods of working with students on their architectural diploma projects must have been subject to the implementation of relevant guidelines leading towards the achievement of environmentally responsible and energy effective solutions.

INTRODUCTION

The ever-changing situation in architectural design methods, which is closely correlated with the paradigm of sustainability, has a significant impact on the teaching methods in schools of architecture throughout the world. This does not come as a surprise, because the constant pressure on architects and builders to adapt to new challenges in the construction market must have modified their ways of thinking about new structures built in the gradually more respected environment. By the early 1970s, the energy crisis erupted, and since then, spectacular developments in the methods of architectural design and new building technologies started to compete and simultaneously to enhance one another. This competition, and the increased expectations of investors concerning the quality of architectural projects and buildings, must have made the schools of architecture work out new methods of teaching design.

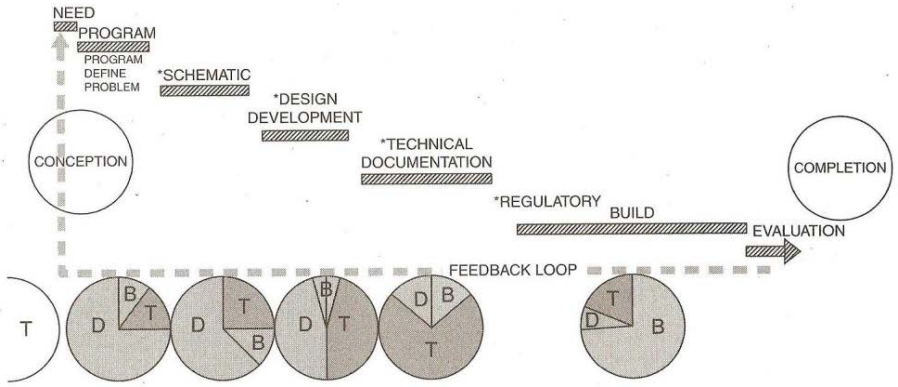
TRADITIONAL VERSUS CONTEMPORARY DESIGN METHODS

In recent decades, the design methods have been subject to substantial modifications due to new challenges in the construction industry. The author can now discern three basic approaches in architectural design:

1) traditional design;
2) sustainable design;
3) regenerative design.

The traditional methods of designing have been questioned more and more often, as they did not take sufficient account of new requirements concerning: reduction in energy demand, use of renewable energy sources and application of ecological materials in buildings. New guidelines for architecture, respecting the environment by the least possible intervention of new buildings in it, have promoted integrated design methods involving many stakeholders, not only architects, traditionally structural engineers, but also heating, ventilation and air conditioning (HVAC) specialists. This radical change in design team structure contributed to the development of larger architectural offices and more intensive cooperation between the multidisciplinary professionals involved. Traditional method of designing architecture is a purely direct process - sequential and linear. It can be seen as *…a stepwise approach, in which the spatial concept is realized by translating the vision from two-dimensional constructs into three-dimensional reality* [1] (Figure1).

Despite the introduction of computer-aided design methods, which has accelerated drawing procedures and increased the effectiveness, basically the methods for development of spatial ideas have not changed much, and were conditioned by conventional, traditional ways of thinking. The technical aspects of the project were usually considered in the final stage of designing. This would isolate the building from many environmental problems, and first of all, its feature was excessive energy demand. Due to this *...conventional architecture pushes people away from the natural environment* [1].



D-design expertise, T-technical expertise, B-building expertise, *- review cycle

Figure 1: Rational, linear design model (Source: D. Vallero and C. Brasier, *Sustainable Design. The Science of Sustainability and Green Engineering*) [1].

Sustainable design and architecture, as the next generation replacing the traditional, are in opposition to that. Their main goal has been to get the users of buildings closer to the immediate environment, and even to introduce natural elements and materials to interiors.

> *It takes into account all of the environmental effects, which buildings will have on a place. Green architecture-people become more in touch with the environment which they live* [1].

Sustainable or green projects are now subject to objective assessment concerning the fulfilment of sustainability guidelines defined in certification systems that are a reference model in this regard. They moved up the technical input to the earlier phases of a project's development and encouraged more complete synthesis and innovation in the architectural design process and in constructed buildings [1].

