Improving student competence through workshops

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ABSTRACT: Student workshops are created to facilitate the improvement of student qualifications and competencies, and the authors of this article focus on this. A workshop was held on algorithmic and parametric design, with the software supplied being Rhinoceros 5 + Grasshopper. The workshop concerned design topics and locations. The topics and locations were within a group of activities by students in the final year of studies at the Faculty of Architecture, Cracow University of Technology (FA-CUT), Kraków, Poland, as a part of the project *Designed for Professional Success - Competencies Commissioned for Architects* (in Polish: *Zaprojektowany na Sukces Zawodowy - Kompetencje Zamawiane dla Architektów*), co-financed from the European Social Fund.

INTRODUCTION

The work reported here concerns a student workshop organised as a part of the project entitled *Designed for Professional Success - Competencies Commissioned for Architects* (in Polish: *Zaprojektowany na Sukces Zawodowy - Kompetencje Zamawiane dla Architektów*), co-financed from the European Social Fund, agreement no. UDA-POWR. 03.01.00 - 00-K258/15. The project was for students in the final year of study at the Faculty of Architecture of the Cracow University of Technology, Kraków, Poland. The main goal of the project was to improve the competencies of young people. The Descriptive Geometry and Digital Technologies Division proposed a workshop with Rhinoceros 5 + Grasshopper software. The students had not been familiar with these programs, but there was no difficulty recruiting students for workshop groups (from 2017, the first- and second-year students of architecture have had classes introducing them to algorithmic and parametric designing [1]).

Over the course of two years, a total of four rounds of workshop were organised, conducted according to a pre-set schedule. The basis for the activity was the needs of cities concerning changes in public spaces. The first stage involved a selection of the area that the students were meant to focus on. This was typically one or two sites proposed by a municipal government. This selection determined the subsequent step, which was to obtain the materials required to prepare a design project. These primarily were maps procured (by request of the organisers) from the surveying and cartographic database. Additional materials were also provided by municipal entities. Their task also was to secure a location for the workshop. These were hotels, providing a place in which to work for a group of about 20 people, during the workshop.

The detailed course of the workshop was set by the organisers in consultation with municipal entities and representatives of the business sector. In these workshops, the business sector was represented by two companies: Chemobudowa and GRC Technologie. This form of workshop provided students with the possibility to tackle a design problem that constituted an answer to some specific needs of a city. At the same time, they were to face new programmes that were to become their sole design tools. Taking into consideration the meetings, lectures and the necessity of performing an on-site visit, the six-day workshop was a period of highly intense work, both for the organisers and students. In this article, one of the four meetings is the subject of detailed analysis.

STUDENT WORKSHOP: ANDRYCHÓW 2016

The workshop organised in the town of Andrychów between 20 and 25 October 2016 had the following title: *Algorithmic and parametric design using Rhinoceros 5 + Grasshopper software on the example of selected design subjects and sites in the municipality of Andrychów* (in Polish *Projektowanie algorytmiczno-parametryczne przy użyciu oprogramowania Rhinoceros 5 + Grasshopper na przykładzie wybranych tematów projektowych oraz lokalizacji w*

gminie Andrychów). The organisers selected the following sites: Pańska Góra, in the western part of Andrychów and bridges in neighbouring localities: Sułkowice, Targanice and Rzyki. Twenty nine students enrolled for the workshop. The first element of the workshop was a meeting at the Office of the Town of Andrychów. The students were greeted by the Mayor of Andrychów, Tomasz Żak (see Figure 1a).

a) b)

Figure 1: Day one of the workshop: a) meeting with the Mayor of Andrychów (Photograph by K. Paprzyca); b) on-site visit (Photograph by M. Nessel).

During the meeting, he presented not only the history of the town, but also the policy concerning urban and spatial planning. The students learned of planned projects, both short and long term. They also obtained much information about Pańska Góra, concerning the change of its form of use. In accordance with the vision of the town authorities, it was meant to become an area of rest and recreation for the residents of Andrychów.

During the meeting, the students received materials to aid them (booklets, documentation) in working on the design proposal. Another equally significant point of the programme was the on-site visit. It concerned Pańska Góra and the bridge crossings across the Wieprzówka and Targaniczanka rivers. This was the only occasion during which the students could see the sites, where they were to design a new form of use or new bridges or shared traffic bridges. The workshop itself took place at the Łysoń hotel, which is in the nearby town of Iwałd.

