The evolution of education spaces - from plan as generator to regenerative architecture, virtual rooms and green campuses

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ABSTRACT: The study programmes are often considered the main formative factors in the process of educating future architects. Another highly influential component is the architectural characteristics of learning spaces, and consequently the impact of the physical built environment on the quality of education has been widely discussed. However, not often do we realise that the characteristics of education spaces correlate with the organisational structure of schools of architecture. Thus, the purpose of this article is to identify the trends in the evolution of educational spaces for training future architects, and investigate how much their characteristics have always been dependent on the architectural theories of the time and correlated with the organisational structure of the schools of architecture. The conclusions allow to draw a postulate that not only spaces ought to be in a focus of prospective future transformations, but also re-thinking the organisational structure of the schools of architecture.

Keywords: Educational strategies, technical education, university buildings, school environment

INTRODUCTION

The study programmes are often considered the main formative factors in the process of educating future architects. They result from the current paradigms understood as a totalising view, a model or a *belief system* that organises and shapes people's perception and response to architectural issues [1] along with the views of academic teachers based on these paradigms. Consequently, the content of training toward achieving the professional title of architect is subject to numerous international and national regulations, with the Directive 2013/55/EU of the European Parliament, as a good example [2].

However, in addition to the content of the curriculum, there are other instruments that, in a less obvious way, influence architectural education. One of the highly influential components that play an important role in the process of educating future architects is the architectural image of buildings and characteristics of spaces where training takes place. The famous phrase expressed by Winston Churchill in 1941, *We shape our buildings; thereafter they shape us,* only acknowledged the fact, that architecture not only is a means of expressing the cultural, political or social trends, but also supports and endures them in the materiality of the built form. This material form influences people's attitudes, beliefs or behaviours and informs their future decisions. Following this thesis, the OECD report published in 2011 calls for innovative learning spaces contrasting today's needs and expectations with the standard industrial-era classroom that isolated students from the environment, and provided an undiscussable strict layout of the desks that prevented interaction and reduced learning to a one-way transmission [3]. Consequently, the impact of the physical built environment on the quality of education has been widely discussed, both in relation to school [4][5] and academic education [6][7]. The quality of spaces for learning is particularly important in the case of educating architects. They exert an impact on students' architectural views, thus being a direct educational message [8]. As such, they have a strong influence on the decision-making process of future engineers who shape the entire built environment.

A closer analysis of the changing concepts of education spaces reveals that the discussion on the learning environment offered to future architects ought to be broadened and involve also another important aspect. It is the correlation between spatial solutions of learning spaces and the organisational structure of the schools of architecture, i.e. a school-specific division into particular departments that group academic teachers around certain issues or topics. As introductory studies reveal, both spaces for learning and the organisational structure of the schools of architecture are mutually interrelated and have always been deeply influenced by available in given time publications that offered theoretical foundations for the design process: guides and compendia of professional knowledge, textbooks and scripts.

Only rarely can one observe a situation, where an outstanding architect has the opportunity to simultaneously be the author of theoretical foundations, create a student education programme, decide on the organisation of the units and design buildings in which this process will take place. Frank Lloyd Wright erected two sets of buildings that were both his residences and a place of student education [9]. At the same time, they were a demonstration of the author's architectural views. These were Taliesin Wisconsin, USA, originally built in 1911 and Taliesin West, Arizona, begun in 1937, which housed the School of Architecture at Taliesin. Both structures were continually renovated and added to until the architect's death in 1959. Taliesin was a private, one-man venture by Wright, funded primarily by the architect himself. However, a similar phenomenon of merging an architectural theorist, creator of the study programme, head of the school and author of the building design in one person also took place in the structures of a large research university. Ludwig Mies van der Rohe, from 1938 head of the School of Architecture at the Armor Institute of Technology in Chicago (now Illinois Institute of Technology) had the opportunity to create the entire system of architectural education and build school buildings. Van der Rohe designed the university campus, including Crown Hall - the seat of the architecture department. The building was erected in the years 1950-1956, and the possibility of designing it was the condition under which van der Rohe agreed to take up a position at the university [10].

