Freehand drawing versus digital design tools in architectural teaching

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ABSTRACT: The oldest drawings resembling modern architectural designs date from the 22nd Century BC. Throughout history, the first drawings have evolved into the basic tool of the architect's work. The exchange of information between the architect and the contractor began to take place through a drawing system, allowing to describe three-dimensional space using flat representations. With time, architectural drawings also began to resemble true works of art, delighting with their artistry and ability to show even the most complicated spatial and technical solutions. With the increasing use of digital design tools taking place today, the teaching and practical use of freehand drawing and traditional methods of presenting students' work is beginning to disappear in architecture schools. The purpose of this article is to investigate students' ability to use traditional and digital methods to create and present architectural designs, based on architectural education carried out in the Faculty of Engineering at Gdańsk University of Technology (FA-GUT), Poland, in the academic year 2020/2021.

INTRODUCTION

Hand drawing has almost always been an element of architects' work and a tool for their communication with the environment, used to illustrate ideas and design solutions. Over the centuries, the role of drawing grew, becoming not only the basic element of conveying information about the design, but also a way to develop the artistic aspect of the architect's work and an element stimulating his/her creativity. Drawings made in various graphic techniques by architects are often true works of art, stimulating the imagination and inducing deep reflection.

The digitalisation of the architectural profession, gaining, especially recently, increasing momentum, has called into question the usefulness of traditional ways of presenting projects, both in design practice and in the architectural education process [1]. Modern, easy-to-use digital CAD 2D design tools allow quick, error-free and very precise representation of designs and the impressive, realistic visuals produced by 3D CAD software are a pleasant alternative to freehand drawing not only for architecture students but also for mature, professional architects.

With the increasing use of digital tools for architectural design, the teaching and practical use of traditional (analogue) methods for students to present their work is beginning to disappear in architecture schools. The purpose of this article is to investigate students' ability to use both methods of making and presenting architectural designs at different stages of their creation.

The research was conducted on the basis of literature studies, analysis of students' semester and diploma projects, and on the basis of a questionnaire carried out among students of the fourth and sixth semester of first degree studies, and students of the last semester of second degree studies in the Faculty of Architecture at Gdańsk University of Technology (FA-GUT), in the academic year 2020/2021.

ARCHITECTURAL DRAWING THROUGHOUT HISTORY

The first architectural drawings resembling modern designs were created in ancient Egypt. Drawn on papyrus scrolls, they have not survived to this day, but the complexity of monumental Egyptian stone buildings must have required the creation of designs by highly regarded architects of that time, such as Imhotep (2667-2600 BC). Many surviving stone statues show Imhotep in the characteristic position of a man sitting and writing or drawing on papyrus scrolls.

However, a later drawing dating from the period of the unification of Egypt by the Theban princes (ca. 2065 BC) has been preserved. It is a plan of a garden on the Nile, drawn on a wooden board [2] - resembling a contemporary urban design.

The oldest known drawing that resembles a modern architectural projection is a plan of a palace engraved on one of the statues of Gudea, the Sumerian ruler of the city of Lagash, dating from around 2150 BC. This drawing resembles projection drawings made by architects today, although it is characterised by a very low level of detail [3].

In ancient Greece and Rome, architects used drawings very similar to the simplified designs of modern architects, using projection, section, elevation and even perspective drawings. These drawings are known from numerous surviving descriptions, but unfortunately none of these designs have survived to the present day [4].

The Middle Ages also produced drawings similar to modern architectural designs. They were usually made on parchment and their detailing was not too great as architects in those days were builders, staying all the time at the construction site and supplementing the design message with verbal commentary. Some medieval drawings made by the builders of the time survive to this day. An example is a parchment plan of the monastery of St Gallen in Switzerland, dated 820 AD [5].

The modern era was at first slow and then dynamic in the development of architectural drawing and quite complex design studies. This allowed for a change in the role of an architect from that of a builder who is constantly on site to a designer who may delegate the management of construction works to other persons. Communication between the architect and the contractor began to take place through an abstract drawing system that allowed three-dimensional space to be described using flat drawings. Perspective drawing also began to be widely used, later also by painters, and the profession of architect became more and more like that of an artist who is both an engineer and a humanist.