The key element of the workshop was the use of the Rhinoceros 5 program and Grasshopper plug-in, which is applied in parametric and algorithmic design. None of the students had worked with these programs before. Therefore, the workshop made it possible for students to gain a new and highly essential competency. Lectures and presentations concerning these tools began during the first day of the workshop. Discussed were the latest trends in parametric design, which is also called algorithmic or algorithmic and parametric design.

Algorithms and parameters primarily are applied in mathematics and computer science. According to the definition provided in the PWN encyclopaedia:

> *An algorithm is a set course of conduct leading to the solution of a specific problem, defining a sequence of elementary actions that need to be performed to this end* [2].

In reference to architecture, Mario Carpo wrote that an algorithm is:

> *…a parametric function that can define an infinite variety of objects, each of them being different (one for each set of parameters) from one another but all being similar to one another (because the basic function is the same for all of them)* [3].

The term, *parametric*, was first used for architecture in the 1940s by Luigi Moretti. He defined parametric architecture as the study of architecture systems with the goal of *defining the relationships between the dimensions dependent upon the various parameters* [4].

The application of digital algorithmic technologies in earlier times required knowledge of programming languages or the skill to operate highly specialised software, which constituted a significant barrier to architects. Of particular significance to the development of algorithmic methods in architecture was the development and later popularisation of graphical programming software in the first decade of the 21st Century. The Grasshopper plug-in for Rhinoceros was important in this regard, as it makes it possible to apply algorithms without needing to write a computer code.

John Frazer wrote the following about design with algorithmic and parametric design:

> *In this way what I have long solicited and call* parametric architecture *will be born. Its ineluctable geometric character, its rigorous concatenation of forms, the absolute freedom of fantasy that will spring up in places where equations cannot fix their own roots, will give it a crystalline splendour* [5].

Algorithmic and parametric methods are at present applied by leading design offices around the world. These include: Arup Associates, Foster and Partners, Grimshaw Architects, Kohn Pedersen Fox, LAB Architecture Studio and Zaha Hadid Architects.

After the lecture on algorithmic and parametric design, students were acquainted with the basics of design in applying the Grasshopper plug-in. These presentations laid the groundwork for the formulation of conceptual design proposals. This was a period of high activity for the workshop organisers, who helped in formulating algorithms that realised the design intent of the students. Because the work was complex, students formed nine groups of between two and four people.

The knowledge of students was enhanced by two meetings:

- A training course concerning the footing of structures in difficult soil conditions, conducted by Marcin Pomierny, a representative of Keller (a sub-contractor of Chemobudowa-Kraków S.A.).
- A training course concerning the real estate development process on the example of the construction of the Cricoteka building in Kraków, conducted by Rafał Kowalczyk, site manager for this project from Chemobudowa-Kraków S.A.

In their design projects, the students applied information about the shape of the terrain, the history of the site, and the tradition associated with the textile and cotton processing industry. The projects they prepared can be divided into two groups:

1. Conceptual proposal of a bridge crossing across a river. This subject was taken up by two groups:

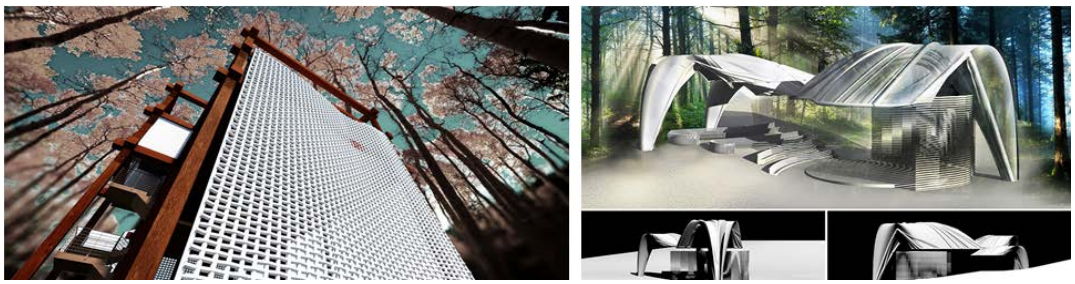
    - In the project entitled *Przeplecione z tradycji* the authors referred to the textile industry and to the shape of the terrain. After drawing numerous conceptual sketches, they used the capabilities of the program to alter, many times, the form of the footbridge and the pattern that covered (see Figure 2a).
    - In applying parametrics and referring to the form of the pergola, nature and weaving, another design of a footbridge across the Wieprzówka River was prepared (see Figure 2b).

a) b)

Figure 2: Fragments of student projects: a) Justyna Bukowska, Aldona Chechelska, Małgorzata Korulczyk, Katarzyna Weberbauer; b) Anna Baczyńska, Olga Dziedzic, Karolina Gielas, Kamil Krzysztof Kazanecki.

