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The role of international student workshops in the process of educating architects - conceptual design and the development of preliminary energy objectives

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ABSTRACT: The student exchange between the Faculty of Architecture at Cracow University of Technology, Kraków, Poland, and the Lycée Le Corbusiere, Strasbourg, France, has been organised for the last five years. During the student exchange, a cycle of theoretical classes is taught, as well as the design of buildings that have a high energy efficiency. The theoretical classes are supplemented by the *Integrated Energy Design* workshop. This article describes the course of the first part of the exchange and the international, cyclical student workshops. It is focused on the development of a design of preliminary energy objectives for a designed building during the stage of a conceptual architectural design, as well as familiarisation with basic materials and construction technologies. This stage of the workshop takes place in Kraków, at the Faculty of Architecture of Cracow University of Technology. The continuation of the first part of the workshop takes place in Strasbourg. Here, education includes theoretical classes at the Lycée Le Corbusier campus at the *Genie Civil*, Civil Engineering Faculty, as well as visits to the sites of the construction of residential buildings and design workshops. In this article, the author examines the role of international student workshops, the exchange of thought, teaching methods and experiences in the process of educating future architects.

Keywords: International student workshops, process of educating, conceptual design, energy objectives

INTRODUCTION

The year 2012 saw the initiation of cooperation between the Faculty of Architecture of Cracow University of Technology, Kraków, Poland, and the Lycée le Corbusiere in Strasbourg, France. The cooperation includes, among other things, the exchange of students between the two institutions and their participation in the *Integrated Energy Design* workshop [1].

The exchange features a cycle of theoretical classes associated with the subject of building construction, materials science, architectural and construction design, as well as the design of buildings with a high energy efficiency. The exchange programme features two parts. The first part is focused on the subject of designing buildings at the conceptual design stage and an initial design programme. It includes theoretical classes at the Lycée le Corbusiere, visits to construction sites of multi-family residential buildings, and workshop classes focused on the energy objectives of a designed building. The second part, discussed in the publication by Markiewicz, includes theoretical classes at the campus of the Lycée Le Corbusiere and at the *Genie Civil*, Faculty of Civil Engineering on the subject of designing energy efficient buildings [2].

The organisation and supervision of the exchanges from the Polish side was conducted by Magdalena Jagiełło-Kowalczyk of the Institute of Urban Design and Przemysław Markiewicz of the Institute of Construction Design of the Faculty of Architecture at Cracow University of Technology, while on the French side it was carried out by Cecile Couasnon and Jilles Dugard, an engineer of the Lycée Le Corbusiere.

THEORETICAL AND PRACTICAL CLASSES AT THE LYCÉE LE CORBUSIERE CAMPUS

From the perspective of students from Poland, the Lycée Le Corbusier is an extraordinary school, which at first, causes shock and disbelief that the teaching of widely understood architectural and construction design can be performed in a manner, which is so practical and grounded in reality [3]. This is, of course, associated with the abundant funding of this educational facility. However, the essence of the extraordinary nature of this school is not only the result of its high funding, which is covered from the budget of a wealthy region of Alsace, but first and foremost, its innovative method of teaching. This method at first brings to mind the SimCity computer game, which is a reflection of the real world within virtual reality.

The teaching method of the Lycée Le Corbusier is based on a similar philosophy of creating real-world conditions that are present on actual construction sites under the roof of enclosed halls. Each hall has a set of stations for classes, which are fragments of buildings on a 1:1 scale. They focus on the various stages of construction, starting from the frame stage - the technology of the construction of the foundations, walls and floor slabs, including the construction of roofs and flat roofs, insulation, glazing and interior finishes. The halls are divided into specialisations in accordance with the logic of the construction process. And so, in one hall, there are stations at which one can erect exterior walls in various technologies. In another, there are life-sized models of roofs, on which one can learn roof tile laying technology and the manner of developing structural details, such as chimney flashing, eave finishes and the ways of constructing dormers. In other halls, one can learn the basic set of finishing work, such as painting and finishing an interior with ceramic tiles, conservation technology and building solutions that were used in historical buildings. Inside the hall, featuring the timber frame technologies one has at their disposal, like in the other halls, complete buildings on a scale of 1:1. One building is built using Canadian timber frame technology, using small cross-section structural elements, while another is a post-and-beam one, composed of elements with a wider placement, but that are more massive and supported by beams and braces.