The 19th and 20th Centuries saw a turbulent development of various types of graphic techniques used in architectural design. Apart from two-dimensional projection, section and elevation drawings, three-dimensional perspective and axonometric drawings were used. The architects' drawings began to resemble true works of art, delighting with their artistry and ability to show even the most complicated spatial and technical solutions. Examples include the works of Otto Wagner, Eugène Viollet-le-Duc or Antonio Sant'Elia and later, in a different style, of course, Alvar Aalto, Aldo Rossi or Jean Nouvel.

Contemporary architects still, especially at the conceptual stage, use hand drawing; however, more and more often they also make use of digital CAD 2D and CAD 3D tools, which allow for quick, easy and effective presentation of the design idea (Figure 1). Solutions that to some extent combine the art of freehand drawing with digital techniques are tools derived from the group of 2D CAD, such as digital drawing boards and digital graphics screens. Such drawings are both analogue and digital.

a)   b)

Figure 1: Design of the new building of Gdańsk University of Technology, Gdańsk, Poland: a) hand drawing; and b) computer visualisation (Source: FORT Taraszkiewicz Architekci Sp. z o.o. in Gdańsk).

CONTEMPORARY TECHNIQUES AND TOOLS FOR PRESENTING ARCHITECTURAL DESIGNS

Nowadays, architects have a huge variety of techniques and tools at their disposal to present designs. Their choice depends on factors such as the designer's knowledge and experience, artistic talent, individual proficiency in a particular technique and habits. Above all, however, the choice of design tools today depends on the development phase of the design. Other techniques are used by architects at the conceptual stage, others at the stage of obtaining appropriate administrative decisions, and still others at the detailed design stage.

Hand drawing is used primarily in the initial, conceptual phase of design development as a synthetic sketch showing the general idea of the designed space, without going into details. Here one can observe very free, almost painterly,

often abstract presentations of architectural visions, speaking only about the ideological message of the design and not about specific functional-spatial or technical solutions. But also, in the conceptual phase, there are often hand-drawn and yet very concrete projections, sections, elevations, perspectives or axonometries. When creating conceptual designs, architects use numerous traditional graphic techniques, such as pencil, crayon or ink drawing, water-colour painting, gouache, acrylic and even oil painting. They also use numerous mixed techniques. These drawings are often attractive, artistic studies becoming contemporary works of art.

However, freehand drawing is also very commonly used in the later stages of design development, although it is rarely part of the final study. Since the architect's work is usually a team effort, the freehand drawing is a method with which, even in the technical phases of design development, ideas are exchanged quickly and accurately within the project team, and final solutions are arrived at jointly. In the rapid exchange of thoughts and views, the technique of hand drawing, as a complement to verbal communication, has a definite advantage over digital techniques, in which the designer's reaction occurs with a certain delay due to the necessity of computer mediation, and thus is deprived of creative exaltation.

The design process does not end, of course, with handing over the project to the investor or contractor. Even though, as it has been mentioned above, thanks to the improvement of the ways of presenting the designs, a contemporary architect ceased to be a construction worker present on the construction site all the time and could delegate the management of the construction works to other persons, it is still extremely important for him/her to participate in the execution of the investment, enforcing the contractor to respect the design assumptions, clarifying ambiguities and making the necessary changes to the design.

In the course of such supervision on the building site by the author, often conducted in difficult atmospheric or local conditions, the architect's use of hand drawing has proved a great and difficult to overestimate value. The ability to quickly explain design solutions or changes introduced to the design, using a drawing, is highly valued by contractors, giving the architect an additional asset in building his/her, so necessary at the construction site, authority.

Modern architectural design, moving from the conceptual stage to the detailed design stage, is becoming more and more comprehensive, which entails the use of techniques and digital tools of 2D CAD, 3D CAD and BIM (building information modelling). For several years now, countries around the world have been adopting regulations that encourage or require the use of BIM. The increasingly complex spatial and technical nature of modern buildings, the need for architects to coordinate the designs of other engineering industries, including sometimes very complex installation branches, means that some designs simply could not be created without the use of digital tools. Frank Gehry and Zaha Hadid's projects are prime examples. However, there is also a belief that CAD tools are not for designing but only for a precise, error-free recording of the design. The computer does not support design in the sense of creating functional-spatial solutions, but only supports the creation of design documentation.

