Architectural technology: Education objectives

Radu Sfintes[1] and *Anda-Ioana* Sfintes[1*]

[1]"Ion Mincu" University of Architecture and Urbanism, Center for Architectural and Urban Studies, 18-20 Academiei Street, 010014, Bucharest, Romania

Abstract. Architecture requires many aspects to be considered – during research, concept development, detailing, construction and even post-occupancy. Not many architects nowadays see to all the aspects mentioned as it is easier and sometimes better to collaborate with architects specialised in each area. However, knowledge about each aspect (and most of all understanding the importance of each in the whole building process) is essential in order to corroborate information and thus assure the quality of the final product – the building in use. An important question arises in an architecture educational environment: which aspects must be considered as core elements to be taught? We wish to set didactic objectives of architectural technology and follow specific pedagogical methods that underline its specific role in an academic environment, but also its role of reaffirming, refining and enriching the design. Beyond its obvious constructive role, architectural technology can be regarded as a tool along the various phases of design, including post-occupancy. Its approach as such throughout the years of study has an undeniable effect upon its understanding and further application in practice. Also, how architectural technology is taught and guided can contribute to the achievement of general competences and abilities linked to the general didactic objectives of a school of architecture.

1 Introduction

Architects must have knowledge of many aspects, related not only to the design and construction of buildings in particular. Every step in the design process requires other information to be considered. Let us take for example the design of an ordinary building. During research, they must read, analyse and understand the context, in terms of history, socio-demographics, in political and economic terms etc. They must also know about, or research, various aspects regarding the function of the future building, the key aspects of the program, the challenges and trends. During concept development, they must possess knowledge that helps them frame the concept in correlation to the theme and scope of the future building, they must synthetize information and know how to best sketch their ideas. They must also know how to present their concept, both in words and drawing. Further, they must know about relationships between spaces, about needs in terms of space, dimensions, light, air etc. for each space, and some of these aspects result from the particular research

* Corresponding author: anda.sfintes@gmail.com

carried out previously, not necessarily from regulations, norms or design guides. Configurations, elements of design, materials used will have impact upon use and perception, thus that also requires particular sets of information to be known. Knowledge about materials and systems, about how they work together, is also essential during detailing. Knowledge about how these can be laid, or about how they behave in time, can make a great difference in the process of construction or post-occupancy.

Not many architects nowadays see to all the aspects mentioned [1] and that is usually a good thing as collaboration with other architects or professionals specialised in other domains or areas of study can lead to a higher quality of the design and the building. However, knowledge about each aspect (and most of all understanding the importance of each in the whole building process) is essential in order to corroborate information and thus assure the quality of the final product – the building in use. Moreover, true architecture resides in how all these aspects merge in a coherent discourse, concept, design and built object, seen and understood in its complex context. Beyond aesthetics and functionality, architecture is used, experienced, perceived. As Pallasmaa states: "Architecture arises from purpose, not from a desire to make an aesthetic object. Architecture has fundamentally a multiple essence in being utility and expression, technique and metaphysics, reason and poetics, aesthetics and existential concerns, all at the same time" [2].

Specialisation is the result of the complexity assumed by each phase and the need of possessing a vast intelligence that goes more in depth of the subject matter than in breadth. However, in an educational context, this problem raises important questions regarding which aspects must be considered as core elements to be taught. In part, the answer to this questions depends on the specificity of the school of architecture, some being more conceptual, others more technical. Moreover, the main answer resides in the settlement of educational objectives, many being shared among various institutions. The objectives themselves are based upon the settlement of sets of competences and skills relevant inside the disciplines, but also in regard to the society at large. Architecture education, thus, assumes preparing future professionals to deal with various situations they will face in practice, but, more than that, preparing them to manage a self-process of dealing with new and challenging conditions. Besides learning how to design and gaining other competences and skills related to designing, architects should become "more adaptable, flexible and versatile over the span of their professional careers", given that, as new professionals, they "are likely to have to update their knowledge and skills many times over a lifetime" [3], following the rapidness of advancements and changes in current society.

Going back to Pallasmaa's understanding of the essence of architecture, we find that things are even more complicated as architecture is also art, thus doing architecture also requires talent, intuition, creativity, the capacity to interpret things, to give meaning and so on. While it is hard to impossible to master all the aspects discussed so far, we consider essential the capacity to understand and negotiate the elements in a coherent approach.

