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METHODS OF TEACHING TECHNICAL ASPECTS AND CONCEPT DESIGNING IN ARCHITECTURAL EDUCATION

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Abstract:
Teaching architectural design is related to some substantial educational problems in many respects. Among them is the issue of mutual relations between concept design and technical aspects in architecture. The student's attitude in this regard is strongly differentiated. Some of them deny the significance of technical aspects and focus only on the conceptual vision, while others acknowledge the importance of a technical approach to their projects at an early stage of development. Inconsistent is also the position of the teaching staff in this regard. This is a well-known issue among the educators in the discipline of architecture. Some of them propose and insist on some method of integration between the modules of concept and technical designing, which they consider a better and more efficient way of teaching students. This issue is analysed in the paper, and some proposed methods to resolve this problem are specified. They are confronted with the opinions expressed by undergraduate Ph.D. students, given their differentiated experience concerning the analyzed relations and their effect on the methods of their activities.

Keywords: architectural design; technical design in architecture; education in architecture

INTRODUCTION

Building construction is the knowledge in the profession of architecture, which is crucial for architects, however, the technical approach to architect education peaked with the establishment of the Bauhaus school in Weimar in 1919 [R. Spacek et al. 2020]. In recent decades, its importance has substantially increased as novel technologies appear systematically on the building market almost day by day. Some authors even claim that contemporary architecture is actually characterized not so much by unusual forms, new functions, and breath-taking spectacular structural systems but by novel technologies introducing new building materials. If so, these technologies should gain a proper place in architecture offices, and also in the curricula of architectural studies. Analysing these technologies, it has been usually revealed that they are largely based on traditional or conventionally well known methods of construction, but with modifications in terms of so far unknown materials or methods of their implementation. These new technologies, along with ever-changing building standards and building codes, indicate and force new ways of architectural designing as well as improvements in the organization ofwork in architecture offices. It stands to reason that these developments bear on the ways the schools of architecture teach students.

We live in a time when the teaching methods in the discipline of architecture are subjected to pressure exerted by professional architectural circles, especially the employers in architecture offices, as well as professional organizations like chambers of architects. They expect the schools to graduate students capable of performing basic architectural jobs professionally while being employed in architecture offices. Unfortunately, they usually are confronted with problems to find the new adepts of architecture capable of meeting the requirements set for them at the beginning of their professional career. Bearing that in mind, they occasion-

ally report their grievances to the faculty staff [W. Celadyn 2023]. Their complaints regard mainly the reported poor knowledge of technical aspects of architecture by the graduates. Because of this, the issue of effective methods of education regarding the technical subjects in academic curricula becomes a crucial problem.

The present paper considers this question and proposes a few different systems of teaching related to building construction and concept designing. This research aims at a contribution to the debate on integrity in the architect`s education.

1. METHODS

There are multiple subjects in the curricula of architecture schools for the Bachelor or Master programs that are part of technical education. The most important ones usually comprise: building construction, structures, building services, and building physics. Depending on the school of architecture, they are either separate courses or are embedded in the modules composed usually of technical subjects. The latter system is used at the Faculty of Architecture, Cracow University of Technology, and is the subject of this research.

We can consider building construction as the basic subject because it mostly impacts the formal and technical solutions to buildings, the remaining ones usually being classified as complementary. Building construction is a technical area that is under the heavy influence of the sustainability paradigm requirement in architecture and interior design [Celadyn 2019]. The relations between this subject taught at architecture schools and the work carried out at architecture studios define the problems we are considering in this paper. Analysing them, we can assume that there are different possibilities in this regard. In many discussions among the relevant faculty members teaching technical subjects, especially building construction, a few different approaches have been put forth. They should be properly formulated and then discussed. There are two aspects of this problem taken into account in this research: one considers a faculty's opinions and approaches, and the other evaluates it from the student's perspective. As expected, they differ, and in some cases substantially.

To compare them, and to draw conclusions, an anonymous survey for students was put together and administered. It concerned two groups of students with different experiences: active students in the 6th semester who major in architecture, and students of the Doctoral School at the Cracow University of Technology, Faculty of Architecture, who are postgraduate students after earning a Master`s degree. The method of inviting students of both education levels to participate in this research is sensible because both groups have differing knowledge and experience in the field of architecture. The Ph.D. students were working as architects in architecture offices in addition to their studies. This allowed them to assess reliably the teaching program they had gone through a few years before. For this reason, their opinion expressed in the survey can be considered interesting, especially in the context of student`s approach and relevant impressions.