Relationships between the theoretical foundations expressed in publications, organisational structures of schools of architecture and the characteristics of learning spaces also exist in less obvious cases, where authors of buildings did not have the opportunity to create original, individual education systems. They can be found in the history and present situation on Gdańsk University of Technology campus, Poland, where the evolution of education spaces mirrors changing concepts in the theory of architecture and correlates with the organisational structure of the Faculty of Architecture.

The purpose of this article is to identify the evolution of educational spaces for training future architects, and investigate how much their characteristics have always been dependent on the architectural theories of the time expressed in publications and correlated with the organisational structure of the schools of architecture.

METHOD

The Faculty of Architecture premises at Gdańsk University of Technology campus, Poland, were taken as the material for the analysis. The whole campus complex has been developing harmoniously since the beginning of the 20th Century. Almost all university buildings are concentrated in a relatively small area. The complex was not destroyed during the Second World War and never changed its function. Individual faculties and institutions of the university are still located in the places intended for them in the design from 1899. The Faculty of Architecture still occupies the same rooms that it used to on the opening day of the university in 1904.

Three elements were analysed to identify the correlations that influence the education process:

- recommendations of architectural guidebooks published in the 19th and 20th Century, used by both architects and students as a source of knowledge;
- the architecture of the buildings and characteristics of learning spaces where architectural education takes place;
- organisational structure of the Faculty of Architecture.

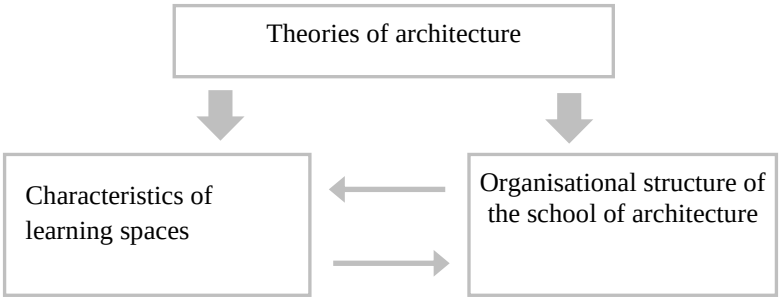

Figure 1: Correlation between different factors influencing architectural education.

These elements were analysed in the three main stages of campus development: 1900-1904, 1960s and 1970s, and after 2000. These stages of implementation directly relate to the three main architectural paradigms of the time: the 19th Century advent of functionalism with historical appearance, modernism and the postmodern breakthrough (Figure 1 above).

AN ARCHITECTURAL MODEL OF A HIGHER TECHNICAL SCHOOL AT THE TURN OF THE 19TH AND 20TH CENTURY

The contemporary model of a higher technical school was established in the middle of 19the Century [11][12]. It was based on the idea of Wilhelm von Humboldt, who postulated combining the development of science and its transmission. A typical set of units forming a technical university in Central Europe at the turn of the 19th and 20th

Century were the faculties of architecture, civil engineering and mechanical engineering, whose operation was a condition for the existence of a technical university. Often this set was supplemented by the faculty of chemistry and the faculty of general sciences and arts. The search for an architectural solution for a completely new institution had to be based on the latest architectural theories of the time. The basis for these theories can be found in the writings of Jean Durand in the early 19th Century. The French theorist believed that:

> *The entirety of any given building is and can only be the result of the assembly and combination of more or less numerous parts; one can only assemble and combine what can be arranged* [13].

Durand proposed an architectural system based on three components: the elements (e.g. walls), the composition (the layout of the plan) and the programme, which was supposed to be based on functional analysis. Although historical in appearance, these assumptions set foundations for the modernist functionalism [14].