Uta Graff describes best what being an architect means in the context of our paper – she considers that "The integration of scientific, design, and technical aspects in a convincing holistic work is the achievement of a thinking and acting architect" [4]. In this paper we focus upon the didactic objectives of architectural technology, regarded as integral in the larger context of educational objectives in teaching architecture. Architectural technology has an important role in reaffirming, refining and enriching the design. A technical approach can just as well be creative in its solution or in the way it relates to the whole, in how it reflects it or augments it. The technical solution contributes to how a building is perceived, thus it entails emotion just as much as it is vital for the good behaviour of the building over time or even for its health (if we consider, for example, systems that allow the building to breath). Technical solutions can shape spaces, if we see them as constraints, or be the result of how a space is shaped, if we search for solutions that respond to certain needs [5]. In the end of this argument we can dare to look even further, at innovative solutions that take technical aspects at another level and make them a generative part of the process. We can give as example the approach of transforming the material into a form-generating parameter in computational design [6], thus the material dictates the form.

These are all desired outcomes in the form of skills and competences that architects should have or aspire to, as they specialize. The school of architecture should set the tone for such aspirations and, in this context, we shall identify didactic objectives of architectural technology, following specific pedagogical methods that underline its specific role in an academic environment. The aim is that of highlighting the way architectural technology can contribute to general didactic objectives and of shading light on how technical aspects can be taken into consideration more, and given a greater importance, in schools of architecture, during any step of the design process. Curricular and extracurricular activities coordinated or tutored by us are taken as examples of applied methods and substantiate the results and conclusions of the study. The shared view of the co-authors that otherwise are on the two sides of the story – one tutoring technical disciplines and the other being a tutor in a design studio – can help frame an approach in which students can be guided towards understanding how various aspects of design can work together, leading to a coherent and meaningful understanding of the profession.

2 Educational objectives

In a certain degree, all the competences and skills mentioned above should be approached during the years of study. What can be debated is the depth and breadth, from the hours of study dedicated to each to the way the various disciplines are correlated inside the curricula. Some aspects should be learnt (obviously the fundamentals), other aspects should be understood (like various principles), some tested (working with different systems of construction, with different materials), upon others the students should be able to reflect (critical positioning in certain contexts), and some can be the result of individual study and work (like learning to use certain software, or finding one's own way of expression in drawing). The skills acquired range from abstract to concrete [7], from questioning and challenging issues, ideas, programs, contexts etc. to applying/implementing. Through them, designing assumes first of all framing and reframing, the entire process of designing being defined as an "adaptive creational process" [5] between and across the various phases of design, from research, to concept development, detailing, construction and, in the end, post-occupancy.

Based upon an analysis of the educational objectives embraced by the university we teach at, as applied in the architecture studios, we identify a set of objectives that will further become the ground for discussing how technical disciplines can be part of an integrated approach. The university is neither technical, nor an art school; it considers architecture in its own right, but it is, however, inclined towards preparing its students first of all for current practice.

With a different distribution among the years of study, the educational objectives follow:

1. knowledge and understanding of distinguished examples;
2. knowledge and understanding of typologies;
3. knowledge and understanding of various programs and issues, as well as developing the ability to research them;
4. developing the ability to identify and carry on relevant analysis for the project;
5. developing the ability to understand and work with particularities of the site and of the context;
6. developing the ability of framing the concept of the intervention/design;
7. developing the ability to design the architectural solution;

8. working with various functions, types of structure, constructive systems, materials etc. in relation to the program, the context, the key issues of the design;
9. integrating technical aspects into the design;
10. developing the design in correlation to the financial possibilities of constructing the building, as framed by the real or imagined scenario;
11. understanding and implementing sustainability;
12. designing according to norms, or at least in knowledge of norms and possibilities of amendment in relation to the design scenario;
13. training towards actual practice;
14. training in the use of a specialised language and thought;
15. training in the use of graphic forms of expression;
16. training critical thinking and the ability to synthetize information;
17. training creativity and innovative thought.