2. Site development plan for Pańska Góra. This subject was taken up by seven groups:

    - References to the tradition of weaving occur throughout the conceptual design proposal of the team which covered an observation tower with fabric (see Figure 3a). A space for a café in the crowns of trees was planned as well. The team also designed a series of other places for rest and recreation.
    - The idea behind an amphitheatre proposed by a different group was inspired by nature. In the written part of the proposal, the students stated: *The organic shape was created as a metaphor for the leaf* (see Figure 3b).



a) b)

Figure 3: Fragments of student projects: a) Jan Janik, Joanna Skrzypek, Aleksander Świat; b) Klaudia Lekston, Karina Maziarek, Anita Nowak, Anna Pandyra.

- A comprehensive development plan for Pańska Góra with a dominant, geometricised observation tower was presented in another project (see Figure 4a).
- An observation tower with triangular twisted platforms, referring to the workshop lectures and presentations (see Figure 4 b).
- An organic form of plants climbing a structure featured in the design of an observation tower situated at the tallest point of Pańska Góra (see Figure 4c).

a) b) c)

Figure 4: Fragments of student projects: a) Sylwia Marcinkowska, Patryk Szuba, Łukasz Szumal, Piotr Krukierek; b) Ivanna Soloviova, Khrystyna Ratush; c) Dominika Suder, Karolina Żeglińska.

- Connecting the three nearby localities (Wadowice, Inwałd, Andrychów), a bicycle path running up to an observation tower was designed. The structure was planned at the top of Pańska Góra. The proposal featured covering the surface of the path with a chemical compound (luminophor) in the colour yellow, resulting in a unique appearance of the entire route (see Figure 5a).
- The logo of the town, visible from a bird's-eye view, was the primary motif of an observation deck proposed as a structure composed of four identical elements leading to four observation points (see Figure 5b).

A presentation of all projects was held on the final day of the workshop. Every showcase and presentation of each design proposal ended in a discussion participated in by Tomasz Żak, the Mayor of Andrychów; Mirosław Wasztyl, the Vice-Mayor; Mieczysław Trojan, a representative of Chemobudowa; and the organisers (the authors of this article).

Between 15 and 26 May 2019, *Galeria Kotłownia* and *Galeria Gil* hosted an exhibition entitled *University - Local Government - Business* (in Polish: *Uczelnia - Samorząd - Biznes*). As a part of this event, the student projects prepared during the workshop in Andrychów were presented. The participants of the workshop took part in the event. Apart from the organisers, the vernissage of the exhibition was attended by the Vice-Mayor of Andrychów, Mirosław Wasztyl, and a Member of the Board of Chemobudowa-Kraków, Mieczysław Trojan. The meeting became an occasion to exchange ideas between all parties participating in the event.

a) b)

Figure 5: Fragments of student projects: a) Marta Wójtowicz, Katarzyna Wojewska; b) Aleksandra Stefańska, Magdalena Szarlej, Paulina Szczepan.

DISCUSSION

As the workshops were conducted within the framework of the project co-financed by the EU fund, workshop results were analysed by opinion surveys given to students, who answered the same set of questions twice: before and after

the workshop. Students were asked to rate their level of competence in a number of areas related to the profession of an architect. Additionally, they were asked to comment on the usefulness of the workshop in the development of their professional career. The comparison of answers provided by students before and after the workshop makes it possible to discuss the effectiveness of the workshops.

The survey included the following questions:

Q1. How would you rate your current (before the workshop/after the workshop) level of competence in the area of creating design solutions to meet client's needs and to satisfy the requirements of a particular environment?
Q2. To what extent the outgoing workshop in socio-economic environment (will be/was) useful in the development of your professional career?

Please rate your current (before the workshop/after the workshop) level of competence regarding the following issues:

Q3. Creating optional architectural design concepts.
Q4. Knowledge of the latest trends in the industry.
Q5. Knowledge of the needs of the socio-economic environment of self-government and business in the region.