This way of thinking was developed in the writings and architectural practice of École des Beaux-Arts, Paris [15]. In the first years of the 20th Century, one of the university's professors, Julien Guadet, published a monumental, five-volume work constituting a compendium of contemporary architectural knowledge [16]. Chapters III-VI of volume II concern higher education buildings. Guadet explains that the architecture of academic buildings shall be based on the plans and patterns of historical Baroque architecture, but concentrates primarily on functional solutions. For Guadet plan is an essence of composition, and the plan ought to clearly express the distinction between circulation and utility spaces, i.e. corridors for movement and classrooms for learning [14]. Besides, delving into functional analyses the author presents very detailed recommendations for the design of auditoriums, laboratories, lecture and exercise rooms, and deals with the issues of ventilation, acoustics and lighting. Even if Guadet reaches for historical examples to support the argumentation, he is not interested in questions of form, but only in plan and function. Guadet compares the plan of the Ecole Polytechnique auditorium with the plan of the amphitheatre in Pompeii, treating the ancient building as an example of a good solution to the issues of visibility and acoustics. This way of thinking lay at the heart of the functionalism that dominated architecture in the 20th Century.

Parallel to French publications and the activity of École des Beaux-Arts, experiences in the construction and operation of technical universities were codified in textbooks published in German, which were both one of the foundations of architectural education and templates used by active architects. These textbooks also presented the history of architecture and its latest achievements. The most eminent publication was *Handbuch der Architektur*, 143 volumes of which were published in 1880-1943. The authors of the *Handbuch* were over a hundred German, Austrian and Swiss architects and engineers, including Hermann Eggert, the author of the concept for the Gdańsk University of Technology campus, who was the co-author of the volume on school architecture. However, the chapter on university design was written not by Eggert, but by Claus Körner. In the 1888 edition of the book, Körner postulated the separation of the chemical institute from the main building, where all other functions were to be located [17]. This idea was implemented by teams of technical universities in Dresden, Lviv and Berlin. Within several years, however, there was a change in Körner's views. In the 1905 edition of the textbook, he stated that the university complex should consist of four or five buildings [18]. These objects were to be: the main building, the building of the chemical institute, the building of the machine laboratory, the building of the electrotechnical institute and possibly the building of the physical institute.

Another textbook for designing schools, including universities, was a book edited by Ludwig Klasen and published in 1884 [19], which gave 40 recommendations regarding architectural and technical solutions for university buildings, including storey heights, size of lecture halls, number of service apartments, furniture sizes or how to run installation. Most of Klasen's recommendations were supposed to provide great comfort to lecturers and students. The dimensions of the drawing tables, the width of the seats in the auditoriums, the width of the corridors and many other requirements would be considered too luxurious today. Klasen recommended that the hall should not be decorated with vivid colours, because it would interfere with the ability to display slides in this room. Designers of auditoriums in universities did not respect this recommendation. The most representative rooms at technical universities, for example, at Lviv Polytechnic, were designed with Baroque splendour.

Gdańsk University of Technology was established as a higher technical school of the German Empire, which after 1920 became the University of the Free City of Gdańsk, and after 1945 the Polish University of Technology began operating in the same buildings. The first, oldest part of the campus was built in the years 1900-1904. The complex consisted of four large buildings: the main building, housing, among others, the premises of the university authorities and the Department of Architecture, the building of the Chemical Institute, the building of the Electrotechnical Institute and the Machine Laboratory. The programme on offer was functional, which in 1905, in the second edition of his textbook, Körner proposed as optimal for higher technical schools. Such a solution was later adopted, among others, in the campus of Wrocław University of Science and Technology, Poland, the construction of which began in the year of publication of Körner's book. The implementation of the Gdańsk University of Technology programme was therefore a successful experiment, which was first carried out, then described as a model in the textbook and finally applied in other cases.

In the buildings of the University of Technology, a façade solution based on the patterns of the local Northern Renaissance [20] was used. The architectural costume, conveying appropriately designed content to the recipient, drew from history but also spoke about modernity. The decorations of the main building featured, for example, sculptures and bas-reliefs depicting: a steam locomotive, coils and insulators.