Given a multifaceted, and multidisciplinary set of new requirements, defining the paradigm of sustainable architecture and construction, a new tool for designers must be taken into account; this is the team working and integrated design method. It can be defined as follows:

> *Integrative building design is the practice of designing with sensitivity for sustainability. It concerns itself with energy, water and material resources, and indoor environmental quality decisions. It means that design decisions made earlier in the process do not compromise the effectiveness of design decisions that need to be made later* [2].

> *Green buildings incorporate given site characteristics and conditions: microclimate, light exposure, vegetation and urban factors into the design* [1].

But, design methods are modified along with constantly changing architecture; and, therefore, some *transitional models* can be specified (Figure 2).

A transitional model put forth by Vallero and Brasier [1] encompasses:

1) project description;
2) team building;
3) education and goal setting;
4) site evaluation;
5) baseline analysis;
6) design concept;
7) design optimisation;
8) documentation and specifications;
9) building and construction;
10) post occupancy.

Here, each step includes feedback to the preceding steps. Transitional models integrate human health, safety, comfort and ecological considerations. Some identify global goals, as indicated by Mendler, that must be part of green design and include:

1) waste nothing (i.e. dematerialisation);
2) adaptation to the place;
3) use of *free* resources (i.e. renewable materials);

4) optimisation rather than maximisation (synergies);
5) creation of a liveable environment [3].

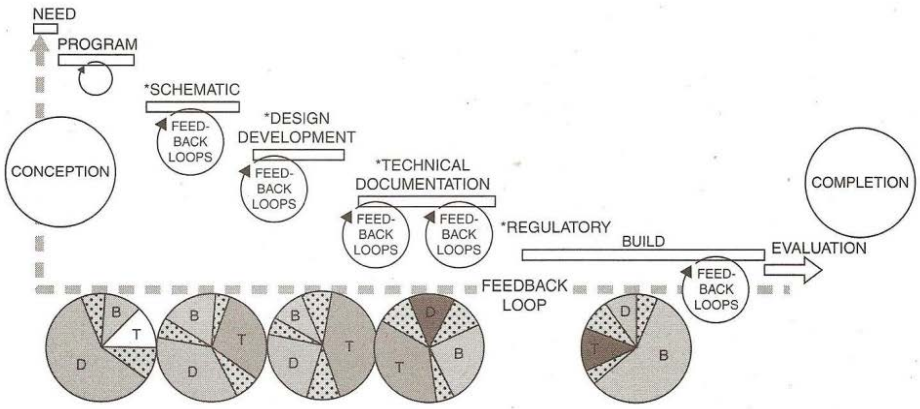


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Figure 2: Transitional green design model (Source: D. Vallero and C. Brasier, *Sustainable Design. The Science of Sustainability and Green Engineering*) [1].

As can be seen above, the basic feature of contemporary environment-aware architecture is a holistic approach to the whole procedure following the requirements of the sustainability paradigm.

Sustainable architecture can be characterised by spectacular complexity to which the traditional design methods had to be adapted. However, in the course of time, a regenerative architecture has evolved as the newest emerging trend in space shaping, following the observation of continuous, regenerative processes or cycles found in nature. It aims at further minimising the impact of buildings on the environment by seeking symbiotic solutions. In view of this philosophy, the materials are classified as either biological or technical. They should return to the biological or technical cycles and re-enter the system as productive inputs to a new cycle [1].

This idea has broadened the use of biological materials in architecture. Thus, the symbiotic design solutions are preferred to traditional systems. The linear system in design methods is being replaced by a cyclical approach leading towards the permanent circulation of building materials and the substantial reduction in waste.

TEACHING METHODS FOR DIPLOMA DESIGNS

It has been broadly recognised that the basic issue in traditional, sustainable and regenerative architecture is energy. The excessive use of energy has a major responsibility in the negative impact of buildings on natural environment. It is obvious that the issue of energy, prioritised in traditional, and especially in sustainable or regenerative design methods, should also be adequately addressed in the teaching methods relevant to architectural design. The problems of energy in building industry emerged in the 1970s, but schools of architecture effectively introduced them into their curricula much later. However, this introduction was not at the level of basic teaching programmes, but in specialised and postgraduate courses about the issues of energy-effective or low-energy buildings.