Q6. How would you rate your current (before the workshop/after the workshop) level of competence regarding readiness for co-operation with local self-government and businesses in the region?

Please rate your current (before the workshop/after the workshop) level of competence regarding the following issues:

Q7. Creating a conceptual plan adjusted to a particular budget.
Q8. Client-oriented approach.
Q9. Ability to persuade others to one's ideas.
Q10. Ability to discuss and conduct presentations in public.
Q11. Ability to work in a team.
Q12. Ability to solve problems.
Q13. Collection, selection and processing data from a particular site or object.

The survey consisted of 13 questions which could be answered using a 5-level Likert scale, from 1 to 5. The survey results were analysed, so as to check the influence of attending the workshop on the competence of the participants. The analysis was conducted for each question. The survey results have been illustrated by means of two diagrams, where the question number is placed on the horizontal axis.

The first diagram (see Figure 6) illustrates an average increase in the grade given by students for each question. Blue indicates an arithmetic average of the grade given before the workshop, whereas green shows as an arithmetic average of the increase in the grade after the workshop.

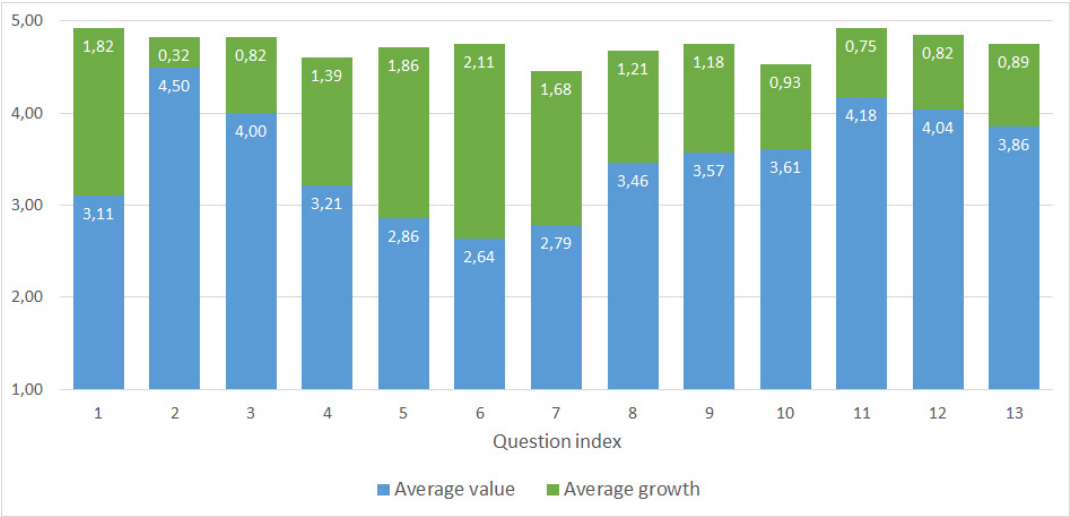


Figure 6: Increase of students' competence based on the surveys (Author: M. Nessel).

The second diagram (see Figure 7) presents numbers of students who indicated an increase, a decrease or no change in their level of competence for each of the 13 questions. This has been marked in blue, orange and green, respectively.

Both diagrams indicate a considerable increase in students' competence in their own opinion. The lowest increase can be seen for question 2, which can be noticed in both diagrams. Students were asked to give their opinion regarding the influence of their participation in the workshop on the development of their career. However, it has to be pointed out

that students' expectations before the workshop were very high indeed, which is shown by the average grade of 4.50. In the case of 16 students the workshop fully lived up to their expectations; for eight students the workshop exceeded their initial expectations and only three students described the workshop as being below their expectations.