Architecture studios assume, by default, the integration and use of knowledge acquired by studying other disciplines or topics, inside or outside the university. However, just as it is impossible to master all the specialisations, it is impossible to implement or develop all the aspects assumed by the didactic objectives at the same level of depth or detail. That is why a design needs a leading concept, establishing key aspects to which everything else must be related to [8]. Coherence comes from establishing hierarchies and from a deep understanding of the role each aspect has in the developed scenario. This also means that every aspect must be at least reflected upon, in order to understand the potential impact of its consideration or neglect. That is why we advocate for integrated approaches among disciplines (involving various professionals, specialized in various fields of study), in order to understand more fully the extent of the impact and/or problems generated by the proposed design and its elements. In this context we shall follow objectives of architectural technology, identifying the ways that a more focused understanding and discussion of technological aspects can contribute to reaffirming, refining and enriching the design. In fact, such an integrated approach, and the objectives we shall frame further, has as underlining argument views upon (the future of) architectural education and profession some stated many years back [9], but still valid, as architects in practice and education highlight [10]. These views give a crucial importance to skills otherwise considered general in nowadays society – like decision-making, complex problem solving, active learning, or critical thinking [11] –, not to mention interdisciplinary knowledge and collaboration as vital in solving the wicked problems architecture usually faces [5].

3 Objectives in the context of architectural technology teaching and mentoring

Architectural technology is one of the concrete design aspects – "[it] relates to the anatomy and physiology of buildings and their production, performance and processes" [12]. It is a complex area of study, at the intersection of science, engineering and technology, and it brings into question important issues of responsibility as it is directly linked to the actual construction (how? with what?) and use (physical impact) of the building. However, as we stated before, technological aspects also have an aesthetic impact, an impact upon perception, as well as an influence over the physical and psychological well-being of the user. In a general discourse, these aspects are not always linked to architectural technology – choosing a certain material for a façade can just be an issue of aesthetics, or of message to be transmitted through the image. We consider that acknowledging the role of technological issues even just as secondary in every aspect of design is a matter of coherence and complexity, a way of assuring a process of informed decision-making. Despite what less experienced researchers (including architecture students as researchers) may consider, dealing with a greater amount of information does not complicate the process of decision-making; it rather brings together a greater array of issues that, if synthetized and prioritised accordingly (in a process of critical thinking), can further facilitate the task of solving wicked problems. Flexibility and adaptability is the result of a coherent approach that uses enough organically linked data, enabling more than one way of dealing with a problem. The problems themselves must be regarded in the larger context of global challenges that blur boundaries between objects, services and processes, while needs and requirements become more complex and wide-spread.

Now let us go back to de educational objectives and discuss how they can be correlated with aspects of architectural technology.

Objectives 1-3. Previous examples, typologies, as well as case studies more specifically focused on the program or the project to be developed are a first and very good way of understanding architectural technology put in practice – understanding what systems, materials, technological assemblies work in various contexts, how and why. Moreover, such an analysis is a way of training the ability for critical thinking as long as the examples are questioned and confronted against the requirements of the project to be developed (Objective 16).

Objectives 4-6. Analysing the context following relevant topics of inquiry, identifying the particularities of the site and of the context and developing a strategy for intervention and a concept can also be addressed through aspects of architectural technology as so many discussions around the topic of specificity prove. For a building to integrate into a particular context it is not necessary to replicate certain details or to use the same systems or materials; it rather is about critically understanding their use and arguing for a solution after acknowledging what that use implies and entails – for the context, for the site, and for the program.

Objectives 7&8. The same judgement can be taken further while developing the architectural solution and deciding the technical details of the project. Now it would be about acknowledging what that use implies and entails for the building, for the way it will be exploited and how it should behave. An assessment can be made concerning how the building and its spaces receive natural light, how they are ventilated, how the systems and materials contribute to the thermal mass, or to the general health of the building and so on. How changing elements of a technical nature influences the general design, its message, or its intent should also be considered.

Objectives 9-13. Some of the educational objectives are from the start more channelled towards a technical conception – like those related to costs, sustainability, designing according to norms, or as in actual practice. Others can be directed towards a technical understanding – like learning to correctly use technical terms, or learning to graphically express an idea through proper technical drawings (Objectives 14&15).

