Developing students' spatial skills and teaching the history of architecture through *structural drawing*

Maria J. Sołtysik

Gdańsk University of Technology
Gdańsk, Poland

ABSTRACT: S*tructural drawing* is a method applied in teaching the history of architecture in the first year of study in the Faculty of Architecture at Gdańsk University of Technology (FA-GUT), in Poland. The three main goals of structural drawing cover teaching the history of architecture, developing students' spatial skills and training their architectural drawing ability. Structural drawing is used to create axonometric and orthogonal views of historic architectural objects, important to the outline of architecture. During a 1.5 hour exercise, the students create a hand-drawn spatial study of one given object. The first part of the exercise is closely guided by the teacher, who performs the drawing on the board and students follow the teacher's instructions. The other part of the exercise is carried out by students on their own. The effectiveness of the Faculty's approach is revealed in both the students' questionnaires and the examination results.

INTRODUCTION

Teaching History of Architecture in the Faculty of Architecture should differ from teaching the same subject at, for example, the Faculty of Art History. The reason for that is the architect should not only know certain historical processes, important dates, names and facts, but they should also know the spatial structures of historical objects and be able to analyse them as drawings. This results from the very basis of the architectural profession, in which drawings and the language of plans or spatial views play a role - both in creating a new architecture and in understanding the historical one.

Many authors have stressed the role of freehand drawing in architectural education, especially *the drawing from nature* concerning both existing architectural objects and created fine arts compositions [1-4]. The author's point is to stress the role of a special form of analytic drawing in teaching and learning the history of architecture: a structural drawing. The author is a teacher of world history of architecture with vast experience in teaching in the Faculty of Architecture at Gdańsk University of Technology (FA-GUT), and in the Faculty of Landscape Architecture at Sopot High School in Sopot, Poland.

STRUCTURAL DRAWING IN TEACHING AND LEARNING HISTORY

One of the main tasks for future architects in learning the outline of architecture is to understand the main spatial ideas of the buildings most crucial to history. The structural drawing method was developed to support this process, by presenting the analytic, pictorial views of historical objects. The method is applied at the FA in Gdańsk in teaching the history of world architecture over two semesters of first-year study.

This course consists of lectures and exercises comprising the outline of architecture, from ancient times to the end of the 19th Century: in semester 1, from Prehistory until the Romanesque times; and in semester 2, from Gothic times to the end of Historicism. The lectures show the main processes in the history of architecture, stressing important architectural creations, famous architects and their architectural ideas. Although the exercises are closely related to the lectures, they focus on the chosen historical objects - one object in one exercise - which are analysed with the help of structural drawing (see Figure 1).

The three main goals of the structural drawing method in the course are: 1) to teach the history of architecture; 2) to develop students' spatial skills; and 3) to train students' architectural drawing ability. All these goals are highly important to architects' education. The structural drawing is performed in the class interaction between the teacher and students for all exercises. In semester 1, there are 12 exercises lasting 1.5 hours each, and in semester 2, ten such exercises. Thus, during the course the students can learn thoroughly and draw 22 architectural objects most important to

history. At the same time, they learn the structural method of analysing architecture, which then may be employed in their future professional practice.