2. RELATIONS BETWEEN ARCHITECTURAL EDUCATION AND PROFESSIONAL EXPERIENCE

Architectural design is a process based on deeply rooted and effectively realized procedures that allow the development of projects that are based on established principles concerning functional, structural, and aesthetic aspects of designed buildings. This corresponds to the classic Vitruvian Triade: *utilitas* (convenience – function), *firmitas* (durability – structure), and *venustas* (beauty – aesthetics) [Witruwiusz, 1956]. Another shaping factor is legal guidelines, which must be respected. Therefore, the architectural design is a complex process. It has a multi-professional character and requires cooperation with other specialized contributors, mainly in technical domains. A typical architect`s activity can comprise the following: preparatory works, definition of functional program, concept design, and a multistage technical project. The latter typically has two stages, defined depending on the country. In Poland, they are referred to as building projects and technical projects, but in reality, they are both technical projects executed to different scales.

In the context of discussions concerning the inadequate preparation of graduates for relevant professional activities, architectural education is frequently considered imperfect and even flawed in this regard. Reservations about its insufficient quality are being raised by professional organizations and active architects in offices. These may result from strikingly imbalanced relations between the workload related to design subjects in educational programs and the actual demands of office work dedicated to particular stages of the development of projects. The comparisons in this regard can cast light on the situation we consider in thisstudy (Figure 1).

There is a ministerial document that defines the range of workload assigned to particular architectural project stages [Rozporządzenie Ministra Infrastruktury]. It stipulates that a maximum of 15% of the work time is ascribed to concept designs, and the remaining 85% to technical design. The diagram in Figure 1 indicates

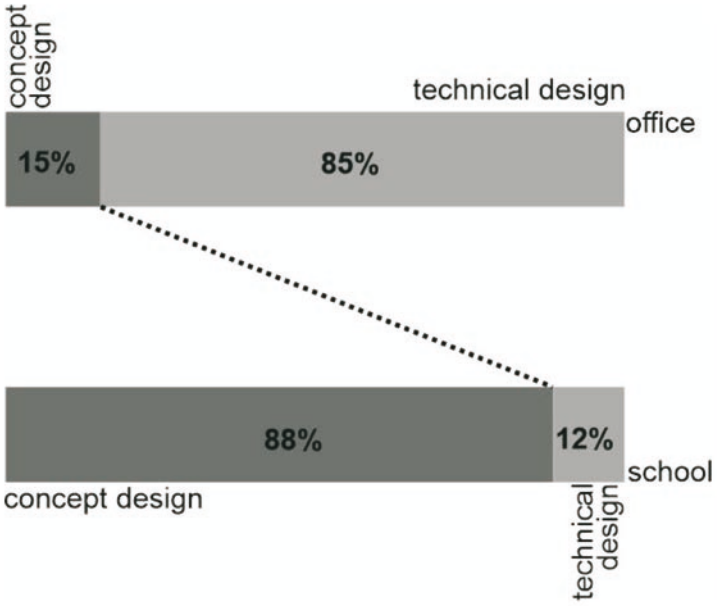
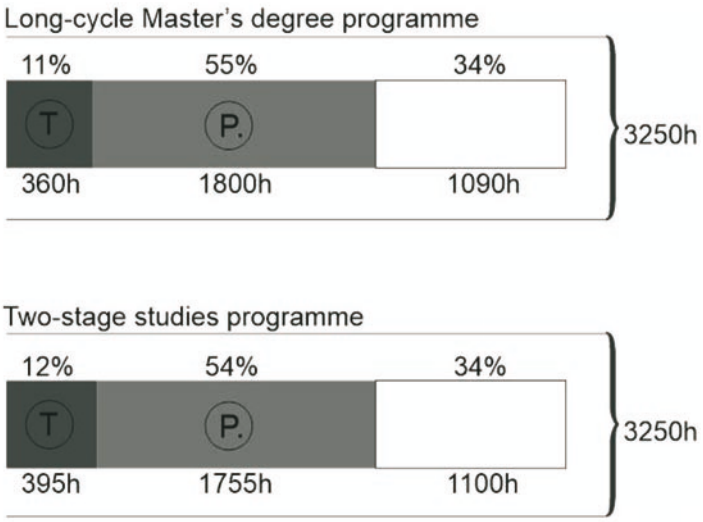