Strict symmetry was used in the plan of the main building, with long corridors that enabled circulations and provided entrances to utility spaces - lecture rooms with rigid rows of desks facing slightly elevated stands for lecturing ex-cathedra. The separation between spaces for movement and spaces for static positions was rigorous according to the French theory. The strict layout of long corridors and sequence of rooms did not allow for any unambiguous spaces. Despite the strict division between circulation spaces and learning spaces and the rigid arrangement of learning units, the grand scale of the space allows today for using corridors as a venue for exhibitions (Figure 2).

Figure 2: Long corridors as a space for circulation according to the 19th Century French Academy tradition and the in-between space for experimentations - 3D modelling laboratory.

However, on the photographs from the beginning of the 20th Century, they are rather empty, classrooms were presented with students working in isolation at their desks or listening to lectures. It should be noted, however, that not all functionalist theoretical recommendations were respected by the designers of the University of Technology. As in other buildings of higher technical schools, the main hall in Gdańsk received very rich decorations.

The organisational structure of the faculty followed the same principles, mirroring the functionalist approach to architecture and rigid division of learning spaces, each for one faculty department. The department where students learn how to design public buildings was called the Department of Composition, acknowledging one of Guadet's design principles. Since circulations characteristic in Baroque architecture, delved later by Durand and Guadet, were predominant in plans of public buildings of the early 20th Century, the Department of Composition was also delivering lectures on the history of Baroque architecture. This rule was general for other units arranged according to specific functions of buildings: departments, where designing of particular types of objects was taught, simultaneously conducted courses on the history of the style that was considered appropriate for a given function [21]. For example, the Department of Sacral Architecture delivered lectures on the history of Gothic and Romanesque architecture. It should be noted, that already in the initial conceptual design of the campus, the workplaces of individual organisational units (departments) were precisely defined. Both the spatial distribution and the organisational structure of the Faculty of Architecture reflected the design principles depicted in the architectural publications.

At the beginning of the 20th Century, both the architecture of the buildings, the organisational structure of the Faculty of Architecture and the published compendia of professional knowledge conveyed the same idea: the basic task to be solved by an architect is the correct arrangement of functions, separation of spaces for movement and spaces for learning arranged as a set of isolated rooms. All these with the use of modern technologies and pre-modern functionalistic approach. Nevertheless, the building was covered with a costume consisting of details taken from history.

MODERNIST CONTINUATION OF 19TH-CENTURY ARCHITECTURAL IDEAS

In the 1920s, there was a shift in the architectural paradigm and a new trend emerged - modernism. However, it was not a complete change. The new, modernist paradigm took over the characteristic of the French Academy principles of functionalism and the arrangement of a building as a composition of separate elements. It was Le Corbusier, who studying Durand's concepts proclaimed in 1923 the idea of *plan* as a generator of architecture and continued delving into the role of circulation spaces in buildings. The priority of function in buildings was expressed even stronger, but multi-volume guides were replaced by smaller publications. The authors of the new books, intended to be the foundation for architectural education and guides for professional architects, postulated the detachment of architecture from its former role of conveying meanings, and thus the detachment of contemporary architecture from history.

In 1932, simultaneously in New York and London, the first modern architectural textbook was published by Ramsey and Sleeper [22]. It contained several thousand schematic drawings showing ways of solving technical and functional architectural problems. Unlike earlier similar publications, the handbook did not contain elements of the history of architecture. In 1946, the first edition of another important American book, time-saver standards, a manual of essential architectural data, for architects, engineers, draftsmen, builders and other technicians, was published [23]. These publications had their sequels and had a great influence on architectural education and practice.

Ernst Neufert, a graduate of the Bauhaus school and later its teacher, published his textbook in 1936, which became one of the most important architectural publications [24][25]. In the years 1936-2022, 43 editions of Neufert's book in German were published. As early as 1949, the manual was translated into Italian, and to date, nine editions have been published in this language. The first French edition of Neufert appeared in 1951. The manual has also been translated into: Bahasa-Indonesia, Chinese, Greek, Hungarian, Japanese, Portuguese, Russian, Serbo-Croatian, Spanish, Turkish and Vietnamese. To date, about half a million copies of the manual have been printed worldwide. In the latest editions of Neufert's book, more than a century after the publication of his prototypes, one can still find drawings presenting similar issues raised by Guadet, Korner, Klasen and others. Not only the content, but also the way of graphic presentation of issues has not changed.