The halls with stations for practical classes associated with construction craftsmanship are supplemented by various laboratories, such as the materials strength laboratory, in which experiments can be performed, analysed, comparing various alternative materials. The digital technologies hall is an important element of the educational pathway, with designs developed in the form of virtual models and, following the precise parameterisation of all the elements of a building, the performance of various types of digital analyses.

Stations for making mock-ups of buildings, composed from equivalents of elements of the most common construction technologies that are widely available on the market and made on a scale of 1:20, are an interesting idea in terms of education, leaving a positive impression on students from Poland. Elements of a system including concrete masonry units (CMUs) or infill blocks are composed of a specially prepared putty, which is poured into appropriate rubber casts, from which they are removed after setting. The mortar used to bind the CMUs and blocks at a *construction site* is a water-soluble cellulose mass, which can be easily rinsed off after a class, in order to reclaim the CMUs and blocks for reuse.

One part of the halls assigned to practical classes in the conditions of an actual construction site are halls with stations that allow the fitting of alternative infrastructural elements of a building, as well as elements of its fittings. It needs to be highlighted that the infrastructural solutions that can be configured include the latest options currently available on the market. A distinct example of a station for the practical learning of infrastructural engineering is a station used to calculate the surface area of solar collectors used to heat domestic hot water in a building [4].

Students are tasked with selecting the appropriate size of collectors on a roof to the number of inhabitants and their needs. Sunlight that affects the collectors in real life is simulated by using halogen lamps. The collectors can be combined into a serial array, allowing for the increasing or decreasing of the effectiveness of the set, depending on current needs and the size of the storage tank.

While summing up the teaching methods used at the Lycée Le Corbusiere, it should be added that the education system in France is composed of two stages, similarly to that in Poland, but with a more precisely defined division. The Lycée Le Corbusiere conducts education at the first stage of the licentiate that corresponds to Polish engineer-level studies. It includes education on the theory and practice of the architectural and engineering professions within the scope that includes all the distinct, modern and currently available construction materials, technologies, infrastructural systems and building fittings on the French market. It does not lead to research, which is understood as the search for new, innovative solutions.

Research is reserved for second-stage studies, which correspond to Master's level studies in Poland. In France, second-stage studies are university studies, which means they take place at a different school. A description of a visit at the *Genie Civil* [5] university faculty by Polish students is featured in a publication by Markiewicz [2].

a) b) c) d)

Figure 1: Examples of practical teaching of building constructions.

Class stations include the hall with stations for the practical teaching of building construction:

a) A 1:1 scale roof used for the practical teaching of the roofing profession;
b) A station for the practical teaching of steel sheet flashing on steep roofs;
c) Materials science - examples of construction systems used in France;
d) A 1:20 scale model of a building during its frame stage, made from miniaturised elements of a specific construction system.

VISITS TO CONSTRUCTION SITES OF MULTI-FAMILY RESIDENTIAL ESTATES

Teaching a trade like the architectural profession would be difficult and incomplete, if it were limited only to the enclosed confines of a school's walls, without the opportunity to see real-life projects in the form of the construction sites of various buildings in different stages of completion. It is for this reason that the student exchange and the workshops that take place at the school have been supplemented with a cycle of visits to construction sites of multi-family residential buildings of varying quality standards and featuring various levels of energy efficiency.

The residential complex near 4 Rue de la Thumenau in Strasbourg is an estate that can be called normative, which means that it meets the bare minimum requirements contained in construction regulations. This medium-sized residential complex is composed of 48 social housing apartments (featuring from two to five rooms). The lower part of the building, from the side of the street that surrounds the complex, features service facilities.

The buildings were at their lockup stage during the students' visit, which means they were at a stage when work was starting on external and internal finishes. This made it possible for all the structural and technological details to be visible, such as the still-exposed tie-beams, beams and columns, the filling of wall-spaces with ceramic masonry units, etc.

On the other hand, the *Le Patio des Alseides* housing estate in Strasbourg is a housing estate that can be described as above-standard, having been awarded a prestigious energy efficiency certificate. The construction site of this estate has been located within an *eco-district*, in the direct vicinity of the campus and complex of the Lycée Le Corbusiere.

The students who participated in the exchange had the opportunity to observe the stage of the construction of multi-family residential buildings during the initial part of the frame stage - when the main load-bearing structure is being erected. Of particular educational value was the opportunity to observe the cause-and-effect relationships that occur during the construction of buildings. The necessity of coordinating heavy concrete works with work on infrastructural couplings was a very important practical lesson for all students, teaching them that the high quality of the *paper* documentation is important for the appropriate carrying out of construction in the field.

a) b) c) d)

Figure 2: A visit at the *Le Patio des Alseides* housing estate in Strasbourg: a) formwork during the stage of erecting the above-surface storeys; b) the water insulation of the ground level; c) pouring concrete for the ground-floor slab; and d) the group of Polish students participating in the workshop.