Fig. 1. Relations between the proportional workload of design stages in professional offices and relevant proportions in education curricula (in percent)
Source: author's drawing



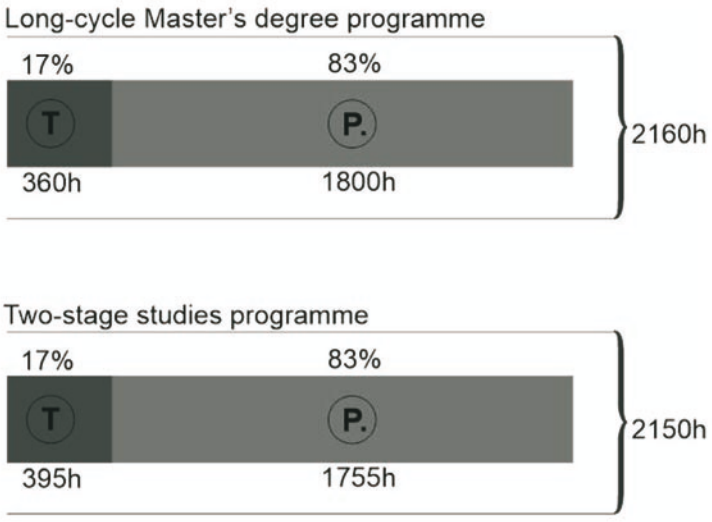
T – technical subjects, P – concept design
Fig. 2. The relations between technical subjects and concept design workload in the architecture studies curriculum specified in Polish ministerial standards
Source: author's drawing

these values in comparison to the average teaching hours assigned to technical subjects within the curricula for the Master's Degree and visualizes the reversed situation in terms of the structure of both areas considered in this research. It seems quite natural that educational systems in the architecture domain should correspond logically and effectively to the method of work used in architecture offices for producing building projects. It should be true not only if it comes to the substance of teaching but also to methods concerning the stages of designing. But as can be seen in Figure 1, the striking discrepancies between what is expected of students and what is expected of employees raise serious doubts about the adequacy of the teaching process. This requires deeper insights into this dilemma.

Figures 2 and 3 visualize the mutual relations of workloads between technical subjects and concept projects for both types of higher education in architecture, and in relation to the entire teaching programme.

These data are taken from the ministerial requirements for architectural studies, which are named architectural educational standards [Rozporządzenie Ministra Szkolnictwa Wyższego].

The position of technical subjects in relation to the concept design instruction workload depicted above confirms the previous concerns that there is a misalignment between what is demanded by the workplace and what students are being taught. We can analyze this phenomena further by exploring the role of technical subjects in architectural studies in other distinguished architecture schools (Table 1).



T – technical subjects, P – concept design
Fig. 3. The relations between technical subjects and concept design workload specified in Polish ministerial standards for architecture studies
Source: author's drawing.

Table 1 shows a very differentiated approach to the issue of mutual relations of both analyzed elements of university architectural education expressed in the relevant workloads. They demonstrate the role of technical education depending on the country. The results of these comparisons suggest that architecture education in Poland compares with the medium attention assigned to the technical component of architectural stu-

Tab. 1. Architecture schools and the technical subjects related to the total amount of credit points in the curricula of the Bachelor`s and Master's degree programmes jointly

	University	Faculty/Department	Final score		
			Technical subjects and assigned modules credits	Total subjects and assigned modules credits	Relation Technical / Total (%)
1.	Technical University of Berlin	Faculty VI Plannen, Bauen, Umwelt	114	258	44,2
2.	Vienna University of Technology	Faculty of Architecture and Planning	85	240	35,4
3.	Czech Technical University in Prague	Faculty of Architecture	69	249	27,7
4.	European University of Madrid	School of Engineering, Architecture & Design	80	318	25,1
5.	Politechnico di Milano	School of Architecture, Urban Planning, Construction, Engineering	52	270	19,3
6.	Technical University of Delft	Architecture and the Built Environment	50	270	18,5
7.	University College London	The Bartlett School of Architecture	75	480	15,6
8.	Cracow University of Technology	Faculty of Architecture	40	269	14,9
9.	Swiss Federal Institute of Technology Zurich	Department of Architecture and Civil Engineering	32	244	13,1
10.	UTH Royal Institute of Technology, Stockholm	School of Architecture and Built Environment	25,5	240	10,6
11.	Columbia University in New York	1/Bernard College, 2/School of Architecture, Planning and Preservation	22,5	127	17,7

Source: author's diagram

dies in European architectural schools and elsewhere. However, it does not significantly change the optics we consider the appropriate image of the analyzed issue.