Gradually, all schools of architecture were introducing the principles of energy-effective buildings into their regular programmes of teaching design in all educational cycles. Diploma projects are the proof of professional maturity, satisfactory knowledge and skills of graduates in architecture. As such, they should display the evidence that all architectural aspects have been taken into account by the student in his or her project. So, the substantive scope of their work is usually larger than in the case of earlier course designs. As the methods of designing have been changing in accordance with new requirements concerning energy aspects, so were the methods of teaching design. This article considers mainly the problems related to diploma designs, as those give a more synthetic view of the development and present situation in architectural education concerning the energy-related issues.

In the first phase of energy-related problems considered in architectural design, termed above as traditional, the students would be given design tasks taking into account such issues as compact plan layouts, simplified forms, and enhanced insulating systems for walls and roofs. All these new measures were designed to meet the modified building regulations related to the reduction in heat losses from buildings. These guidelines for architectural design had influenced the resulting forms to a certain extent. However, the students were not satisfied with simple forms, as they usually wanted to be more innovative using fancy spatial compositions.

The next phase - the sustainable design paradigm, has introduced many more sophisticated requirements, and first of all: architectural science, which ever since had to be involved into architectural thinking. Among many new considerations to be analysed, the ecology, building physics and *healthy* materials have been subjected to close attention. Every

diploma project had to contain and display the evidence of integration of energy principles into the design presented. It should take the form of supplementary relevant sketches and diagrams in its graphic part, and explanatory information, comprising sometimes convincing calculations in the written specification.

Graphic energy concepts have become a standard part of diploma projects, and just as it is in the case of professional projects, these are carried out in architecture offices by competent architects. The graphic material supporting the energy concept in diploma designs is diversified and depends on the character of a given project. It is the location, size and function of a designed building that are determiners of the energy-related input. Energy should be considered and analysed in the many different forms in which it occurs: heat, light, air movements and acoustic waves.

Depending on the intensity of their impact on the form and technical solutions in a given project, the energy-related factors should be properly addressed. Some examples of form finding, taking into account the solar and wind energy, are shown further (Figures 4, 5 and 6). The important elements of a typical graphic and developed energy concept are presented in Figure 3.