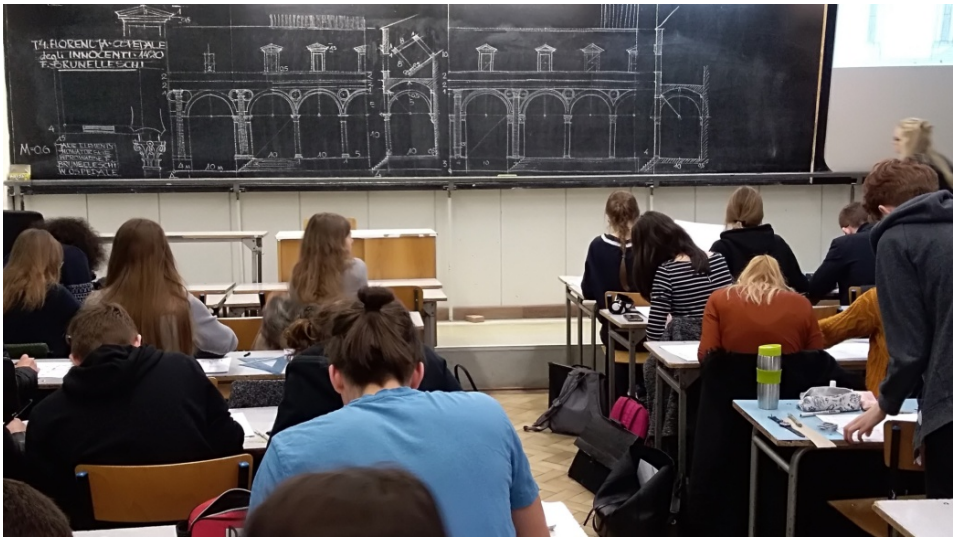

Figure 1: An exercise in the history of architecture during first-year study (Photo and drawings on the board by M.J. Sołtysik).

Structural drawing is a technique applied to creating a spatial, axonometric view of the chosen object and two-dimensional, orthogonal projections of it. Therefore, it gives a consistent drawn picture of the whole edifice or of a part of it, and involves such crucial information of the building as the layout, vertical dimensions, the idea of the construction, composition of the façade and the details.

The method is meant to teach students how to create the axonometric views on the basis of orthogonal ones, and *vice-versa;* how to draw the plan, cross-section and the façade out of the three-dimensional picture of the object. In this way, it not only helps students to learn the history of architecture, but also develops their spatial imagination and drawing ability.

The structural drawing method applied in the course on the history of architecture is performed according to certain rules. The first rule is that it allows only a freehand drawing, made *a vista* in pen, during a 1.5 hour exercise. The second rule is that it is performed using general, simple proportions, without the exact measurements. The third rule is that the process of drawing is performed in an analytic way, which means that all the phases of its construction are visible and the very object is presented as if it was transparent.

Since the course is addressed to beginners in architecture, the exercises are closely guided by the teacher. But, the level of guidance differs over time. The first few exercises are almost fully guided, which means the teacher draws the whole object on the board (see Figure 2), and the students then follow simultaneously. But, as the course progresses, the teacher's drawings gradually are limited, giving more room to students' own work. At the end of the course, the teacher gives only the general drawing disposition, and the students make the whole spatial study only with the help of photographs from a projector. The difficulty of the subject changes, starting from the simple prehistoric entities up to the most complicated structures of modern times.

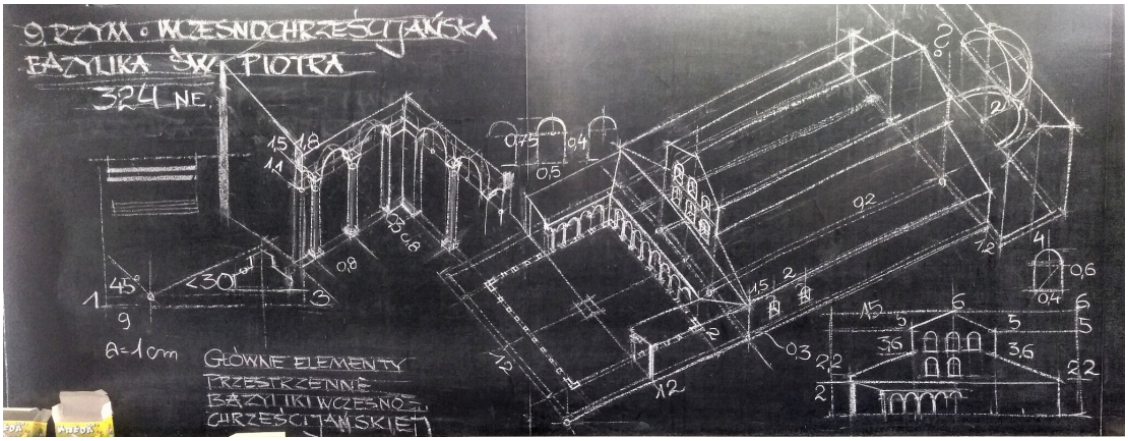

Figure 2: During the first few exercises the teacher draws on the board the whole object and its details (Photo and drawings on the board by M.J. Sołtysik).