All three manuals mentioned above, as well as other, less popular equivalents, propagated similar values, such as function priority in architectural solutions, modular systems, normalisation and standardisation.

The first Polish edition of Neufert's textbook was published only in 1980. Since 1945, the resources of Gdańsk University of Technology included copies of the first and second German editions, and soon after the French translation was published, it also found its way to Gdańsk. The convergence of architectural solutions recommended in Neufert's manual with new building designs is clearly visible. The strictly understood functionalism became a priority in the design of the new buildings and spaces for learning on the Gdańsk University of Technology campus. Common spaces, such as halls and corridors have been limited to the minimum necessary for communication purposes. In one of such buildings, the so-called Edifice B students of architecture learned geometry and languages. Narrow dark corridors excluded the possibility of exchange of opinions and reduced learning to the passive reception of strictly divided *knowledge packages* in the education *boxes*.

The organisation of the Faculty of Architecture changed - the departments were reorganised into more function-oriented units and removed the elements of the history of architecture. Instead, a new unit was established, the Department of History of Architecture. In this way, the departments where students learned how to design buildings of certain functions were detached from conveying the knowledge on the development of architectural thought and theories that underpin the evolution of architectural concepts. The history of architecture slowly became identified as a piece of knowledge with no links to the present. In 1946, there were 16 departments at the Faculty of Architecture, assigned to various narrow scopes of education. Later, the number of departments decreased, but they were divided into narrowly specialised departments according to separate functions of buildings, such as, for instance, industrial architecture, port architecture, healthcare architecture, housing architecture or rural architecture.

CHANGES AT THE TURN OF THE 20TH AND 21ST CENTURY

In the last decades of the 20th Century, the modernist paradigm of functionalism was challenged, although it was not an unambiguous and consistent change. Despite the growing popularity of new, electronic sources of information and a variety of publications presenting different approaches to the design of university spaces, Neufert's textbook is still being reissued. The fifth English edition was published in 2019, the eleventh French edition in 2021 and the fifth Polish edition in 2022. *Architectural Graphic Standards*, a continuation of the 1934 publication, is now available by subscription in a downloadable Web format [26]. Although, a variety of sources on how to design, including numerous printed books, booklets, on-line platforms and open-source publications appeared. This has transformed the unambiguous message of how to design, once contained in several key publications, into a cloud of information from which anyone can select the relevant data to undertake a discussion on an emerging issue.

At this time also, new civilisational challenges and new concepts for the education of architects appeared [27][28]. The ambiguous term *postmodernism* began to be used in relation to architecture, covering a wide spectrum of issues [29]. Instead of seeing architecture as an assembly of separate elements, as postulated by Durand, and normalised in modernism, new concepts of in-between, transitory and hybrid spaces emerged, which both responded to and fostered the need for the interdisciplinary and transdisciplinary education practices [30-32]. Campuses became a venue for the intercultural practices, generators of social change and an inspiring place for reflection and experimentation [33][34].

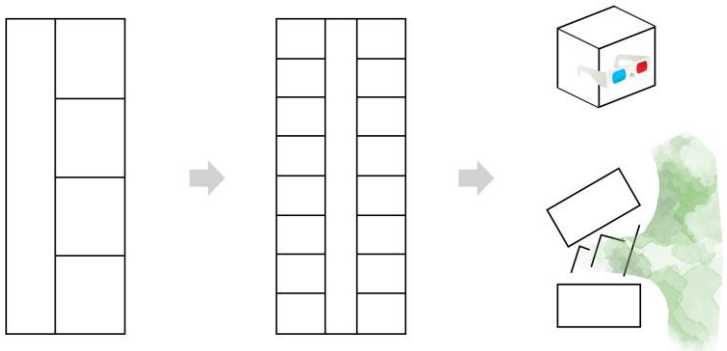

Figure 3: Transformation of learning spaces: a) 19th Century French Academy tradition; b) modernism and the plan as a generator for architecture; c) 21st Century regenerative spaces, virtual rooms and green campuses.