However, developers of CAD tools are now trying to adapt them to conceptual work by creating 2D and 3D programs for sketching and painting. Conceptual drawings created in this way, thanks to their digital form, can be easily, more easily than drawings made with analogue techniques, used in further stages of project work, even in BIM design. The disadvantage of these tools, however, is that due to their digital form, the sketches lose their ambiguity, so important at the conceptual stage and easy to obtain with analogue drawings.

The main domain of modern CAD tools is, therefore, the creation of extremely detailed, error-free 2D drawings using the method of showing three-dimensional solutions on mutually perpendicular planes (projections, sections, elevations, architectural detail) and 3D drawings. 3D drawings are mainly digital models, made in accordance with the principles of BIM and computer visualisations [6]. These visualisations, often very realistic, are however also often very misleading. Images illuminated with light that does not exist in reality, exposing details that are unnoticeable in reality or details whose existence is detrimental to the architecture of buildings, are sometimes a trap into which many architects fall.

To create architectural virtual models, especially to meet the requirements of BIM, modern architects have additional tools in the form of algorithmic programs, i.e. a set of functions that, based on input data, allow to achieve a specific goal. Today, the use of algorithms in design, unlike in the past, does not require knowledge of a software language or an advanced level of mathematics. Digital tools for algorithmic design are fairly simple and intuitive. Today, almost every designer, even inexperienced ones, can use these tools to effortlessly create algorithms whose operation and effects can be successfully used in professional work. The advantage of using algorithms is that changes are easy to make and immediately executed by the computer.

USE OF DESIGN TOOLS IN ARCHITECTURAL EDUCATION

The architectural design record, despite the use of the new design tools and techniques described above, has remained essentially unchanged for centuries. The basic form of architectural design still largely consists of flat drawings on paper or other similar media or their digital equivalent. Despite this, especially in the situation of a huge variety of design tools, instilling architecture students with the skills of making the best possible record of architectural thought that is creating and presenting designs, should be one of the most important goals of architectural education.
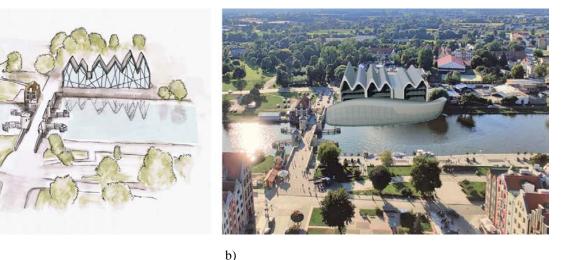
Although at many faculties of architecture around the world, including the FA-GUT, students are taught both hand architectural drawing and the use of digital design tools, there are no classes explaining the usefulness and role of a particular technique at a particular stage of the design process. In addition, despite the teaching of drawing and painting, drafting geometry, and subjects such as history of architecture or construction, which require the use of both freehand-drawing and computer techniques, students are not able to apply the knowledge gained in these subjects in architectural design. Students and then mature architects, without adequate knowledge and experience in using design tools, arrive at specific conclusions and solutions by trial and error, which often leads to the unnecessary multiplication of time-consuming attempts and accumulation of errors.

In order to verify this claim, an analysis was made of semester designs (first degree studies) and diploma theses (second degree studies) carried out at the FA-GUT in the academic year 2020/2021, and a questionnaire was conducted among students studying at that Faculty in the academic year 2020/2021.

The analysis of semester and diploma designs at all stages of their creation has shown (a total of 52 designs were analysed) that students made little use of hand drawing, and if they did, it was usually to make simple sketches with pencil, crayon or ink and only at the conceptual stage of design development. It is interesting that despite the fact that students of the FA-GUT, before being admitted to university, take a test verifying their predisposition to the profession of an architect, an important element of which is a check of their drawing skills; and despite the fact that, as mentioned earlier, during their studies there are many subjects requiring drawing skills, which the students deal with very well, their hand drawings made during the design process were often unsuccessful in terms of composition, perspective views, colouring or just diligence.

The implication is that students are unwilling or unable to transfer freehand and perspective drawing skills from drawing and painting, drafting geometry, architectural history or construction classes to architectural design classes. They seem to be unaware of the power and importance of the tool that is freehand drawing. What is interesting in the analysis of the designs is the fact that students from lower semesters, who have not yet had time to learn and master many digital tools, used hand drawing more often in their designs. Less frequently, however, hand-drawing techniques were used in designs by students of higher semesters, who preferred numerous, sometimes very advanced digital 2D and 3D techniques.