DISPOSITIO: DRAWING THE PLAN, CROSS-SECTION AND FAÇADE

The Plan is the generator. *The Plan holds in itself the essence of sensation,* wrote Le Corbusier in his book, *Towards a new architecture* [2]. That simple truth was known from the beginnings of architectural history. Recognising it, the ancient Greeks perfected the layout of their temples, developing a few main types of plan, and allowing in practice only small variations of them. Marcus Vitruvius Pollio in his famous treatise, *De architectura libri decem* [3], writes about one specific feature of architecture, which he calls *dispositio,* and which means a proper disposition of all elements of the object, both horizontal and vertical. *Dispositio* determines the quality of building through the proper drawing of a plan of it, and the good proportion of the façade and side walls. In this meaning, *dispositio* plays a most important role in architecture.

The three main elements of *dispositio:* the plan, the cross-section and the façade, are crucial also in structural drawing employed in the course on the history of architecture. At the beginning of each exercise, the plan of the building is drawn. Sometimes, the plan is drawn both in orthogonal and in axonometric views, for example, as in the exercise that opens the course, entitled, *The neolithic house in Çatalhöyük* (see Figure 3)**.** In many cases, the plan is drawn as students' own work, after they have finished the axonometric view of the object. It trains their imagination and helps them to remember the main spatial idea of the building. This is the case, for example, in the third exercise, presenting the *Hypostyle Hall* of the Khonsu Temple in Carnac (Figure 4).

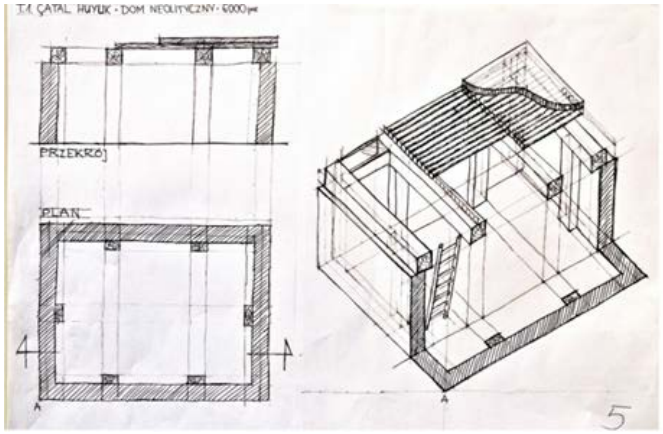

Figure 3: The house in Çatalhöyük by student Anna Kass.

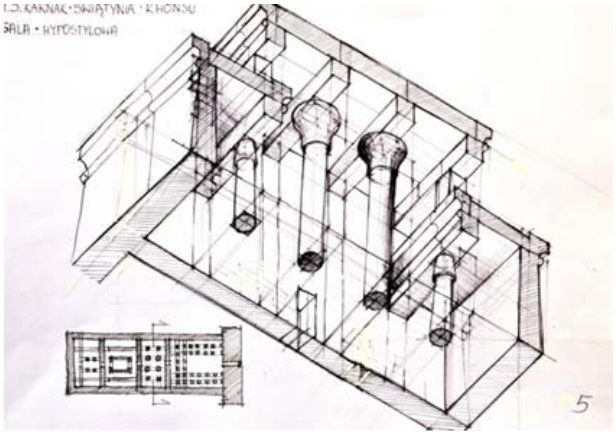

Figure 4: The *Hypostyle Hall* by student Anna Bronk.

The second element of *dispositio* is the cross-section, which completes the main information about the vertical proportions and construction of the building. The cross-sections in the structural drawing are employed to present the architecture, either in spatial or in orthogonal views. These can be seen in Figure 3 and Figure 4 above.

The façade is the third most important element of *dispositio*. Sometimes, due to its complexity, it could be the main subject of the drawing - as with the exercise concerning the façade of the Doric temple or the one entitled, *The portico of the Ospedale degli Innocenti in Florence* (see Figure 5). In those two exercises, the cross-sections are the auxiliary elements of the drawings, partly made by the students themselves.