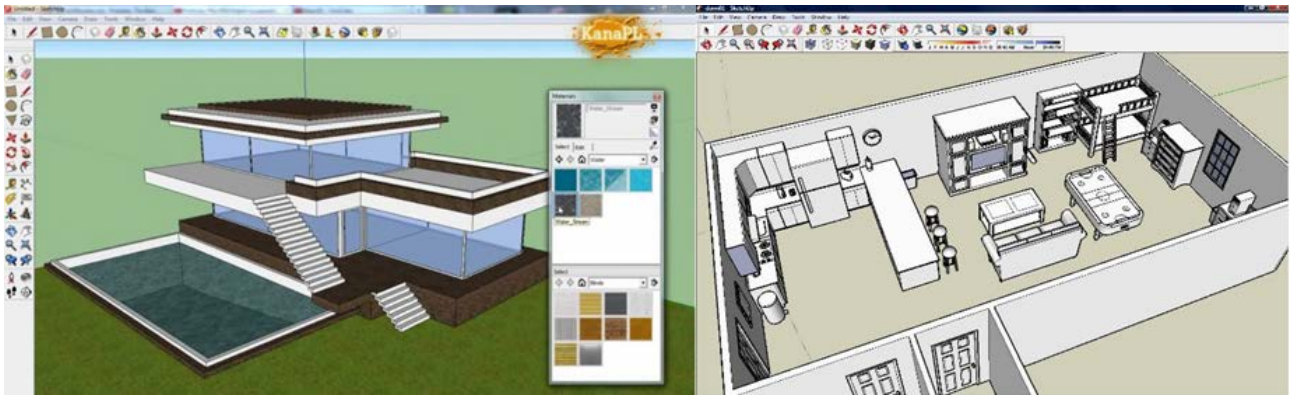
WORKSHOP CLASSES ON THE DEVELOPMENT OF A DESIGN DURING THE ARCHITECTURAL CONCEPTUAL DESIGN STAGE

Visits to educational facilities and construction sites of housing estates constitute the theoretical part that precedes the design workshop, which was the most important practical part of the entire exchange.

The design workshop starts with the development of a conceptual design of single-family residential buildings in the SketchUp computer programme [6]. It is a programme used for three-dimensional solid modelling in the development of a virtual conceptual design of a building. It does not feature the parameterisation of the individual elements of a design in terms of the different structures and technical solutions, which is why this is only the initial stage of developing the design of a building in term of its overall spatial relationships and functional layout.

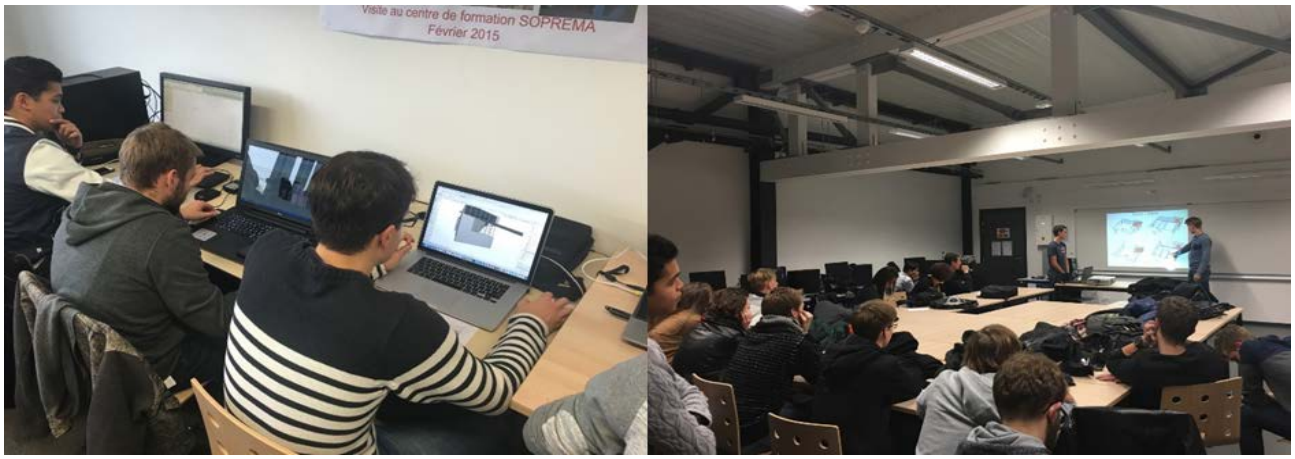
The designs that are being developed fiercely compete with each other in terms of the innovativeness of their form and, as a consequence, the complication of their structure and the size of their often practically impossible glazing. This is