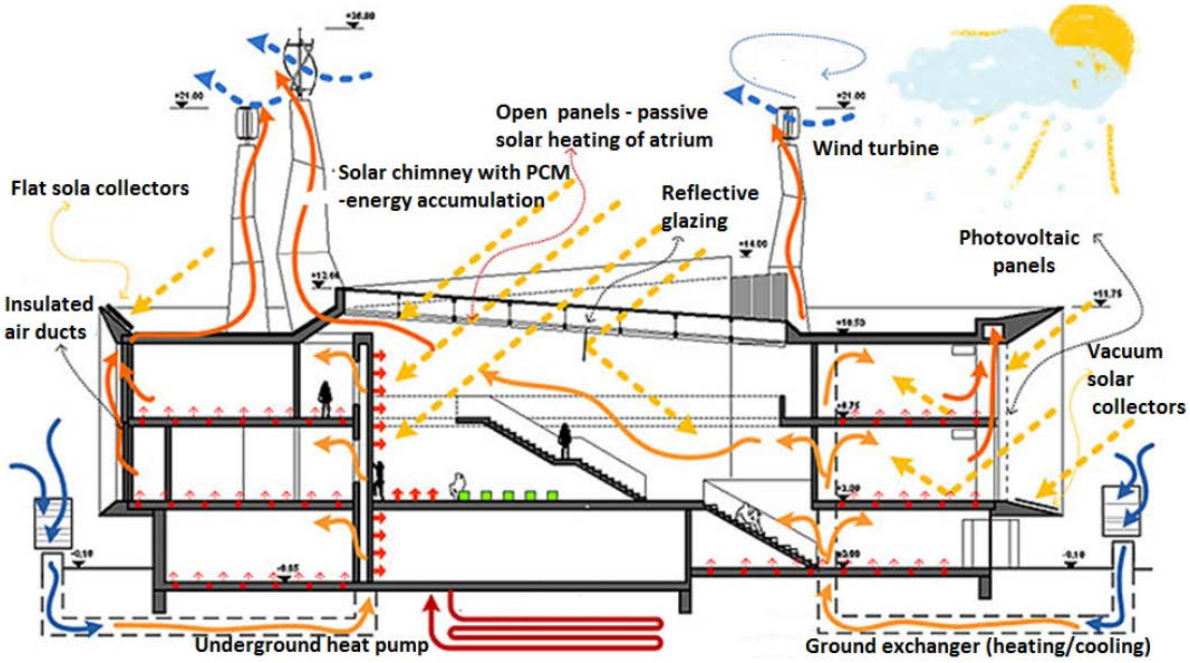

Figure 3: An energy diagram of a building with the close to zero demand for non-renewable primary energy. The building as a system of interrelated solutions. Research and educational complex of the Faculty of Environmental Engineering, Wrocław University of Technology (Source: P. Kuczia, *Educating Buildings)* [4].

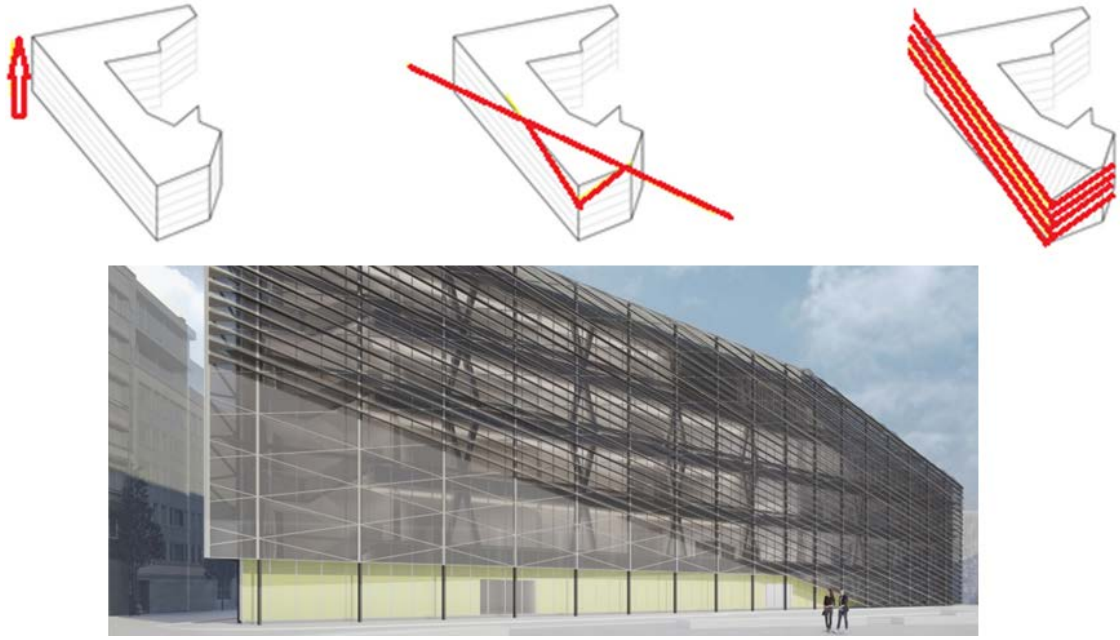

Figure 4: Form-finding analysis of an office building based on a study of insolation and its final shape (Source: A. Dziewit, *Diploma design*) [5].