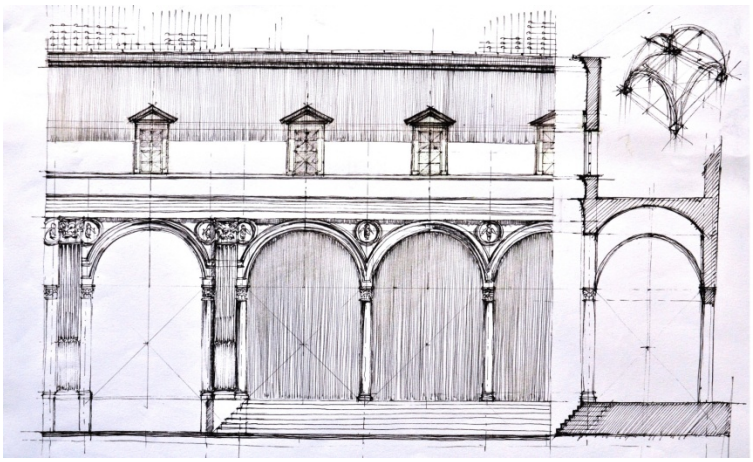

Figure 5: *The portico of the Ospedale degli Innocenti in Florence* by student Piotr Bussold.

While drawing the elements of *dispositio* both in orthogonal and in three-dimensional views several principles should be followed. For example, in presenting the plan, marked in the picture should be all the important structural elements of the object; also those placed above the ground, such as beams and vaults, by using adequately bold or thin lines. The crossing line should be clearly marked on the layout and the cross-section sketched above it. When the cross-

section is drawn, the student should point out vividly all the crossed elements of the construction, highlighting them in bold. The related drawings should be coherent and carried out in the same scale and proportion.

AXONOMETRIC PROJECTION: VOLUMES

The best way to teach and learn the concept of historical architecture is to present it in a spatial three-dimensional view. During the history course, students draw mainly the axonometric views of architecture. The core of the structural drawing method employed there is creating these views in three main stages, obeying a sequence of drawing:

- First, students draw the plan in axonometric projection;
- then, in the same picture they draw the cross-section, which is related to the plan;
- and after that, they finish the whole view.

The first two stages comprise the basic information about the building, so they must be sketched in the beginning. It allows students to place all the structural elements in the right position in the picture, and then to create the volume of the object, as if they were building it. That sequence of drawing is presented in Figure 6, on the example of the exercise entitled, *The Megaron in Tiryns*. But, the sequence must be observed during the whole course.

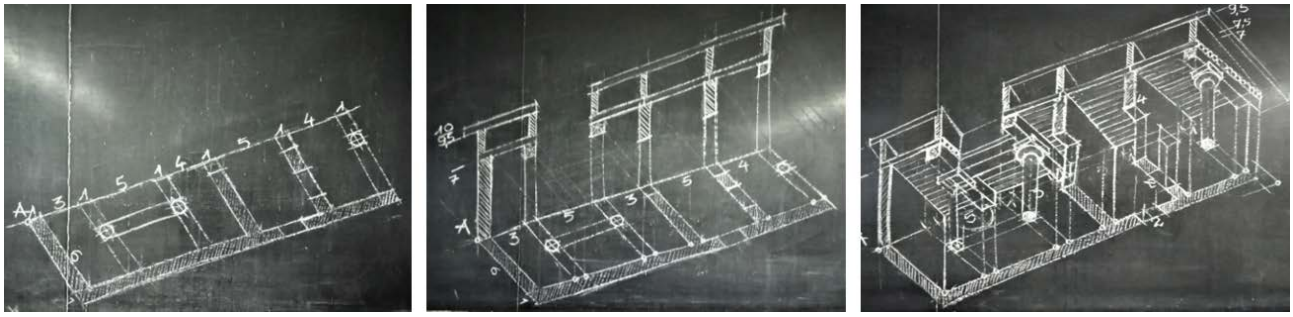

Figure 6: Three main stages of drawing an axonometric view: plan, cross-section and full axonometric projection on the example of the exercise, *The Megaron in Tiryns* (Photo and drawings by M.J. Sołtysik).

The majority of axonometric views drawn during the course concern the volume of a chosen historical building. To develop students' imagination, the volumes are drawn in different views. They are drawn either in the top view, as in the case of the Gothic skeleton system (Figure 7) or in the bottom view, as in the case of the Pazzi Chapel in Florence (Figure 8).