Objective 17. The last educational objective to be discussed addresses creativity and innovation. Architectural education by its nature “should nurture in its graduates the ability and self-confidence to challenge the current boundaries of the discipline and contribute to its development” [13]. The technological aspects of architecture are by far the most challenging and demanding, in need of constant innovation in order to keep up with the rapid changes and demands of the society, as well as with the rapid scientific and technological advancements from other disciplines as well. In school (and not only), the development of such an ability starts with raising questions like ‘what if this element could do that?’ or sometimes with the wish to improve something that does not work well in a particular context.

In this train of thought, next we shall present methods applied during curricular and extracurricular activities, like workshops, webinars, talks, gatherings and guided exercises, that aimed at achieving such objectives. The flexibility of the approach applied along a couple of years proved its success and it revealed outcomes to be further exploited and developed.

4 Methods applied in curricular and extracurricular activities

During curricular activities it is easy to identify both singular or general knowledge gaps, as well as needs of further explanations. Teaching also means addressing these problematic issues and some can be addressed during those activities, while others need more extensive clarifications. Extracurricular activities are more flexible and can be easily directed towards what is needed, but they can only gather those interested in the subject. The truth is that not many are interested in focusing on technological aspects of architecture in particular, and those that are usually are driven by the fact they wish to practice or already practice as interns. This issue underlines the need to change perception and make architectural technology more present, also in a way that supports other disciplines, first of all the design studio.

We are actively concerned with bridging gaps between studio approaches and technical disciplines, as well as with closing gaps in technical knowledge, through various activities and by using dynamic teaching and mentoring methods. Next, we shall highlight the key aspects of these methods, following the educational objectives mentioned before.

Objectives 1-3. We named investigating examples as an instructive task that can help students both understand and identify technical details that they could implement in their designs. During both curricular and extracurricular activities, they are encouraged to research solutions used in similar conditions, and to argue how and why elements of those systems would be appropriate for their project. Many times, the systems are not understood based only on the drawings and images, and in this case videos are used as support; watching videos of building sites is not only informative, but that also brings the students closer to practice. They are asked to find their own videos, but those are always discussed critically, as many could present faults. Asking the students themselves to comment is an important lesson that trains the ability to observe and critical thinking (Objective 16). The same is done with various pictures, captured in ordinary situations rather than found in architecture books, magazines or websites; those are a better teaching material for architectural technology disciplines as they also highlight the responsibility associated with correctly solving a system or detail. Making connections to everyday experience is also important in this regard, as students become more cautious with what they propose when they realise that some of the faults they bump into regularly are, in fact, design faults. Besides all these, visiting building sites and building materials stores, factories and showrooms, organizing presentations and discussions with building materials producers and distributors add up to knowledge of a more concrete nature.

Objectives 4-6. The particular context of the project has a lesser impact upon the technical issues of a project. It can sometimes impose the use of certain materials, of certain systems, especially in the case of interventions on heritage buildings or areas. Otherwise, is a flexible matter and architectural technology, in this context, can support the framing of a general context for intervention. What we do, in our activities, is to encourage free discussions that broaden the context around particular issues, taking into consideration the potential impact of certain technical aspects. In such dialogues, aspects otherwise neglected emerge and the decisions taken further can be more informed.

Objectives 7&8. During the phases dedicated to developing the architectural solution and deciding the technical details of the project, we consider vital the students' understanding of the technical aspects they could implement. Together with the students, we try to break down every complex issue into simpler elements, with the aim of making well understood the principles in use. This way, students gain flexibility in thought and train their ability to change solutions by themselves, in parallel with changes of the design that may result during the studio. Also, potential solutions are always argued and discussed both with tutors and colleagues. When colleagues intervene, the others have a better perception upon the solution discussed, they tend to consider it less complicated and become better motivated to continue the argument and search for the best solution.

Objectives 9-13. Matters of cost are not usually discussed in academic contexts, and even more rarely taken into consideration. Complexity and coherence of a design are considered more important. However, we try to address and balance costs and designs when we identify big discrepancies between the project data and the concept. Sustainability, designing according to norms, or as in actual practice, on the other hand, are approached more often in the studio. There are a couple of concept designs that can neglect these matters entirely. For other projects it is known from the beginning that the studio proposal will be elaborated into a technical project. For these, we require the students to argue solutions by referencing the norms in use. This way, they gain the ability to search for the needed information, to prove their arguments and to work inside the boundaries of various regulations, to understand and interpret the norms.