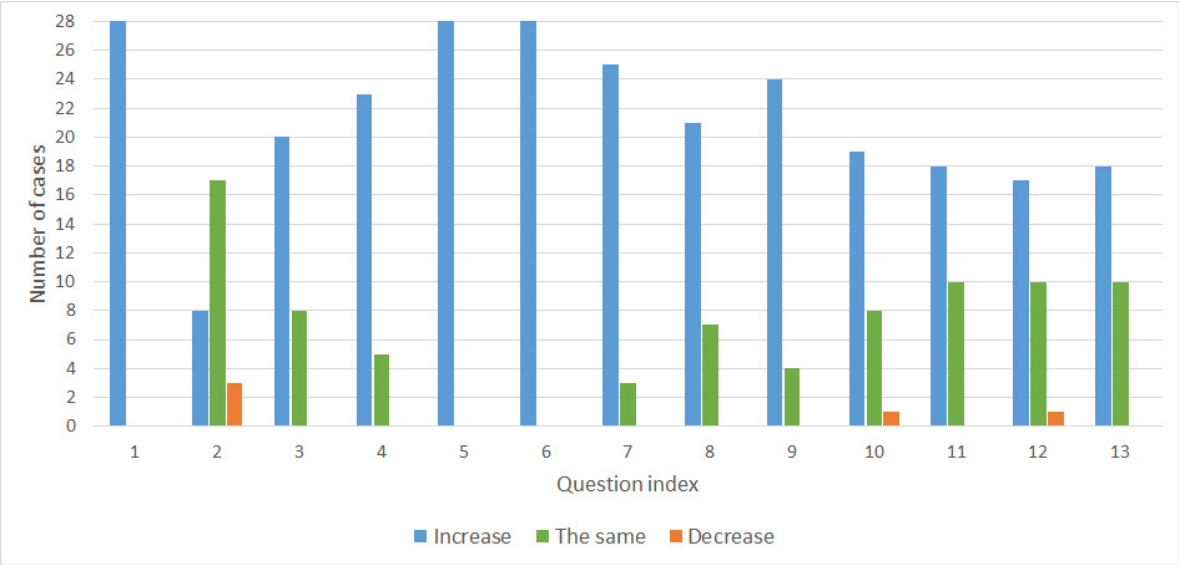


Figure 7: Number of students who pointed to an increase, decrease or no change in their competence for each question of the survey (Author: M. Nessel).

In the case of the last three students, question 2 was graded 4, 4, 3, which would be interpreted as *rather useful* and *partially useful*. The highest increase of students' competence reflected in the grades given by them in the survey can be noticed for question 6, which concerned co-operation with local government. Interestingly, this increase occurred for workshop participants. Also, answers given to questions 1 and 5 point to the increased competence of all students. Only two students pointed to the decrease of their competence and it concerned questions 10 and 12.

CONCLUSIONS

The workshop was a source of numerous observations and analyses, for example:

- Analysis of feedback surveys confirm the effectiveness of the form of the workshop.
- The students took up a subject which was a specific design need within a town. The work, therefore, was an element of professional training.
- Effects obtained during the workshop were strongly associated with the form of its organisation. The trip and the isolation of the students, including those typical for students, as well as personal ones, led to a focus on the content that was presented and gaining of greater amounts of knowledge.
- The work in groups was an occasion for teamwork. Therefore, conditions close to those present in architectural studies were created.
- By using new tools, the students were able to formulate imaginative conceptual proposals and design visions. The lecture by Rafał Kowalczyk (site director of the Cricoteka building representing Chemobudowa-Kraków S.A.) convinced them that even highly complex and complicated designs have a chance of being carried out.
- Rhinoceros and Grasshopper were applied in design work to produce alternative results and select an optimal solution.
- The workshop participants expanded their knowledge concerning styles in architecture, to include Parametricism.

The architect and architectural theorist Patrik Schumacher, who created the term, wrote:

> *Contemporary avant-garde architecture is addressing the demand for an increased level of articulated complexity by means of retooling its methods on the basis of parametric design systems. The contemporary architectural style that has achieved pervasive hegemony within the contemporary architectural avant-garde can be best understood as a research programme based upon the parametric paradigma. We propose to call this style: Parametricism. Parametricism is the great new style after modernism. Postmodernism and Deconstructivism have been transitional episodes that ushered in this new, long wave of research and innovation* [6].

Over the course of only six days, the students mastered a new design tool and formulated their own architectural design proposals. Taking into consideration the fact that during this time they took part in a meeting at the town hall, an on-site visit, as well as in lectures and project presentations, it should be concluded that parametric and algorithmic methods of design make it possible to conduct design work in a highly effective manner, which can constitute

a significant competitive advantage for the students. Ipek Gursel Dino appreciates the importance of parametric design in various fields:

> *Parametric design is a computational method that can act as both a generative and analytical method during design exploration, and has recently gained great acceptance from both practice, research and education* [7].

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