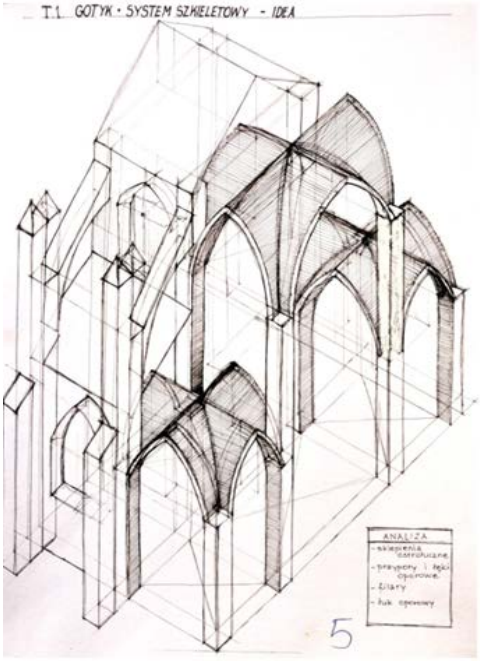

Figure 7: The Gothic skeleton system by student Natalia Wołoszyk.

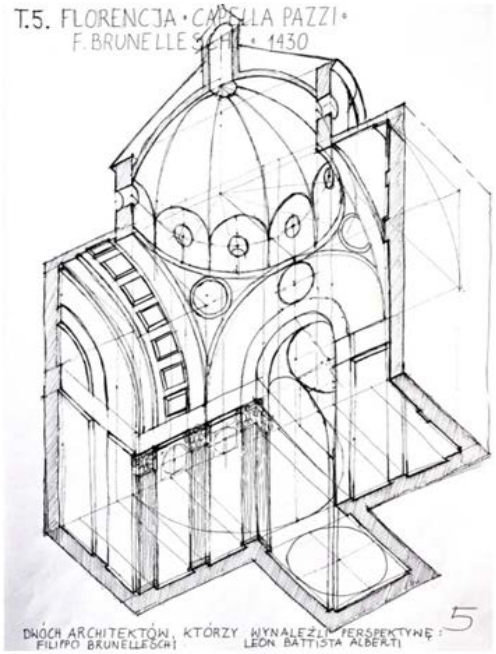

Figure 8: The Pazzi Chapel by student Kasjan Kozuba.

The drawings can be differentiated further by presenting either the whole volume of the object, as can be seen in the picture of the Church of St Michael in Hildesheim (see Figure 9), or only the part of the volume, as in the picture that shows St Peter's Basilica in Rome by Donato Bramante (see Figure 10). The latter allows the viewer to look inside the object. Because all the structural drawings display the buildings as though they were transparent, in every case both the plans and cross-sections are visible, although sometimes only as the starting, auxiliary constructions.

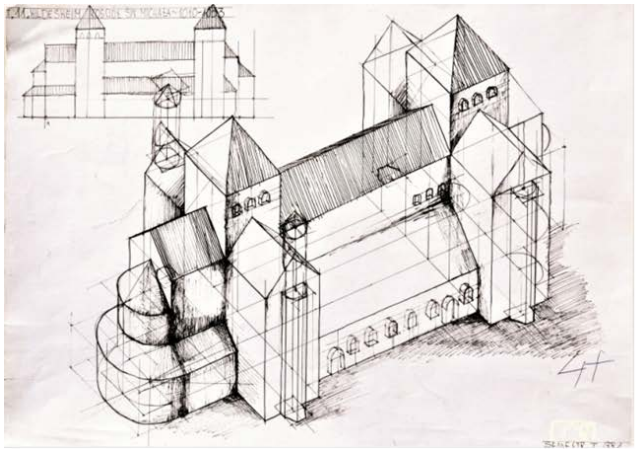

Figure 9: St Michael's Church in Hildesheim by student Weronika Dettlaff.