why the students have been given the additional task of calculating the load-bearing capacity of the main structural elements of the designed buildings, such as beams, lintels over large glazed surfaces, etc, after designing the massing of a building and its functional layouts. It turned out that the level of skill in structural engineering is considerably varied within the student group. It should be highlighted that this surprise lesson in humility exerts a surprisingly positive influence on the integration of the entire group.



a) b)

Figure 3: Conceptual design developed in SketchUp: a) solid modelling; b) functional layout.



a) b)

Figure 4: Workshop classes and a session for presentations performed by individual design teams.

DEVELOPMENT OF PRELIMINARY ENERGY OBJECTIVES FOR A DESIGNED BUILDING

The first part of the design workshop organised as a part of the French and Polish students' exchange ends with the development of preliminary energy objectives for the design buildings. These preliminary objectives chiefly include the determining of the precise geographic location of the site on which the designed building is to be located, and determining the building's orientation in relation to the cardinal directions. These can allow one to determine climate parameters, such as average temperatures, humidity and insolation, as well as to determine the incidence angle of solar rays for individual days within a year. This also constitutes preparation for the second stage of the workshop, which features the development of an architectural and construction design using BIM software in combination with energy simulations [7-10].

CONCLUSIONS

Design preceded by a theoretical part, which introduces the topic of designing energy efficient buildings and practical classes at construction sites is much more effective than education under the conditions of a closed hall at a school. This is a feeling shared by all students who have had the chance of participating in classes that are configured in this manner within the scope of the exchange.

The configuration of three elements is required in the programme of educating architects:

1. theoretical classes that provide an appropriate theoretical basis;
2. field trips to actual construction sites that provide the opportunity to observe how architectural and construction solutions - which are featured in design documentation only in an agreed-upon graphical convention - look in real life;

3. design classes, whose initial - and very important - objective is the appropriate configuration of tools that aid in design in the form of specialist computer software.

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BIOGRAPHY

Magdalena Jagiełło-Kowalczyk, Dr hab. inż. arch., Professor of Cracow University of Technology, Kraków, Poland, was born in Kraków. She graduated from the Faculty of Architecture at Cracow University of Technology. She wrote her doctoral thesis, entitled *Kształtowanie osiedli mieszkaniowych o charakterze ekologicznym* under the supervision of Prof. Wacław Seruga. She obtained the title of doktor habilitowany nauk technicznych (doctor habilitatus of technical sciences) in 2013. The basis for the habilitation was her monograph, entitled *Koordynacja środowiskowa w kształtowaniu zrównoważonych inwestycji mieszkaniowych*. In 2014, she was given the position of *profesor nadzwyczajny* of Cracow University of Technology. Her field of interest includes matters related to the concepts of green architecture, which form the constituent parts of the concept of sustainable design. She is the author and co-author of several tens of publications in the form of books, monographs and papers in scientific journals, as well as numerous presentations delivered at conferences, sessions and seminars. She has been, along with Prof. W. Seruga, the co-editor of the cyclical scientific publication of the Chair of the Housing Environment, *Środowisko Mieszkaniowe. Housing Environment* scientific journal, since 2003, in addition to being the chief editor of *Archivolta*. She is the co-author of the Web sites of the aforementioned publications. She takes part in KBN (Polish research council) grants and international projects co-financed by the European Union, as well as in research conducted by the Chair of the Residential Environment, with separate independent tasks. She is the organiser and co-organiser of conferences, seminars and scientific sessions, workshops, architectural competitions, students' designs exhibitions and post-competition exhibitions, and the author and co-author of several tens of designs of residential and commercial buildings, as well as interior designs of homes and offices. Since 2005, she has been the scientific supervisor of the GROW students' scientific club, operating alongside the Chair of the Residential Environment of the Institute of Urban Design in the Faculty of Architecture at Cracow University of Technology. Since September 2016, she has been the Director of the Institute. As an author of lectures, curriculums and didactic materials, she is in charge of the implementation of curriculums based on integrated design using building information modelling (BIM).