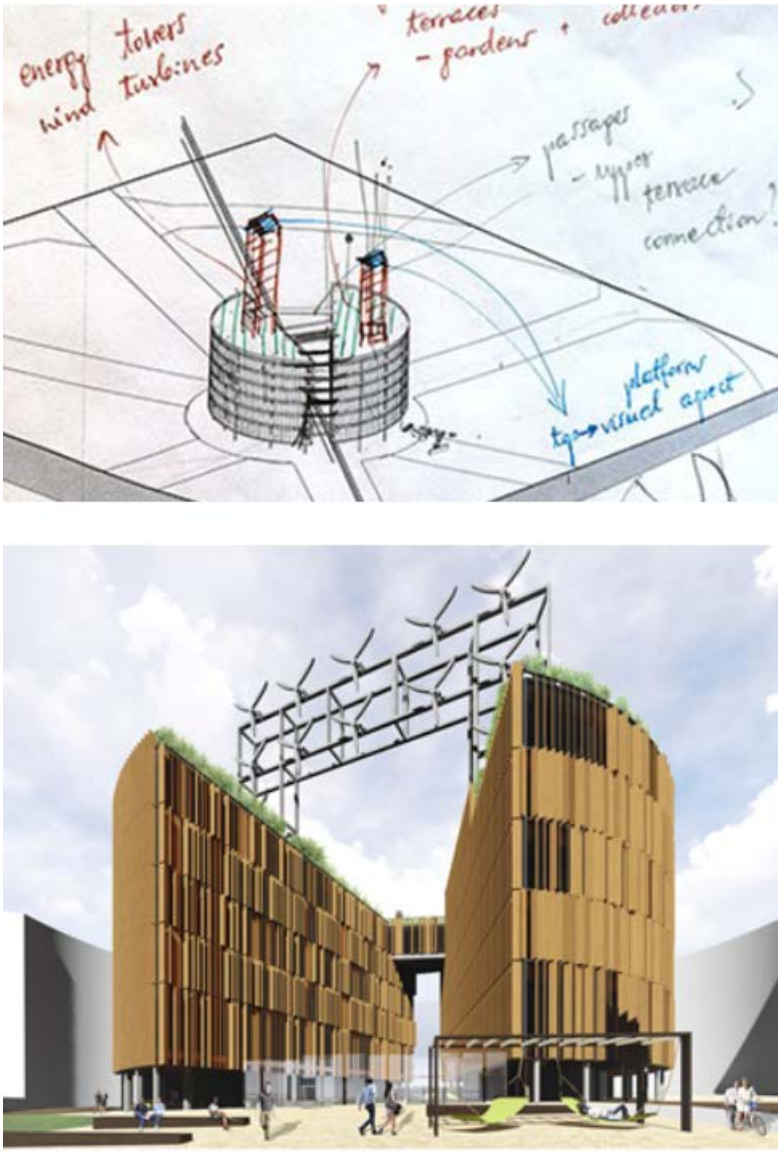

Figure 5: A study sketch for the energy-based idea of an office building (Source: A. Baczyńska, *Diploma design*) [5].

As stated above, sustainable design requires some prior knowledge of architectural science from architects. This is achieved during the preliminary stage of diploma work within the subject *Diploma Seminar*. The students must make a 30-minute class presentation to their classmates, providing an overview of their findings concerning the science-based input into their projects. This makes their designs reliable and closer to the professional reality.

Regenerative architecture has not yet become an issue that has found its proper place in architecture diploma designs. In architectural reality and practice, it is still in the initial phase. It can, therefore, be considered to be the future of architecture. However, the theoretical projects related to these ideas are more and more an interesting vision for young enthusiasts of innovative thinking. One can imagine that further developments in the teaching methods will have to be adapted to this newest challenge sooner than later, because:

> *...The architecture and engineering community must evolve from the current thinking of sustainability and the primary focus on efficiency and high performance to the concept regenerative design* [1].

CONCLUSIONS

It must be said, that student projects cannot entirely follow the same procedure as is in the case of regular interdisciplinary design work carried out in architecture offices, and be based in a reliable way on the sustainability paradigm. As was stated above, sustainable design requires the involvement of other specialists in the interdisciplinary team of designers. In architecture schools, it is difficult to set up design teams comprising students from different majors due to the incoherence of curricula and class timetables. This relates to the prevalent situation in the majority of architecture faculties. As a result, the sustainability rules can only partly be applied within the students' projects. However, there are schools in which the enhancement of architectural design teams by the collaboration of students in other majors and specialities is manageable. It is obvious that such organisation of co-working is indispensable in the case of the above-mentioned generation of design methods.