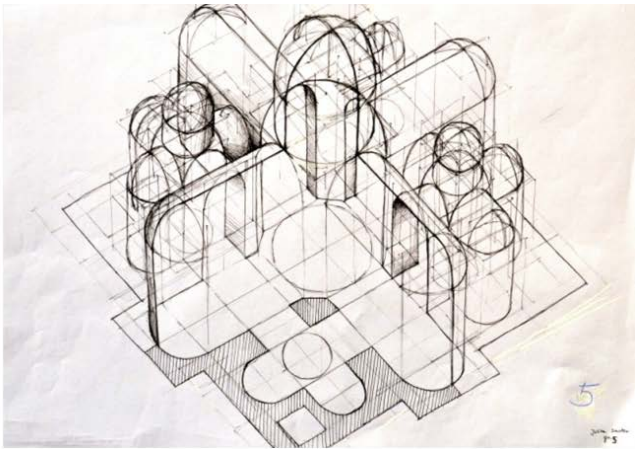

Figure 10: The idea of St Peter's Basilica by student Julita Smoter.

DETAILS

Drawing architectural details is usually difficult for students. During the course on architectural history they can learn it through applying examples from the ancient, medieval and modern capitals. Egyptian capitals are drawn, as are ancient Greek and Roman capitals, as well as their modern interpretations. However, the stress is put on drawing Doric, Ionic and Corinthian capitals, which are the most frequent in the history of architecture. The students analyse them during semester 1 (see Figures 11 and 12). Then, in semester 2, they draw them as a part of many edifices of Renaissance, Baroque and Neoclassicism.

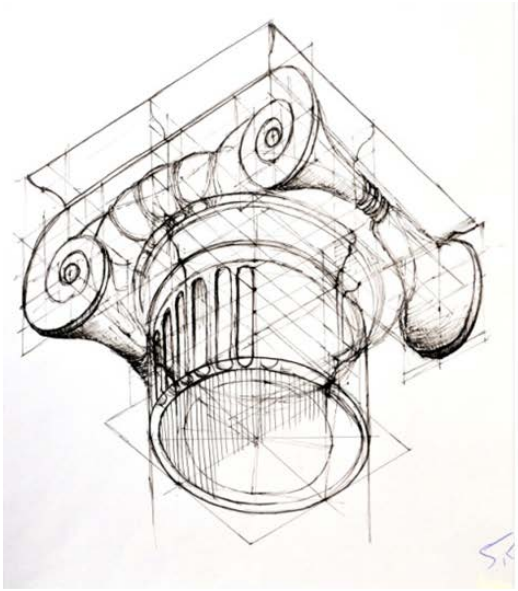

Figure 11: The Ionic capital by student Julia Woś.

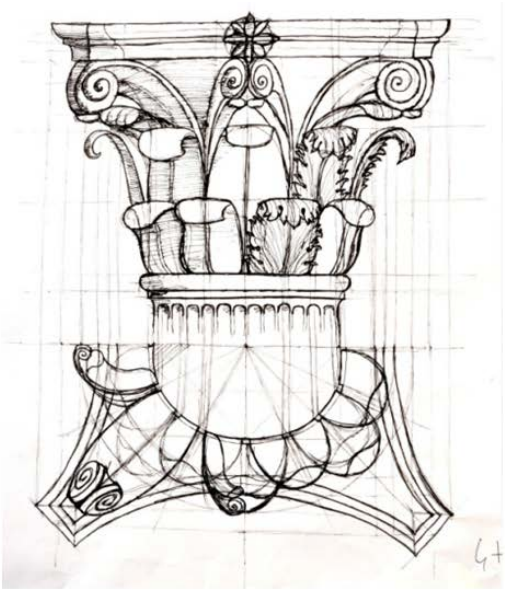

Figure 12: The Corinthian capital by student Monika Merk.

RESULTS AND EFFECTIVENESS OF STRUCTURAL DRAWING

It is important to check the results and effectiveness of the structural drawing exercises performed during the first year of study in architectural history, in terms of the main goals of the course. Those results are checked in three ways. First, every student's work is evaluated after each exercise. The evaluation concerns both the historical correctness of forms and the quality of spatial views created in the drawing. The students can check the results of evaluation during consultations with the teacher, and then they are encouraged to train their drawing ability and spatial skills during their own studies at home. The students' progress is clearly visible when comparing the first simple exercises from the beginning of the course (see Figure 1), with the complicated drawings carried out in semester 2; for example, with the façade of a French Gothic cathedral or of the volume of the Baroque church, *Santa Maria della Salute* in Venice (Figures 13 and 14).

Structural drawing proved effective also in learning the history of architecture. This can be judged by analysing the results of the examinations, which are written, both after semesters 1 and 2. The answers given by students during the examinations are about 80 percent satisfactory, in terms of historical knowledge.