An interesting result of the above analysis is also the fact that while in the initial phases of design the students quite often used freehand drawing as a method of arriving at solutions, in further phases of development and in the final version of the designs they used almost exclusively 2D and 3D CAD techniques (Figure 2), using hand drawing only when talking and exchanging ideas with the teachers.

a)   b)

Figure 2: Student design of a musical theatre in Elbląg, Poland: a) freehand drawing; and b) computer visualisation (Teacher: A. Taraszkiewicz).

As mentioned earlier, the analysis of student designs was supplemented by a questionnaire conducted among students of the fourth and sixth semesters of first degree studies, and students of the last semester of second degree studies studying at the FA-GUT in the academic year 2020/2021. The questionnaire included five questions about a recent design done by students:

1. How did you start working on the design concept - by hand drawing, using digital tools or both? Give a brief justification for your choice of a particular graphic technique.

2. How did you carry out further work on the design - by hand drawing, using digital tools or both? Give a brief justification for your choice of a particular graphic technique.

3. What technique did you use to prepare the final two-dimensional elements of the design (projections, sections, elevations) - by hand drawing or with the use of digital tools? Give a brief justification for the choice of a given graphic technique.

4. What technique did you use to prepare the final drawings showing the building block in three dimensions (external views) - by hand drawing or with the use of digital tools? Give a brief justification for your choice of a particular graphic technique.

5. Do you think it is advisable to use hand drawing in architectural design or should it be replaced entirely by digital techniques? Justify briefly your position on this issue.

A total of 147 completed questionnaires were received. The questionnaire responses fully confirmed the design analyses presented above, and the large number of respondents helped to further substantiate these analyses.

To the first question, concerning the conceptual work on the design, the vast majority of the respondents (106 students) answered that they started this work using the freehand-drawing method. Thirty students declared the use of both freehand-drawing techniques and digital tools during the conception process, and only 11 students used digital techniques exclusively. The majority of students chose freehand drawing as a method for conceptual work primarily because of its ability to quickly capture design ideas and its ease of communication with the teacher.

The answer to the second question, concerning the further phases of design development, was quite different, showing in these phases a definite departure of students from the freehand-drawing technique. The majority of respondents (85 students) used only digital techniques, 53 students used both hand-drawing and digital techniques and only nine students used only hand drawing in this phase. The majority of students justified the choice of digital technology by the greater precision of their drawings, the ease of making changes and the fact that they did not know how to use hand-drawing techniques at further stages of design development.

The tendency to move away from freehand drawing in the later phases of design development was confirmed by the answers to question three, concerning the way in which two-dimensional projection, section and elevation drawings were shown in the final design. Almost all students (143) responded that they used only digital techniques in developing these drawings. Three students declared the use of both freehand-drawing and digital techniques, and only one student made these drawings by hand. The students justified the choice of using only digital tools similarly to the second question by referring to the precision of the drawings, the ease of making changes and the fact that they did not know how to use hand-drawing techniques at this stage of design development.

The answers to the fourth question, concerning the way the building block was shown in three dimensions in the final design, were almost identical to those to the third question. The overwhelming majority of students (138) responded that they used only digital techniques in developing these drawings. Six students declared that they used both freehand-drawing and digital techniques, and three students made these drawings by hand. Students justified the use of digital tools (3D CAD) by the ease of making changes in the built model, and the ease and speed of changing the direction from which the solid of the building is presented. However, nine students stated that hand drawing was useful in this phase of design development and enabled them to make the design more interesting.

In the light of the above responses, the students' answers to the fifth question in the survey about the future of freehand drawing in architectural design provide some food for thought. Well, almost all of them (145 students) in different, but unequivocal words stated that freehand drawing is and should remain an extremely important element of the architectural profession, giving the possibility to create architecture understood as art. The lack of use of hand drawing in their designs, expressed in the answers to the previous questions of the survey, was mainly explained by the lack of knowledge and skills regarding the possibility of using hand drawing in design and the ease and speed of work with digital tools. Only two students answering this question thought that in their professional work architects can completely do without hand drawing, relying only on digital techniques.