Diploma projects should also be supplemented with more energy analysis, schemes and explanatory diagrams to prove that the students are knowledgeable in architecture science, which is so deeply involved in the contemporary sustainable architecture design. The projects must be a comprehensive and complex energy concept, characteristic of real mature projects (Figure 6).

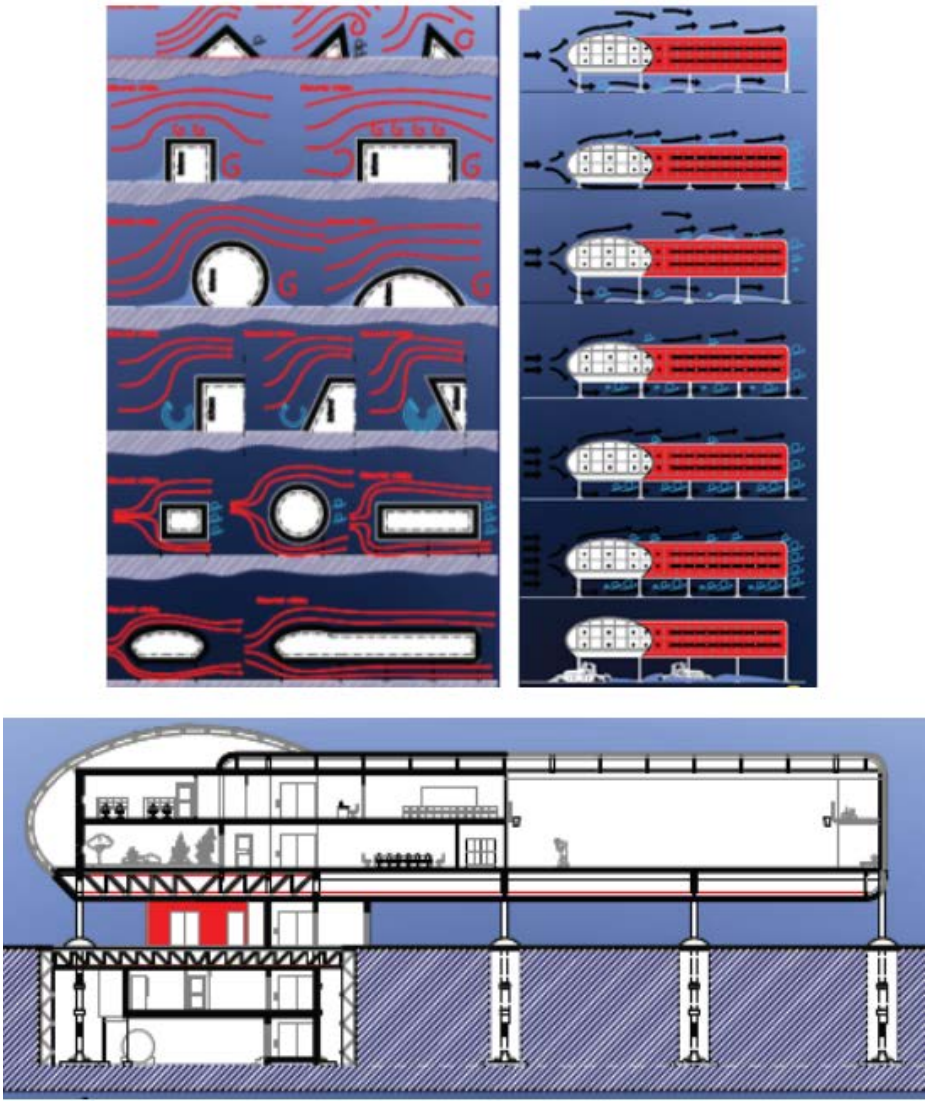

Figure 6: A study of aerodynamics of forms and the resulting solution for an Antarctic energy-effective station (Source: P. Duda and R. Kalinowski, *Diploma design*) [5].

Despite the fact, that much progress has been made in architectural schools with regard to updating the teaching and designing methods applied to student diploma projects, it must be emphasised that a great deal still has to be improved in this area. Only then will the architectural schools manage to deliver fully competent graduates to the construction market of today.

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