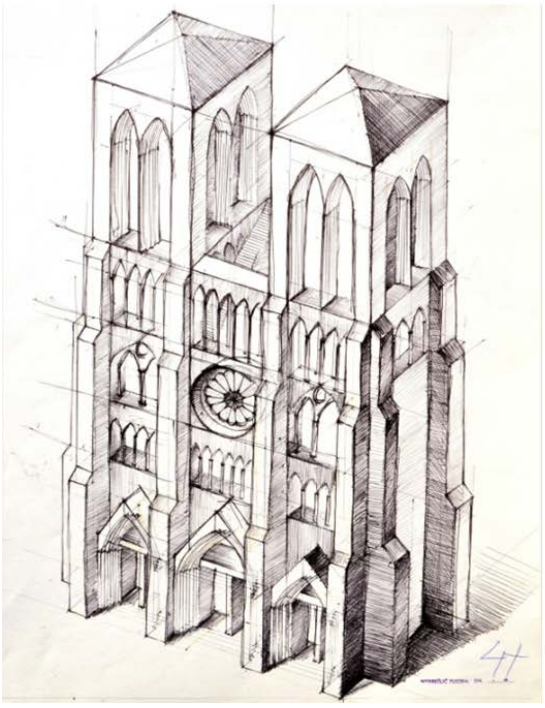

Figure 13: The Gothic cathedral façade by student Monika Knut.

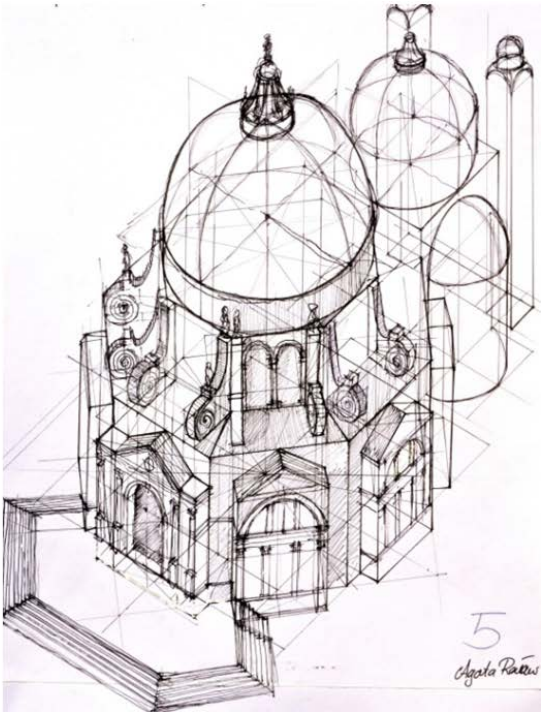

Figure 14: The church, Santa Maria della Salute by student Agata Racław.

CONCLUSIONS

The *structural drawing* method is applied in teaching the history of architecture at the FA-GUT, in Poland. The three main goals of the method were discussed in this paper. During the course, an exercise in structural drawing is both teacher-guided and driven independently by students. A good way to check the overall results of the course is through the students' completed questionnaires, as well as the examination results. They are checked both during the course, and afterwards. Usually, it is found that more than 70 percent of the students of semester 1 answer that the exercises have developed their spatial skills and drawing ability, helping in the same way to understand the outline of architecture.

At the end of semester 2, the great majority of students still claim that the help was significant. The evidence shows that the method of structural drawing is highly effective in learning both the history of architecture and in presenting the spatial views of architectural objects.

REFERENCES

1. Białkiewicz, A., Propaedeuties of teaching drawing to architects. *Global J. of Engng. Educ.*, 21, **2**, 115-120 (2019).
2. Le Corbusier, *Towards a New Architecture*. New York: Dover Publications, Inc., 2-3 (1986).
3. Vitruvii Pollio, M., *De Architectura Libri Decem*. In: Krohn, F. (Ed), Lipsiae: B.G.Teubneri, Lib. I.2, 9-10 (1912).
4. Żychowska, M.J., Teaching drawing to a new generation of engineers architects. *World Trans. on Engng. and Technol. Educ.*, 17, **1**, 60-65 (2019).