CONCLUSIONS

Drawing was in the past and still is today the basic and most important element of conveying information about an architectural design, a means of communication between the designer and the contractor, but also a way to develop the artistic sphere of architects' work and an element stimulating their creativity. The digitalisation of the architectural profession that is taking place today has meant that students of architecture, in addition to traditional freehand drawing, have a huge number of different types of digital design tools at their disposal. The abundance of these tools and the ease of their use have caused architecture students to largely abandon the use of freehand drawing, switching almost entirely to computer work. However, in this way they deprive themselves of one of the important elements of creating architecture understood as art, and turn to activities that can be described as performing an architectural craft.

The plethora of digital design tools, coupled with the lack of proper education on how to use them, also causes architecture students to encounter the phenomenon of *embarras de richesse*, in which they are unable to choose the right one for

a given phase of a design from the vast array of tools. Giving up hand drawing and not knowing how to choose the right digital technique often results in chaotic trial-and-error operations.

The results of the analysis of student designs and the results of a student questionnaire clearly indicate that the current architectural education lacks teaching elements that would enable:

- maintaining and developing freehand-drawing skills using as many traditional techniques as possible, such as pencil, and crayon drawing or ink painting, watercolour painting, gouache, acrylics and even oil painting, as well as the ability to transfer the knowledge and experience gained in this field during the study of other subjects (such as drawing, painting classes, drafting geometry, history of architecture or construction) to architectural design;
- gaining adequate knowledge and experience in using digital CAD 2D, CAD 3D and BIM design tools, taking into account their specific features and suitability for use at a given stage of architectural design creation.

These elements should be introduced into the curricula of architecture faculties as soon as possible, giving students - future architects a sense of full mastery of all, traditional and modern design techniques and knowledge of their advantages, disadvantages, limitations and possibilities. This is the only way to train professional architects who, thanks to their mastery of the craft, will be able to focus on the creative side of the profession, i.e. creating architectural works of art that serve mankind and the planet.

Once the curriculum changes have been implemented and the entire new study cycle has been completed, another survey of student knowledge and skills should be conducted using an analysis of student projects and the same questionnaire presented in this article. The purpose of this second study will be to determine how changes in the curriculum have improved students' mastery of the use of freehand drawing in architectural designs and their ability to use digital design tools. Unsatisfactory survey results should prompt further changes to the curriculum.

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BIOGRAPHY

Professor Antoni Taraszkiewicz, PhD, DSc, architect, works in the Faculty of Architecture at Gdańsk University of Technology (FA-GUT), Poland, where he deals with scientific issues of multi-family residential architecture, public utility, sacred, interior architecture and urban planning. He is also a co-owner and chief designer of the FORT Taraszkiewicz Architects studio in Gdańsk. He graduated from the FA-GUT in 1983. In 1995 he received his doctorate, and in 2006 he received his DSc degree. In 2016, he received the title of professor. He has been working at the GUT since 1983, where from 2008 to 2016 he served as Dean of this Faculty. From 2007, he has been Head of the Department of Residential Architecture and Public Interest of this Faculty, and from 2008 to 2020 he was a member of the Senate of this University. Since 2014, Prof. Taraszkiewicz has been a member of the Committee of Architecture and Urban Planning of the Polish Academy of Sciences. In the years 2014-2020, he was Chairman of the Municipal Urban-Architectural Commission in Gdańsk and was a member of the Regional Urban and Architectural Commission in Gdańsk between 2014 and 2018. Since 2014, he has been a member of the Regional Council for the Protection of Monuments in Gdańsk, and since 1984, a member of the Association of Polish Architects branch of the Coast in Gdańsk, where in the years 2000-2009, he served as Vice-President of the Management Board. Since 2000, he has been a member of the Chamber of Architects of Poland and since 2018, also a member of the Chamber of Engineers of Poland. He is the author and co-author of dozens of publications in the field of multi-family residential architecture, public utility, sacred, interior design, including two monographs. He has supervised four doctoral dissertations, including two defended with distinction, and numerous Master's diplomas. Prof. Antoni Taraszkiewicz is the author of numerous architectural designs and realisations, including new buildings of Gdańsk University of Technology, museums, churches, and settlements and housing complexes. He is also a laureate of many national and international urban-architectural competitions, in which he often received first prizes.