Objectives 14&15. Learning to correctly use technical terms, and learning to correctly draw technical drawings are two vital objectives for architectural technology. In our activity, we consider very important acquiring the necessary technical vocabulary. Along the years, we noted that students master slower the use of technical terms, so we frequently address the proper use and form of words. Following the observation that, although they learned a term during other classes or in other activities, students don’t make a connection between information, we often try to frame a broader context for the understanding of architecture through common points across disciplines. Regarding technical drawing, we underline the importance of a correct drawing as the responsibility to make oneself understood especially in the context of a blueprint that should be used on the construction site. Students have a liberty in finding their way of expression as long as the correct drafting principles are applied.

Objective 16. Critical thinking is one of the skills that can easily be developed in various situations and around any topic. Even during curricular activities, dynamic and less formal interactions are the best way of encouraging students to question any topic, to try to find solutions in a continuous flow of ideas that are judged against relevant criteria. Our methods imply an active involvement of the student in the educational process: students sometime take the role of teachers, under supervision. This way, they are also empowered, and the teaching process becomes less assertive. Also, discussions are held with small groups of students, about the project of a colleague – they must observe, analyse, raise questions, try to understand the project and propose helpful solutions. We underline the idea of small groups, as speaking among 3-4 peers is less overwhelming, and the setting becomes more friendly and encouraging.

Objective 17. Creativity and innovation are fostered in certain contexts, first of all in open, dynamic and flexible environments. What we do in this regard is to encourage multidisciplinary discussions and communication starting from topics that are familiar to the students, or, even better, from topics less related to architecture, that they are interested into. These often become starting points in discussions among themselves and so they start collaborating, helping each other. One of the most successful initiatives we had was to found a messaging group that became a sort of support group in matters related to architectural technical aspects. Under supervision, students start debates, or share information. In such an interaction, issues, gaps, biases, trends become evident and they can be further addressed in curricular and extracurricular activities. Identified subjects of interest can become anchors in engaging students in other activities. All these methods foster creativity and stimulate innovation first of all because the ideas and initiatives come from the students themselves.

Educational objectives are important guidelines that ensure the achievement of skills and competencies. The methods that can be applied in this regard are varied and depend both on the individuality of the teacher and of the students. Flexibility and ongoing adaptability of these methods ensure their success. Architectural technology tends to be considered more rigid given its concrete character, but what the applied methods described above prove is that principles can be understood in more dynamic ways. They can be broken down from characteristics of specific designs, not necessarily learned as such. We observed that such an approach draws students nearer to technical disciplines with which many times there is rather a love-hate situation during studies. Only just in practice the graduates realize the importance and responsibility associated with architectural technology. This is why we consider important a change in perception and attitude, by integrating architectural technology objectives and approaches in a broader context.

5 Conclusion

Beyond its obvious constructive role, architectural technology can be regarded as a tool along the various phases of design. Its approach as such throughout the years of study has an undeniable effect upon its understanding and further application in practice. Links between disciplines are mandatory in comprehending the various components of architecture as pieces of a mechanism/organism. At the same time, connections made between experiences, knowledge and information of any kind ensure the assimilation of various data, concepts, principles and their further use in meaningful and personal ways. Links to current practice and everyday situations, even more in the case of technical issues, bring into the teaching experience the manifold complexities of reality that give purpose to design.

As we have seen in this paper, we consider that objectives of architectural technology disciplines would benefit from a change of perspective. Through the methods described in the previous section, we argued that how architectural technology is taught and guided can also contribute to the achievement of general competences and abilities linked to the general didactic objectives of a school of architecture.

Curricular, as well as extracurricular activities like workshops, webinars, talks, gatherings and guided exercises, at which both students and practitioners participate, can be regarded as reference points in a continuous process of dynamic education and active learning. Outcomes of such activities can be further exploited, followed up and developed during subsequent events.

All the aspects discussed so far point that students can be guided towards understanding how various aspects of design can work together. This leads to a coherent and meaningful approach of the profession, but it also sets the tone for creativity and innovation. A deep comprehension of connections between issues of various natures can further lead to innovative approaches. Many trends in architectural thought and examples of excellence in architecture are based upon advancements in architectural technology. We name, for example: performative architecture that can change and adjust according to needs or desires, morphogenetic designs where buildings change with season, or dynamic architecture that can respond to environmental forces.

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