There are a few reasons that could be responsible for this imbalance. One of them is the unfavorable attitude of students regarding the technical aspects of architecture [J. Legeny et al., 2021]. One survey among students concerning the technical aspects of architectural design, particularly building construction, has proved that they are of minor interest in their projects [A. Taraszkiewicz & K. Taraszkiewicz p. 224]. However, other surveys indicated the high importance of technical subjects in the students' opinions [M. Muszyńska-Łanowy 2021]. Yet another study *has found that students generally have a positive attitude toward technology even though they have only a limited concept of technology* [D. Rupnik & S. Avsec 2019]. These opinions expressed by students show serious differences among them in this regard. They can result from the specifics of teaching methods in various architectural schools or from the personal propensities of individual students in terms of the technical aspects of architecture and their role in professional practice. In the case of a negative attitude by students toward the technical aspects considered, later in their professional practice real problems can arise when theoretical considerations in architectural design need to be translated into specific engineering solutions [A. Taraszkiewicz & K. Taraszkiewicz, 2024 p. 12].

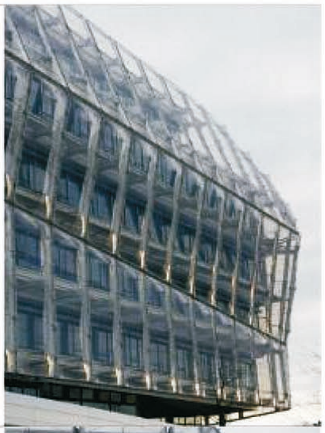
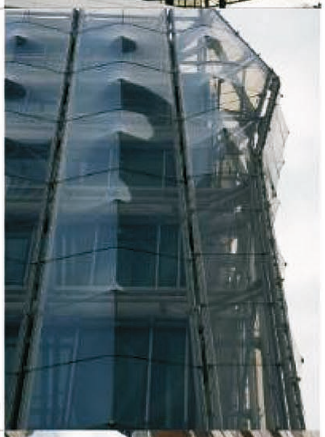
Sustainable design strategy	Protection against thermal losses	
Sustainable design technique	Double facade featuring thermal buffer	
Architectural object	Unilever Headquarters in Hafen City Hamburg, Germany, 2009 Behnisch Architekten a	
Architectural detail	ETFE membranes to form double facade b	
Work of art.	Glass sculpture to fill the window frame, modernization of Louvre Musee, Paris, France c	
Similarity features	_Formal appearance - piramidal forms; _Geometry; _Transparent building materials	

Fig. 4. Exemplary formal associations between thermal buffers on a contemporary office building and a sculpture for filling window framing in a historic building façade that underwent modernization.
Photos (a–c) by M. Celadyn (2015, 2017)
Source: author's drawing

Positive thinking about technical education in architecture studies allows the students to discover usually unperceived potential in building construction subjects. As some authors claim: e*ngineering thinking in design is close to creativity, and, it is of interest to find how engineering design ability develops during architecture education. Architecture creativity would overlap with engineering design creativity* [Avsec et al., 2018, p. 138]. The effects of these sometimes striking relations can be discovered in many contemporary objects where the novel technologies are the basis of architectural concepts at a very initial stage of designing (Figure 5). In such cases, knowledge and understanding of the newest technologies among architects is an indispensable requirement.

It is especially important and visible in sustainable architecture, not only in general spatial concepts but also in architectural detailing [M. Celadyn & W. Celadyn 2024]. Relevant examples should be deeply analysed and be used to encourage young architects, as well as architecture students, to appreciate, to a suitable measure, the instruction in technical subjects during their studies, and later during their professional career. As some authors say presently, *design success relies on cutting-edge technologies* [R. Damiani 2021, p. 13], therefore, such knowledge is of great importance for practicing architects and architecture students.