The search for more flexible learning spaces began, both real and virtual - supported by growing interest in digital environments, media architecture and ICT tools for architectural design and education [35-38] (Figure 3).

The 2019-2023 coronavirus pandemic has strengthened interest in virtual meeting rooms. The image of what a place for education may look like has begun to change. Xristina Argyros and Ryan Neiheiser, the authors of the exhibition on contemporary schools of architecture presented at Venice Biennale 2018 admit that today *classrooms are becoming less important than the spaces between them* [34]. At the same time, sustainable development issues become one of the most dominant topics in architectural education and practice [39][40]. As a response to the climate crisis, many higher education institutions join climatic plans and transform their venues into green campuses.

These new trends are evident in the latest Gdańsk University of Technology campus transformations and the design of new spaces for educating future architects. Places considered to be of little value, and so far unused in the historic Main Building, started to be discovered and refurbished. Vast attics of the building were renovated and transformed into multifunctional open rooms for the Faculty of Architecture, where the division between the circulations and static utility spaces is blurred. The free flow of spaces is perceived by both teachers and students as an advantage and an additional inspiration. The two inner courtyards of the Main Building, which were hidden from view for decades, became the venue for interdepartmental science meetings and architectural diploma public presentations. The newly built 3D Laboratory Pavilion integrates space for sculpture, rapid fabrication digital architecture and testing kinematic innovative building skins, which gives inspiration for new kinds of educational experiments on the boundaries between art, architecture and technology [41] (Figure 2 above).

In response to the climatic threats, a whole set of spatial innovations are undertaken, that integrate architectural solutions with environmental benefits [42]. Students and teachers are involved in the construction of microclimate installations on the premises of the university campus, and work on blue-green concepts to prevent air pollution and restore biodiversity [43][44]. Selected campus areas become open living laboratories, where nature-based solutions are explained and discussed in the open-air learning spaces. Such an approach is radically different from the strict assignment of functions to delimited spaces, as designed by architects at the beginning and in the second half of the 20th Century.

At the same time, organisational changes at the Faculty of Architecture are taking place, but not without resistance from some members of the academic staff. In this process, there is a visible departure from treating architecture as a set of narrow, separate function-oriented units, towards increasing the possibility of their integration and re-formulation. Many of the strictly functional names of departments, such as industrial architecture, rural architecture or healthcare architecture, changed in the last years into more problem-oriented units, such as the Department of Environmental Architecture or the Department of Urban Architecture and Waterscapes. This is an expression of the desire to break through silo approaches and focus on new objectives and challenges in educating future engineers. These changes mirror the reflection that the task of an architect cannot be reduced to the proper assignment of functions but also need to responsibly refer to the social, cultural and regenerative mission of any built intervention.

CONCLUSIONS

The study indicates the main tendency in the evolution of education spaces over the last one hundred years. This evolution may be identified as a path from considering the plan as a generator of architecture to the contemporary concepts of regenerative spaces, digital learning environments and green campuses. Interestingly, the French Academy's idea of a plan that organises the layout of corridors as circulation spaces and a sequence of isolated rooms as learning units remained also valid in the concepts of modern architecture in the second part of the 20th Century. The presented study confirms that different concepts of spaces for learning have always been related to the dominant theories of time expressed in architectural publications and guidebooks. Moreover, taking the Gdańsk University of Technology campus as a case study model, the study indicates the correlation between the dominant given time characteristics of learning environments and the organisational structure of the school of architecture. It reveals the clear evolution from specialised departments oriented on particular functions of the buildings, this tendency reached its apogee in the second part of the 20th Century, towards a pursuit of creating more problem-oriented units which can be observed in the last decades.

The study leads to a conclusion, that textbooks, the organisational structure of the school and learning spaces form a material and immaterial whole that influence the student's education. All these factors mirror current paradigms and influence each other. In this context, it is important to notice that not only study programmes and spaces for learning ought to be the focus of prospective future transformations, but also re-thinking the organisational structure of the schools of architecture.

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