3. CONCEPTS FOR EDUCATIONAL INTEGRATIVE STRATEGY

The imbalanced relations in question can be assessed as disadvantageous, and they require in-depth analyses followed by the elaboration of ways to improve the situation. This would ensure a better quality of the graduates, given their future employment with architecture offices, and make them better prepared for competently undertaking a typical set of responsibilities. However, the modifications regarding this imbalance can be difficult given a standardized approach to the structure of the designing procedure respected in architecture offices. On the other hand, there is a ministerial directive compulsory for architecture schools, and it stipulates a workload structure corresponding to that of the realized therein. These contradicting attitudes practically make any substantial modifications to the educational program impossible. However, some changes within both modules (technical versus concept designing) in terms of methods of cooperation are quite possible. This idea is promoted by some professors and instructors at the Cracow University of Technology CUT. The present relations between the technical and concept designing courses resemble those conventionally seen in architectural programmes, with the precedence of the concept design followed by technical design. This reflects the curriculum in force at the Faculty of Architecture, Cracow University of Technology (CUT), however, it can be representative of other similar architectural schools in Poland and generally also in other countries.

There are expectations of uniting the courses ofconcept designs with technical designs. Such a method is frequently termed integrated designing. Some authors define it as follows: I*ntegrity means proper multilateral relations between institutes or, more precisely, relations between independent teams of teachers. The term, integrity, became important in numerous discussions between university teachers. However, there is a serious problem with this approach. Many important issues of construction (structures, installations, and generally the technical aspects of design) are absent during the conceptual phase. As a result of that, most projects could alter as a result of late conceptual changes* [R.A. Marcinkowski 2018, p. 406]. *Students get the impression that specialist knowledge does not apply to current projects and therefore is useless. Unfortunately, with the non-integrated teaching process, this impression is difficult to avoid* [R.A. Marcinkowski 2018, p. 407].

This statement seems only partly true because the student's attitude in this regard depends largely on the position of their concept design tutors concerning the role of the technical approach. Integrative cooperation mode has been realized in the school for some time and it involves the instructors of the course *building mechanics and structures* who participate in the development of concept designs in the form of parallel consultations. A similar method is also expected by some in the case of the subject *building construction.* However, this proposal proves highly controversial as this procedure is usually not realized in architecture offices and therefore, should be considered impractical as an educational method defining the relations between both subjects.

Due to this discussion and related controversies, new proposals for shaping these relations have emerged. Such answers have been worked out as part of this research and are intended to encompass four options covering the most probable and feasible solutions to the analysed problem. They are as follows:

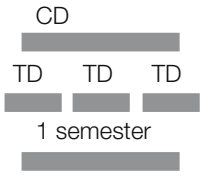
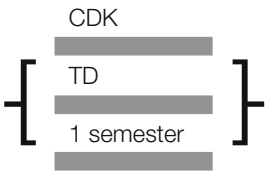
- Sequential method: technical design developed during one semester as a follow-up to the concept design developed in the previous semester;
- Intensified sequential method: technical design developed during the second half of the semes-

ter as a follow-up to the concept design developed in the first half semester;
- Fragmentary method: technical design developed partially (various fragments of concept design dependent on its advanced parts) parallel with concept design;
- Consultation method: one-stage concept and technical design consulted parallel with its development in the area of technical solutions.

The controversies among the teaching staff about the best method of discussed relations can be confronted with opinions expressed by students. A survey has been carried out among the students in the third year of study. Their opinions can be considered valuable due to their experience, which had been acquired by having worked on both stages of designs in previous years. The outcomes of this survey show that the vast majority of them, with only one exception, indicated the sequential method as preferred (Table 2).

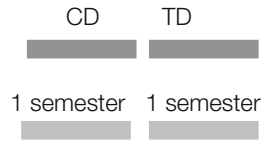
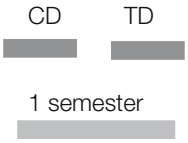
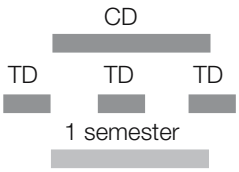
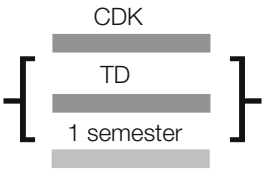
Another survey has been carried out among the doctoral candidates of CUT. They have acquired some professional experience because they work in architecture offices. Therefore, their opinions have a particular value as their retrospective views allow them to assess the educational process more objectively than current students (Table 3). They indicated the sequential method is as equally preferred as the intensified sequential.

Tab. 2. Undergraduate students' survey on the proposed integration methods and its outcomes

No.	Integration method	Temporal graphic diagram	Integration method`s description	Number of respondents	Preferred choice
1	SEQUENTIAL		Technical design developed during one semester as the next stage of concept design from previous semester	14	X
2	INTENSIFIED SEQUENTIAL		Technical design developed during the second half of semester as the next stage of concept design developed in the first half of semester	1	X
3	FRAGMENTARY		Technical design developed partially (different fragments of concept design) parallel with concept design	0	–
4	CONSULTATION		One-stage concept and technical design consulted systematically relative to technical solutions	0	–

CD – concept design, TD – technical design
Source: author's drawing

Tab. 3. Doctoral study students' survey on the proposed integration methods and its outcomes

No.	Integration method	Temporal graphic diagram	Integration method`s description	Number of respondents	Preferred choice
1	EQUENTIAL		Technical design developed during one semester as the next stage of concept design from previous semester	3	X
2	INTENSIFIED SEQUENTIAL		Technical design developed during the second half of semester as the next stage of concept design developed in the first half of semester	3	X
3	FRAGMENTARY		Technical design developed partially (different fragments of concept design) parallel with concept design	0	–
4	CONSULTATION		One-stage concept and technical design consulted systematically relative to technical solutions	0	–

CD – concept design, TD – technical design
Source: author's drawing

4. DISCUSSION

The outcomes of both surveys indicate that the sequential methods, although traditional, are considered by the responders to the survey adequate for the instruction method used in the educational system, assuring good quality of graduates. Especially the opinions of the doctoral candidates who should be capable of the objective assessment of the methods they have experienced are valuable. The consultation method, which is strongly advocated by some instructors, in their view, pretends to be more effective than traditional methods because it is supposed to help students better understand the project concept design during its development through the lens of related technical solutions. However, this method reveals some negative aspects, like the following:

- Incompatibility of design teaching with procedures in office work;
- Acquisition of habits that usually do not find practical application in the office;
- It dissuades students from the commitment to learn technical subjects by relying on the technical assistance of professionals in building construction, who are practically absent from professional spaces;
- Reassuring the false student`s conviction about the technical knowledge in architectural practice not being their competence.

One of the major problems in architectural education is the disinterest in the legal aspects of architecture among the teachers of concept design, who are convinced that it is the competence of the teachers of building construction, and not theirs to consider, despite a number of building regulations that should be applied at the stage of concept design. This makes their cooperation somewhat difficult. In the case of some trials to introduce this method into the educational process, the modifications to concept designs recommended by the participating instructors of building construction revealed errors and negligence concerningbuilding regulations committedby students under the tutelage of concept teachers. This illustrates the potential and already proven problems with the full introduction of the aforementioned methods. Theoretically, it is not a problem as proper corrections can

be made early in the project. However, knowledge of such a possibility may prove disappointing when working in architecture offices. The results of this research indicate that the presented methods of teaching architecture are disputable. However, they testify to the need for further analyses and surveys to be conducted, and a higher number of participating professionals who know best the shortcomings of the teaching systems. This would be beneficial for gaining better insights into the analysed issue and would make it possible to better compare the educational outcomes of the models presented above. The research concerned the mutual relations between concept design and building construction design as a further stage of the design procedure. Another problem refers to the structural design, which was not considered in this research. The reason is that in every method, it is embedded in the concept design, which seems advantageous and does not raise doubts. A structural approach to concept design at the preliminary stage, in a proper measure, could certainly bring positive results.

CONCLUSIONS

It has been proven that there are significant discrepancies between the architectural practice and the educational systems in the field of architecture in terms of the technical knowledge required from professional practitioners and the students of architecture studies. These should not be accepted for the reasons of the creation of high-quality contemporary architecture, which is presently associated with the implementation of novel, demanding technologies. The relations analysed in this paper are also meaningful from the viewpoint of the necessary collaboration of architects with other interdisciplinary professionals forming design teams. A suitable body of technical knowledge possessed by architects always makes this collaboration possible and effective.

The study gave a general overview of the students' attitude toward the meaning of technical subjects in the architecture education curricula. It should be said that the integrity issue within architecture studies emerges frequently. However, it is comprehended in somewhat different ways.

The differing views concerning the undoubtedly important problem of integration of subjects in the curricula of architecture schools prove the difficulties in taking a unified, definitive stand on this issue. The research has focused on only one of the set of related questions. The analysed opinions of various teachers and specialists involved in this area should be confronted with those of students on different levels of education, as they see these problems from a different perspective, as do the doctoral candidates. Their opinions turned out to be somewhat unexpectedly conservative but realistic and worthy of taking account of in the discussion about the teaching methods in the discipline of architectural design.

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